RAMBOLL ENVIRON

ENVIRONMENT & HEALTH

Matthew Sprott
Resource Assessments
Department of Planning & Environment
GPO Box 39
SYDNEY NSW 2001

UNITED WAMBO OPEN CUT COAL MINE PROJECT AND HUNTER VALLEY OPERATIONS MODIFICATION 5 – CUMULATIVE AIR QUALITY IMPACT ASSESSMENT PEER REVIEW

Date 21/07/2017

Ramboll Environ
Level 3
100 Pacific Highway
PO Box 560
North Sydney
NSW 2060
Australia

T +61 2 9954 8100
F +61 2 9954 8150
www.ramboll-environ.com

Dear Matthew,

Ramboll Environ Australia Pty Ltd (Ramboll Environ) was engaged by Department of Planning and Environment (DPE) to undertake an independent peer review of the Air Quality Impact Assessment (AQIA) reports undertaken by Jacobs Group (Australia) Pty Limited (Jacobs) for the United Wambo Open Cut Coal Mine Project (SSD 7142, hereafter UWOC) and by Todoroski Air Sciences (TAS) for the Hunter Valley Operations South Modification 5 (PA 06_0261 MOD 5, hereafter the HVOS) at the existing Hunter Valley Operations South Coal Mine.

As part of the peer review, DPE have requested that the assessment of cumulative impacts from the two coal mining projects be reviewed in light of inconsistent results at the same receptors between the two AQIA reports.

This report provides a summary of the cumulative assessment review undertaken and the recommendations for future analysis.

1. Differences in Predicted Concentrations

Predicted concentrations at surrounding sensitive receptors and across the modelling domain contours were reviewed. Based on the predicted concentrations presented in the two assessment reports, the pollutant and averaging period that was easiest to compare was cumulative annual average PM_{10}. Cumulative 24-hour average PM_{10} concentrations were not presented for all receptors in both reports and therefore could not be readily compared.

Cumulative annual average PM_{10} will therefore be the focus of the results analysis in this report, with the reported concentrations from each air quality assessment extracted.

Further, the two assessments present concentrations for a different set of future years. The UWOC assessment presented predictions for the future scenarios of Year 1, 6, 11 and 16. The HVOS assessment presented future scenarios Stage 2 (Year 2022) and Stage 3 (2026).

Ramboll Environ Australia Pty Ltd
ACN 095 437 442
ABN 49 095 437 442

Assuming a start year of 2018 for UWOC, Year 6 equates to 2023. For the purpose of this review of predicted cumulative impacts, it is assumed that Year 6 of UWOC and Stage 2 of HVOS are roughly concurrent. The Year 6/Stage 2 cumulative annual average PM_{10} predictions are the focus of this review.

For initial reference, colour coded Year 6/Stage 2 cumulative annual average PM_{10} concentrations are illustrated in **Figure 1** and **Figure 2** for UWOC and HVOS respectively.

In addition, the sensitive receptor locations from each assessment were compared. Receptor locations that were used on both assessments, and the relevant concentrations predicted at those locations, were extracted. The difference between predicted cumulative annual average PM_{10} concentrations between the UWOC and HVOS assessments were calculated and are illustrated in **Figure 3** with a negative difference indicating that predicted concentrations were higher in the HVOS assessment and a positive difference indicating higher for the UWOC assessment.

