




**Melbourne Metro Rail Project EES  
Expert Witness Statement of Matthew Stead  
Inquiry and Advisory Committee**

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**Document Information**

<b>Project</b>	Melbourne Metro Rail Project EES	
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### **Qualifications**

1. This statement is prepared by Matthew James Stead in accordance with the Planning Panels Victoria Guide to Expert Evidence, April 2015.
2. My formal qualification is a First Class Honours Degree in Mechanical Engineering which I studied at the University of Adelaide from 1988 and graduated with my final year in 1991. I also have a Masters of Engineering Science from Monash University which I completed in 2001. Both degrees incorporated study into acoustics, noise and vibration.
3. My work experience consists of 24 years as an acoustic consultant in Adelaide, Melbourne and San Francisco. My roles have ranged from a variety of positions with increasing seniority at AECOM Australia (formerly Bassett Consulting Engineers) and the last 5 years at Resonate Acoustics as the sole Director.
4. I am currently the Chairman of the Association of Australasian Acoustical Consultants. The AAAC is the peak industry body for acoustical consultant companies.
5. My project experience is across a variety of projects including numerous assessments of environmental noise, vibration, electromagnetic interference (EMI) and comparison with environmental limits. Over the past 5 to 10 years I have further specialised in the area of sensitive research equipment in relation to noise, vibration, electromagnetic interference.
6. My contact address is Level 1, 23 Peel Street, Adelaide SA 5000.

### **Background**

7. Resonate Consultants Pty Ltd (trading as Resonate Acoustics) has been engaged by Rigby Cooke Lawyers to assess noise, vibration and electromagnetic interference (EMI) from the proposed Melbourne Metro Rail Project (MMRP) in relation to the University of Melbourne (UoM).
8. I was instructed by Rigby Cooke Lawyers on 2 August 2016 to prepare an expert witness statement for the noise, vibration and electromagnetic interference on equipment, facilities and operations at the Parkville campus. The instruction was to provide expert evidence regarding the impacts of the proposed development for the EES Inquiry and Advisory Committee.
9. I have been instructed by Rigby Cooke Lawyers to:
  - consider any unique sensitivities of specific equipment used at the campus;
  - consider any unique sensitivities associated with bio resources facilities at the campus;
  - provide comment on the noise and vibration impact assessment at Appendix I of the EES and, in particular, the Environmental Performance Requirements recommended in that assessment;
  - express my opinion:
    - within the scope of my expertise;
    - using my own judgement and experience; and
  - address any other matter which I regard as relevant to the formulation of my opinion, stating clearly the basis of my views.

### **Basis of statement**

10. The proponent for the Melbourne Metro Rail Project is the Melbourne Metro Rail Authority (MMRA).
11. An Environment Effects Statement (EES) for the Melbourne Metro Rail Project, together with the draft Planning Scheme Amendment, was released for public

comment from 25 May to 6 July 2016. I have reviewed relevant sections of the EES downloaded from the website <http://metrotunnel.vic.gov.au/ees/documents>

12. The Melbourne Metro Rail Project includes the following key components:
- Twin 9 kilometre rail tunnels between South Kensington and South Yarra, following the alignment of Swanston Street through Melbourne's Central Business District (CBD) and linking the existing Sunbury and Cranbourne/Pakenham railway lines.
  - New CBD North and CBD South stations providing direct interchange with Melbourne Central and Flinders Street stations respectively.
  - New stations at Arden, Parkville and Domain, with new train/tram interchanges at the latter two stations.
13. The MMRP will be delivered using "Availability based Public Private Partnership" (PPP) and "Competitive alliance" (CA) models for different aspects of the project (reference <http://metrotunnel.vic.gov.au/about-the-project/procurement-methods>).
14. An early works managing contractor has already been appointed.
15. I have not considered early works associated with the MMRP in this statement.
16. The UoM has a range of equipment located on site that is sensitive to vibration, EMI and/or noise. UoM have provided me with a datapack of sensitive equipment (Spreadsheet CH16 - MMRA Noise, Vibration and EMI Data Pack 20160331.xlsx).
17. The UoM has bio resources which are vibration and noise sensitive.
18. Occupied areas at the UoM are noise and vibration sensitive.

### **Potential Impacts**

19. Based on my review of the EES and experience, the primary MMRP impacts on the UoM include noise and vibration during construction and EMI and vibration during operation of the MMRP. Secondary impacts may be EMI during construction and noise due to operation.
20. Based on the EES, in the vicinity of the UoM the Parkville Station construction is the most significant source of noise and vibration with the tunnel construction being less significant in terms of noise and vibration.
21. There is no assessment of EMI from construction or operational phases of the MMRP in the EES.
22. Based on my experience, train operation within the new tunnels and stations will be the most significant source of vibration and EMI during the operational phase.
23. The UoM has a range of sensitive usages and assets on and in the vicinity of the main campus. These may be impacted by the construction and then operation of the Melbourne Metro. The range of impacts may be from minor (annoyance or distraction) through to potentially extreme in terms of UoM activity i.e. such as years of research activity being voided and/or assets being unusable.