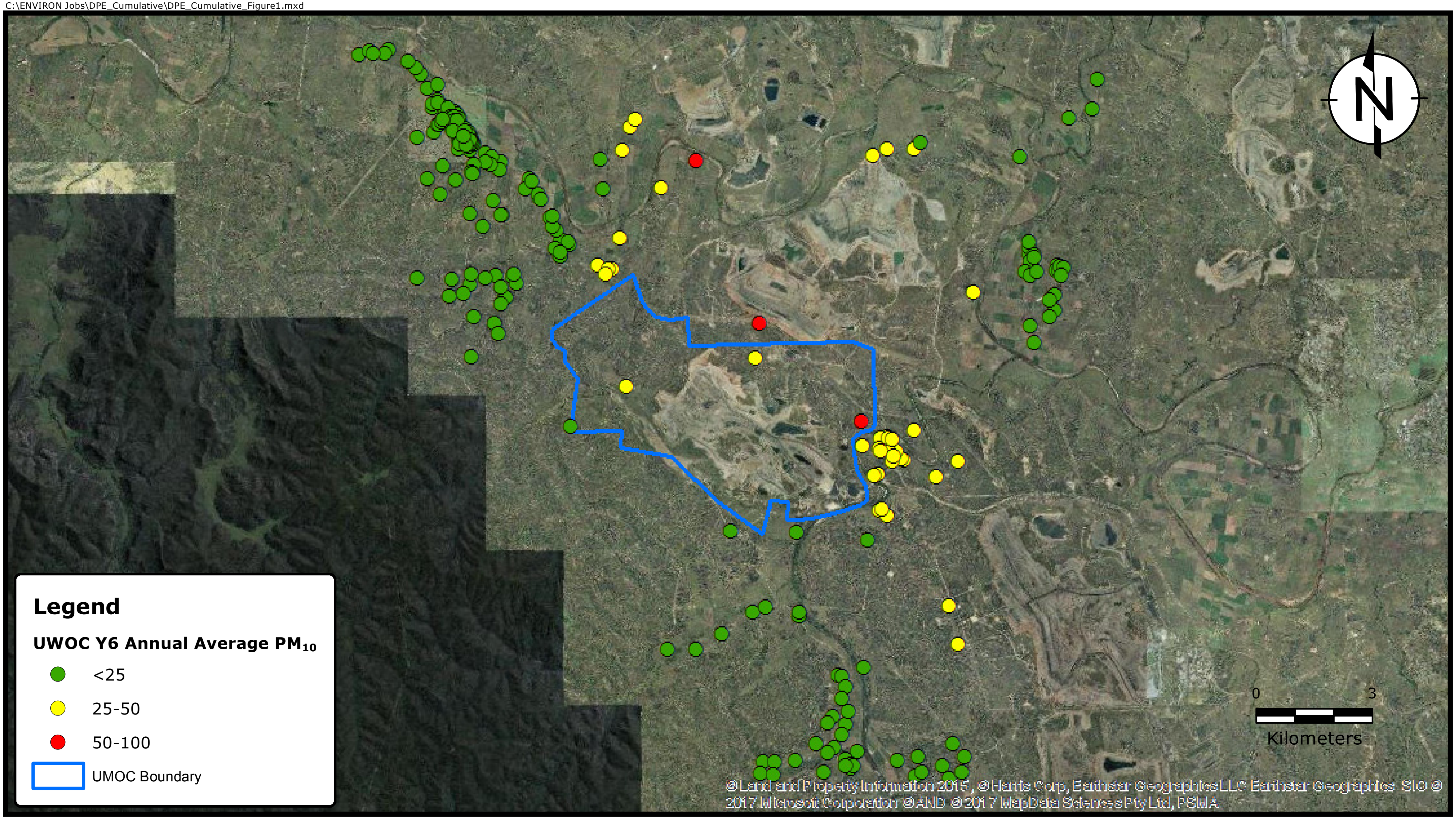
It can be seen from the results presented in **Figure 1**, **Figure 2** and **Figure 3** that notable differences in predicted cumulative annual average PM_{10} concentrations exist between the two assessments. The largest differences between the two assessment predictions occur to the east and west of the HVOS boundary (out to approximately 3km), where the HVOS assessment predicts higher concentrations, however there are also notable differences to the east (Warkworth village) of UWOC.

Reasons for these differences in predicted concentrations may include the following:

- Input emissions inventories for modelled mine sources;
- Background data approach;
- Meteorological modelling and inputs; and
- Dispersion model configuration.

The following sections provide discussion of the potential reasons for differences between the two assessments and lists recommendations for improvement.

C:\ENVIRON Jobs\DPE_Cumulative\DPE_Cumulative_Figure1.mxd



RAMBOLL ENVIRON

DRAFTED BY: SF | DATE: 14/07/17

United Wambo Open Cut

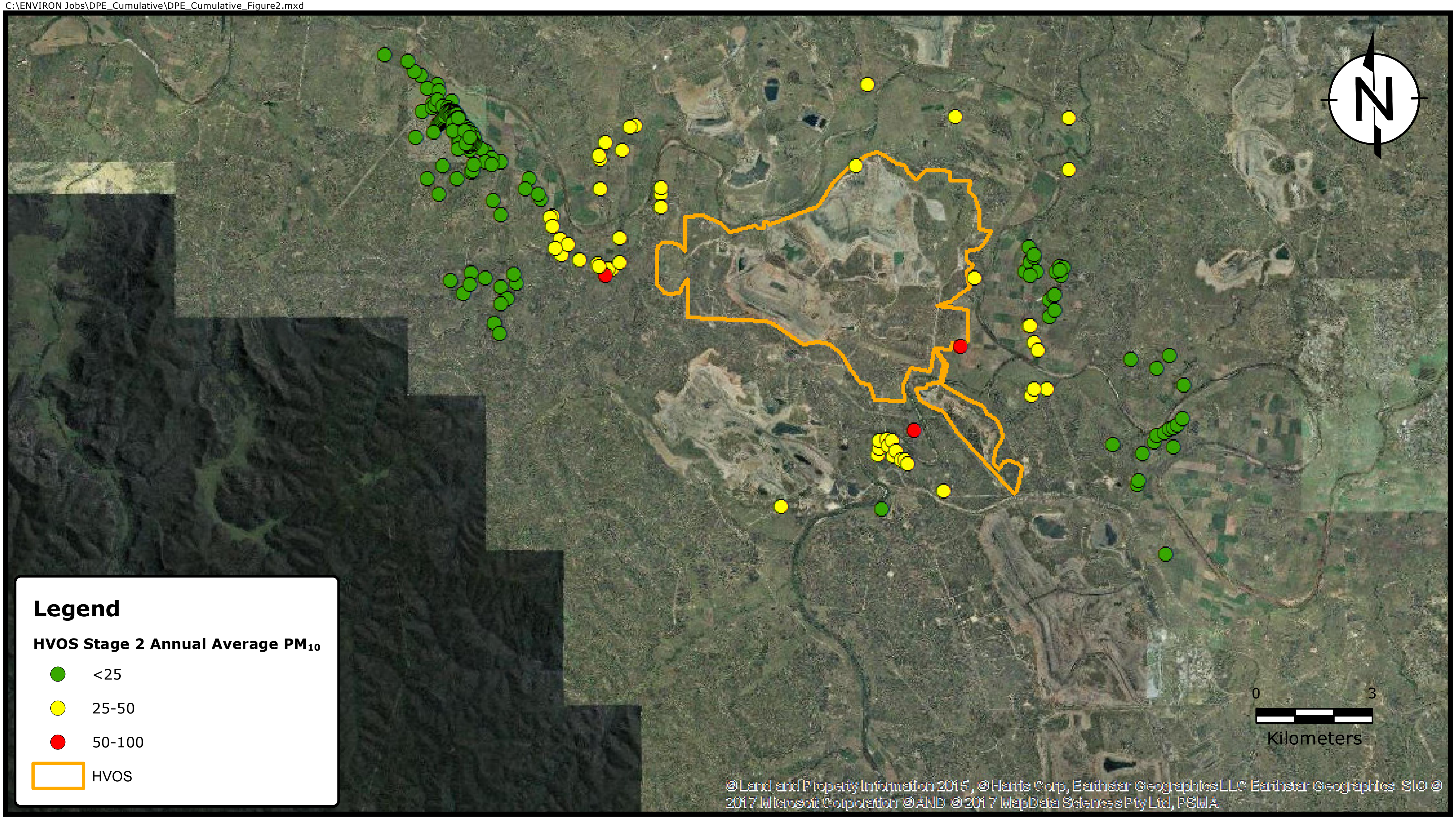
Predicted cumulative annual average PM_{10} concentrations

YEAR 6 Operations Scenario

FIGURE 1

AS122042

C:\ENVIRON Jobs\DPE_Cumulative\DPE_Cumulative_Figure2.mxd



RAMBOLL ENVIRON

DRAFTED BY: SF | DATE: 14/07/17

HVO South MOD5

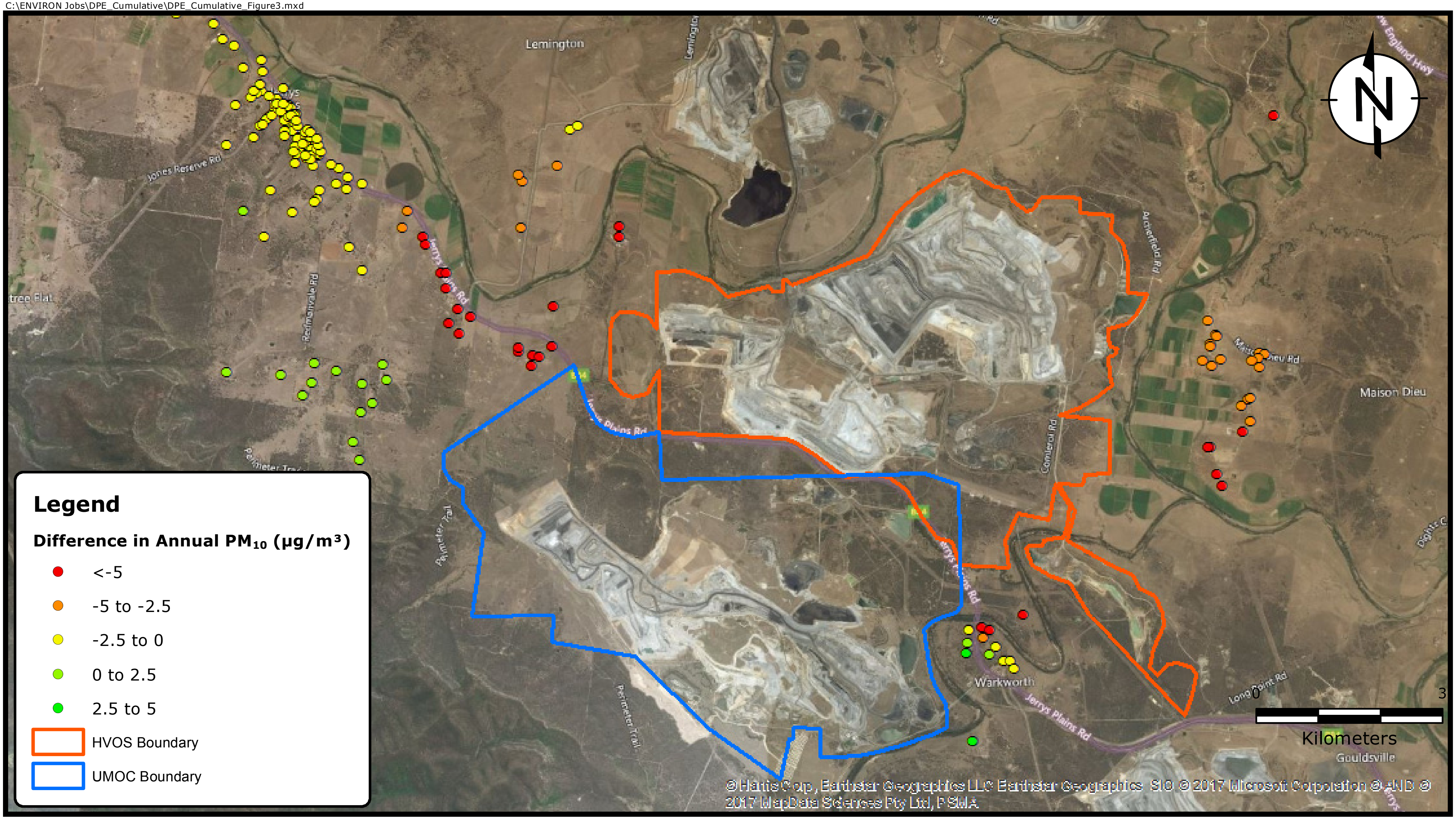
Predicted cumulative annual average PM_{10} concentrations

STAGE 2 Operations Scenario

FIGURE 2

AS122042

C:\ENVIRON Jobs\DPE_Cumulative\DPE_Cumulative_Figure3.mxd



RAMBOLL ENVIRON	**United Wambo Open Cut vs Hunter Valley Operations South MOD5** Difference between predicted cumulative annual average PM_{10} concentrations (negative = HVOS>UWOC; positive = UWOC>HVOS)	FIGURE **3**
DRAFTED BY: SF / DATE: 14/07/17		AS122042

2. Input Emissions Inventories

It is considered that the primary reason for difference in predicted cumulative results between the two assessments is the adopted particulate matter inventories for neighbouring mines. In particular, the inventory for the UWOC is notably different between the two assessments. TAS (2017a) notes that due to the timing of the HVOS assessment, an approximation of the UWOC emissions inventory had to be made based on preliminary information. This was ultimately shown to be 70% to 80% higher than the emissions presented in the UWOC assessment.

In addition to the differences between quantified emissions, the included neighbouring mines also differs between the two assessments. The UWOC assessment included emissions from the Wambo Harmonsiation Modifications; Hunter Valley Operations (south of river plus Carrington) and Mt Thorley Warkworth (north of Putty Road only). The HVOS assessment included emissions from the Wambo (including UWOC); HVO North, Rixs Creek; Ravensworth Operations; Ashton; Integra and Glendell mining operations.

These difference highlight a key issue for the assessment of cumulative impacts in the region, in particular at the Warkworth village. Consistency is required in the included neighbouring modelled mine inventories to better understand likely cumulative impacts. It is noted that in a review of cumulative methodologies for the EPA, Ramboll Environ presented case studies for the Hunter Valley and provided some recommendations for consistent approach to including other sources in cumulative assessment. Although this report has published by the EPA (Ramboll Environ, 2015), recommendations have not yet been incorporated into updated guidance, such as the Approved Methods for Modelling and Assessment of Air Pollutants in NSW.

To achieve consistency across the two assessments, cumulative analysis of impacts should be conducted using the same emissions databases for the two projects (UWOC and HVOS) and include the same surrounding mines. At a minimum, it is considered that mining emissions for each year selected from the following operations (as applicable to that year) should be quantified:

- Mt Thorley Warkworth (both sides of Putty Road);
- HVO North;
- Ravensworth Operations;
- Ashton Coal;
- Mt Owen Complex; and
- Rix's Creek and Rix's Creek North.

Annual emissions inventories for each included mine (not including the HVOS and UWOC emissions inventories) should be derived in a consistent manner. One possible approach similar to that presented in Section 5 of the NSW EPA-commissioned *"Upper Hunter Air Quality Particle Model"* (PEL, 2014) should be applied. This approach involves using published emission inventories from air quality impact assessments to derive a particulate matter/ROM coal ratio for each mine, and applying this ratio to future projected ROM coal production (if an emission inventory for the assessment year is not already available). If the future projected ROM coal production is not known, the future ROM coal production values provided by the NSW Department of Resources and Energy and presented in PEL (2014) can be used.

Emission quantification should first be completed for the base year (2014 from the two assessments reviewed). The future years to be assessed should be selected in collaboration between the consultants to determine the year(s) of likely maximum impact at surrounding receptors, with particular consideration given to the Warkworth village.

Recommendation: Emissions from neighbouring mine sites should be quantified in a consistent manner for matching current scenario year and future years. Future years should be selected collaboratively to ensure potential worst-case impact years are accounted for.

3. Background Data Selection

The approach to representing non-modelled mining sources for cumulative impacts differed between the two air quality impact assessments.

The UWOC applied daily varying concentrations from the Wambo AQ03 monitoring station, adjusted for 2014 operational emissions from the UWOC and modelled neighbouring mines (as per previous section), to obtain a background PM_{10} dataset. Background $PM_{2.5}$ was derived by applying a fixed ratio to the NSW OEH Camberwell monitoring dataset.

The HVOS derives a "non-modelled" background by subtracting the modelled contribution of HVOS and neighbouring mines (as per previous section) from a specific monitoring location depending on the location of the receptor in question.

While there is merit to both approaches applied, the different methodologies would return different background concentrations and has likely contributed to the difference in cumulative result predictions between the two assessments.

To illustrate this point, the NSW OEH Jerrys Plains monitoring station is located approximately 11km northwest of the UWOC and 10km west-northwest of the HVOS. Due to separation distance and dominant wind direction patterns for the region, the station is considered to be a useful indicator of particulate matter concentrations in the Upper Hunter Valley out of direct influence of mining operations.

The recorded annual average PM_{10} concentration for 2014 at the NSW OEH Jerrys Plains monitoring station was 18.2µg/m³, and ranged from 15.5µg/m³ to 18.6µg/m³ between 2013 and 2016. For 2014 operations, the cumulative annual average PM_{10} concertation predicted at the Jerrys Plains monitoring station in the UWOC assessment was 16µg/m³, and 14µg/m³ at receptor 438 (approximately 700m east of the Jerrys Plains station) in the HVOS assessment.

This difference between measured and predicted cumulative concentrations highlights the need for a consistent approach to accounting for background concentrations to address cumulative impacts.

One approach could be to adopt a single regional monitoring dataset that is considered representative of background conditions in the Hunter Valley excluding significant contribution from existing mining operations that are included in the modelling. It is the opinion of Ramboll Environ that the NSW OEH Jerrys Plains monitoring station could be adopted as such a monitoring site, with justification given on the following basis:

- Jerrys Plains monitoring station is located to the west of significant mining operations in the Hunter Valley region and for the most part out of alignment with the dominant northwest-southeast alignment of wind direction in the Hunter Valley;
- Project-only predictions in both the UWOC and HVOS assessments at the Jerrys Plains monitoring station (or Receptor 438 in HVOS assessment) show that the contribution from either project is low (e.g. annual PM_{10} and $PM_{2.5}$ is 0µg/m³ from UWOC and between 0µg/m³ and 3µg/m³ from HVOS). These results indicate that these mining sources are not the key contributors to recorded concentrations at Jerrys Plains;

- Review of concurrent monitoring results at the Jerrys Plains and Warkworth stations, ranked by Jerrys Plains concentrations (see **Figure 5**) indicates that the concentrations at Jerrys Plains are typically lower than Warkworth while still matching in the upper recorded concentrations (i.e. regional dust or bushfire event).

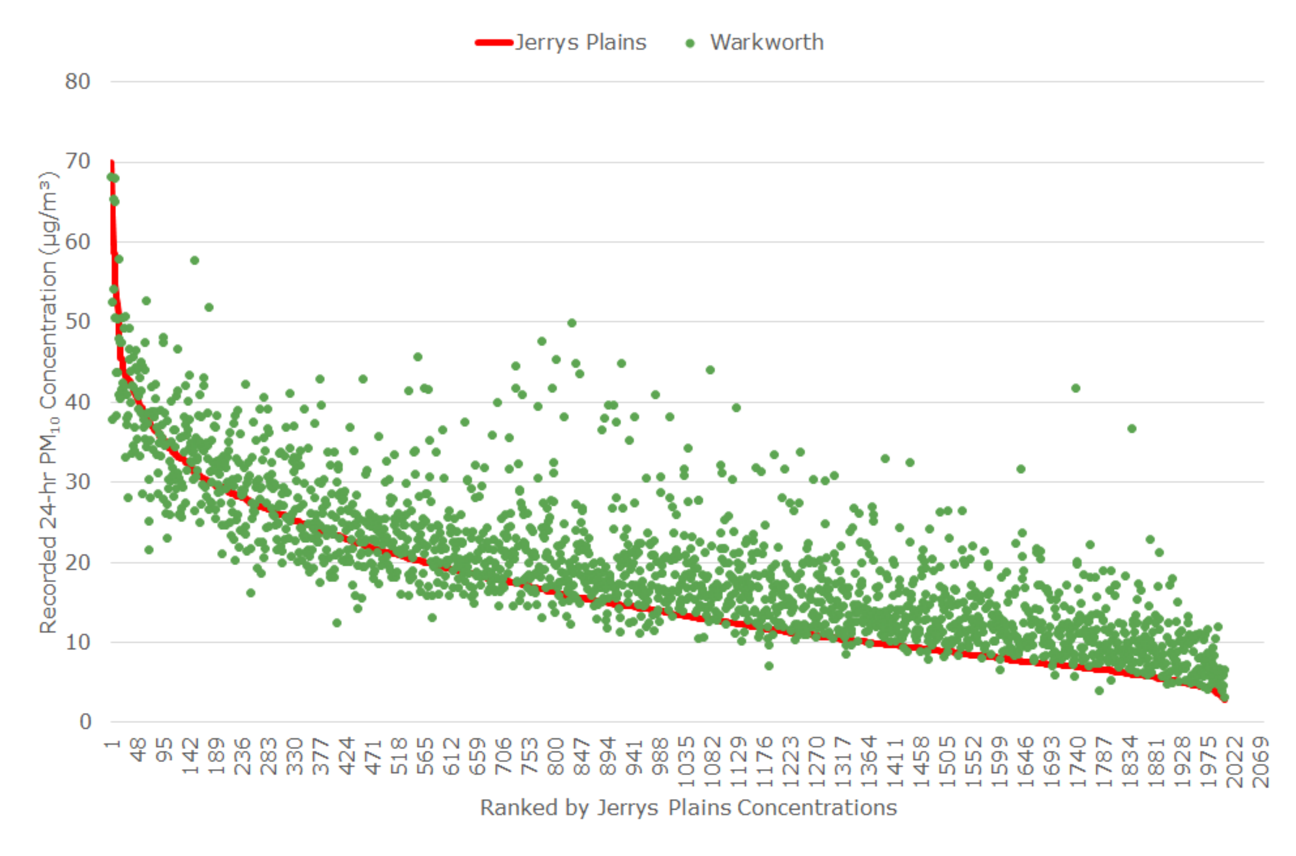
To obtain background concentrations excluding mine contributions, an approach could be to model all significant mining operations for 2014, predict concentrations at the Jerrys Plains monitoring station and subtract from the monitoring results to obtain the non-modelled background. The resultant PM_{10} dataset could then be used as representative of background concentrations at any receptor in the surrounding area excluding the direct influence of mining operations. This dataset could be paired with predicted impacts from neighbouring mines (as per previous section) and predicted impacts from the UWOC and HVOS operations to predict cumulative 24-hour and annual average impacts.

For $PM_{2.5}$ concentrations, limited measurements in the Hunter Valley make the task of deriving a consistent background dataset challenging. While $PM_{2.5}$ is not recorded by the Jerrys Plains station, the relationship between the NSW OEH Camberwell $PM_{2.5}$ and PM_{10} concentrations (most relevant $PM_{2.5}$ monitoring site for the projects) could be used to derive a pseudo-measured $PM_{2.5}$ dataset from Jerrys Plains PM_{10} measurements. As with the PM_{10} dataset, predicted $PM_{2.5}$ concentrations from modelled mine sources could be subtracted from the pseudo-measured $PM_{2.5}$ dataset.

For the derivation of TSP and dust deposition background it is considered that the use of a single monitoring location station is appropriate to derive background levels. Review of the monitoring locations accessed in Jacobs (2016) and TAS (2017a), it is considered that the Wambo AQ03 TSP station and Wambo dust deposition gauge D24 are the most appropriate for TSP and dust deposition background. As with the PM_{10} and $PM_{2.5}$ background datasets, the recorded values from these stations should be adjusted for modelled mine source predictions..

Recommendation: Analysis of cumulative impacts requires a consistent representation of background concentrations. The NSW OEH Jerrys Plains, Wambo AQ03 TSP and D24 dust deposition monitoring locations represent the most appropriate monitoring resource for this analysis.

Figure 4 – Comparison of concurrent 24-hour average PM_{10} concentrations at Jerrys Plains and Warkworth (NSW OEH) for 2011 to 2017 – ranked by Jerrys Plains concentrations



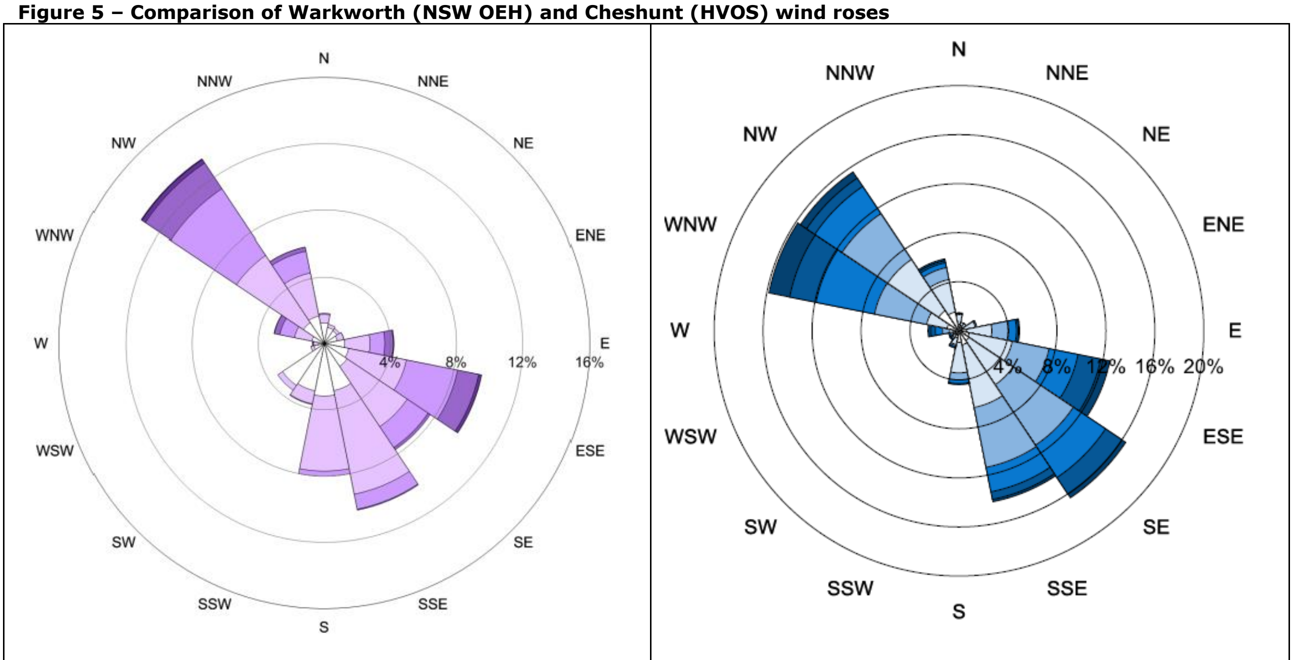
4. Meteorological modelling and inputs

While both assessments used the accepted TAPM/CALMET meteorological modelling approach and modelled for the 2014 calendar year, different local meteorological datasets were used as input. The UWOC model integrated observations from the Wambo Coal weather station along with meteorological observations from the NSW OEH Warkworth, Jerrys Plains and Maison Dieu stations. The HVOS model used observations from the Coal and Allied stations at HVO North, Cheshunt and Charlton Ridge.

While all stations used in the two assessments are considered appropriate resources for the purpose of meteorological inputs, the use of a different set of 2014 input datasets could lead to subtle differences in predicted local dispersion conditions that could lead to potentially significant differences in predicted concentrations.

For example, the closest meteorological stations to Warkworth village from each model are NSW OEH Warkworth station in the UWOC assessment and the HVOS Cheshunt station in the HVOS assessment, located approximately 3km to the north of Warkworth. The 2014 annual wind roses from the NSW OEH Warkworth station (wind rose sourced from Umwelt 2017) and the HVOS Cheshunt station (wind rose sourced from TAS 2017a) are presented in **Figure 5**. It can be seen that the two datasets vary in both wind speeds (the Cheshunt dataset contains higher winds) and direction (winds from the west-northwest to north-northwest occur 22% of time in Warkworth dataset and 38% of the time in the Cheshunt dataset).

Figure 5 – Comparison of Warkworth (NSW OEH) and Cheshunt (HVOS) wind roses



Warkworth (Umwelt, 2017)	**Cheshunt (TAS, 2017a)**

As only one of these two stations was input into either assessment model (i.e. Warkworth in the UWOC model and Cheshunt in the HVOS model), the predicted wind profile in the vicinity of Warkworth village between the two models is likely to be different, which in turn could influence the predicted dispersion conditions and particulate matter concentrations at Warkworth. It is noted that no wind roses from Warkworth CALMET were provided in TAS (2017a) to conclusively verify the meteorological model performance at that location.

This basic focus on just two of the local meteorological datasets illustrates that consistency of input meteorological datasets is important to achieve consistent dispersion model results in a cumulative impact assessment. Differences in input meteorological datasets may therefore have contributed to the identified differences in the predicted cumulative concentrations between the UWOC and HVOS assessments.

Meteorological modelling should therefore be completed for the justified base case year (2014 from the two assessments) with the integration of the following local observation stations, at a minimum:

- Wambo (Wambo Coal);
- Cheshunt (HVO South);
- HVO (HVO North);
- Charlton Ridge (MTW);
- Jerrys Plains (NSW OEH);
- Warkworth (NSW OEH);
- Maison Dieu (NSW OEH);
- Camberwell (NSW OEH);
- Bulga (NSW OEH).

As was completed for the two assessments, CALMET modelling should be configured in accordance with the *Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia* (TRC, 2011). User input settings for CALMET (TERRAD, RMAX etc) should be justified and documented.

Recommendation: Cumulative modelling study should integrate all available meteorological monitoring sites that meet input dataset requirements.

5. Dispersion model configuration

It is considered that the least likely cause of differing model predictions is the configuration of the CALPUFF model. From review of the two assessments, it is understood that CALPUFF modelling was configured in accordance with the recommendations of TRC (2011). Nevertheless, the following steps should be conducted for future cumulative modelling undertaken.

Any modelling conducted for future cumulative analysis should be conducted on a grid domain appropriate to account for impacts from all modelled operations and include a consolidated list of sensitive receptor locations.

Spatial allocation of emissions from the UWOC and HVOS operations should be consistent with the relevant assessments and the selected future mining years. Spatial allocation of emissions from neighbouring mine operations should be conducted in consultation with relevant published air quality impact assessments.

If existing mine pit shell features from the UWOC and HVOS are to be integrated in the modelling beyond publically available datasets, this will require input from both applicants. The further step of integrating future pit shells into the model can be achieved, however for the CALPUFF modelling system this would require the processing of individual CALMET runs for each future year. This further step is not considered critical to the cumulative assessment.

6. Conclusions

A review has been undertaken by Ramboll Environ of the cumulative particulate matter impacts assessments presented in the air quality impact assessments prepared for UWOC (Jacobs, 2016) and HVOS (TAS, 2017a). While the approach implemented in each assessment appears appropriate to quantify the cumulative impacts from each project when viewed in isolation, comparison of the results obtained from the two methods show notable inconsistencies in the model predictions at surrounding sensitive receptors.

Therefore, it is recommended that a standalone cumulative modelling study is required to rectify the inconsistencies in predictions between the two air quality impact assessments. Key areas for alignment and/or improvement are considered as follows:

- Consistency in the input emissions from neighbouring mines, both regarding years selected, quantification approach and mines included;
- Uniform approach to the selection of appropriate background concentrations; and
- Configuration of meteorological model to capture localised conditions through the inclusion of a consistent set of monitoring datasets.

Regarding outputs from the cumulative modelling, it is recommended that for a consolidated set of sensitive receptor locations, the following results should be presented:

- Incremental concentrations of annual TSP, 24-hour and annual PM_{10}, 24-hour and annual $PM_{2.5}$, and dust deposition levels from the UWOC and HVOS projects in isolation; and
- Cumulative concentrations of annual TSP, 24-hour and annual PM_{10}, 24-hour and annual $PM_{2.5}$, and dust deposition levels from the two projects, neighbouring mines and background levels.

Results should be presented in tabular and graphical (isopleth) format. Cumulative 24-hour PM_{10} and $PM_{2.5}$ concentrations should be presented in accordance with the NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*.

Yours sincerely

Scott Fishwick
Manager
Air Quality

sfishwick@ramboll.com

7. References

EMM Consulting (2017), Hunter Valley Operations South - Modification 5 — Response to Submissions

Jacobs (2016), United Wambo Open Cut Coal Mine Project. Air Quality Impact Assessment. 13 July 2016

NSW EPA (2016). Approved Methods for the Modelling and Assessment of Air Pollutants in NSW.

Pacific Environment (2014). Upper Hunter Air Quality Particle Model.

Ramboll Environ (2015). Review of Cumulative Air Impact Assessment Methodologies for NSW.

TAS (2017a), Hunter Valley Operations South - Modification 5 — Environmental Assessment – Appendix F: Air Quality And Greenhouse Gas Study

TAS (2017b), HVO South Modification 5 — Updates of the Approved Methods

TRC Environmental Corporation (2011). Generic Guidance and Optimum Model Settings for the Calpuff Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessment of Air Pollutants in NSW, Australia'.

Umwelt (2017), United Wambo Open Cut Coal Mine Project Response to Submissions PART A