### **Existing Sensitive Equipment on Campus**

24. I have inspected a number of laboratories at UoM and confirm that there are many noise, vibration and EMI sensitive equipment items currently installed on the Parkville campus.
25. Such equipment can be significantly more sensitive to vibration than humans. For example, electron microscopes can be 100 times more sensitive to vibration than a human can feel at less than 1 micro-m/s compared with 100 micro-m/s.
26. The effect of vibration on such equipment can be to make it unusable due to the movement of images at extremely high resolutions.
27. Examples of existing sensitive equipment and/or assets includes:

- Zeiss Helium Ion Microscope/ Focused Ion Beam (Engineering Building 261)
  - Atomic Force Microscopes (Engineering Building 165)
  - Transmission Electron Microscopes (PDI and Bio 21).
  - Scanning Electron Microscopes (Bio 21)
28. Equipment such as the Transmission Electron Microscope (TEM) currently installed within the Peter Doherty Institute (PDI) are sensitive to noise, vibration and electromagnetic fields and have manufacturer specifications which define required environmental requirements to achieve manufacturer guaranteed requirements. This is an example of one of the sensitive instruments on site.
29. In my experience EMI levels can have a significant impact on the resolution of imaging equipment and impacts are easily documented. EMI is currently not addressed in the EES.
30. EMI sensitivity can be as low as 0.3 mG peak-peak for the most sensitive instruments at the UoM.

#### **Future Sensitive Equipment on Campus**

31. In my experience Universities are continually installing more specialised equipment to increase capability and capacity. This supports research grants and research outcomes for UoM.
32. The MMRP is expected to increase EMI and, to a lesser degree, vibration levels above existing levels.
33. Increased EMI and vibration levels will reduce the ability for UoM to install sensitive equipment at new locations on the campus in the future.
34. There will be future and installation of equipment with more stringent EMI, noise & vibration requirements, e.g. FEI Titan TEM which has been ordered. The future installation of such equipment may be impacted on by this project.
35. Existing locations may be redeveloped into research facilities with more stringent EMI, noise & vibration requirements.
36. Mitigation of environmental EMI, noise or vibration at the UoM (if possible and if required) indicates that future development of similar sensitivity will also need to be mitigated in a similar way. For example, future equipment may require an active vibration or EMI cancelation system that would otherwise not be required if the project did not occur. A financial allowance may need to be made to address impacts where onsite UoM mitigation is proposed.
37. It is my opinion that Noise, Vibration and EMI should be reduced as much as practical in the vicinity of UoM to not limit future development flexibility at the campus.

#### **Bio Resource Sensitivity**

38. There are bio resource areas that are sensitive to noise and vibration adjacent to the MMRP on the UoM campus. I have been advised by the UoM that bio resources are licensed.
39. Relevant licensing noise criteria are contained in the Code of Practice listed under the licensing requirements.
40. Limiting noise and vibration exposure to bio-resources is a critical requirement for both licensing and research outcomes at the UoM. From a research perspective, if resources become disturbed as a result of noise and vibration then this could compromise years of research.
41. Bio resources research tests a number of aspects including animal behaviour. Their behaviour is influenced by exposure to noise and vibration as outlined in research (J Am Assoc Lab Anim Sci. 2007, "Noise in animal facilities: why it matters". Turner JG1, Bauer CA, Rybak LP.)

42. Allowable vibration levels are not defined in the Code of Practice. Previous research outlines recommended vibration levels for bio resource areas (TurnKey 2016, "Construction Monitoring in an Animal Facility: Investigating Noise, Vibration, and *Stress Levels in Rats*". Gladys Unger, Marc Newmark, Acentech and Jeremy Beech, Ipsen Bioscience, Inc).

### **Sensitive Periods**

43. The UoM is a 24 hr campus and many facilities may be used throughout the day. Examples include bio resources which are sensitive throughout the day and the Bio21 which may conduct 24 hour Scanning Electron Microscope (SEM) scans.
44. Sensitive periods may extend continuously for weeks at a time and hence scheduling may not be an appropriate method of mitigation.

### **Occupied Spaces**

45. The UoM has a number of teaching, academic, support and laboratory spaces that are occupied by people. The people in those spaces are sensitive to noise and to vibration.
46. Continued construction noise can disrupt communication and/or concentration within these spaces.
47. Construction noise needs to be limited to allow the UoM to continue to operate.

### **Baseline Noise, Vibration and EMI**

48. Baseline testing has been carried out at the UoM on behalf of the MMRA for noise and vibration. Baseline noise and vibration levels have been reported in the EES.
49. Baseline EMI testing has not been reported by MMRA.
50. There are concerns with the baseline vibration testing because they present the highest vibration levels and do not present a statistical range of vibration levels such as  $L_1$ ,  $L_{10}$ ,  $L_{50}$ ,  $L_{90}$ ,  $L_{99}$  to describe the existing environment. Note  $L_x$  refers to the vibration level exceeded for a particular percentile of a given time period, where X = percentile.
51. In my experience sensitive equipment such as electron microscopes are able to successfully operate in environments where the root mean square (RMS) levels of vibration achieve the equipment requirements, and occasional peak or maximum levels are able to be accommodated. The characterisation of the existing vibration environment by maximum levels alone is hence not representative.
52. Noise level exposure has a similar characteristic to the vibration levels in that the noise environment should be classified by the statistics and over an extended period. Short term baseline noise measurements may not represent the long term environment.
53. The existing noise, vibration and EMI levels across the university can generally be mitigated. The baseline levels recorded are hence a guide of existing levels. Examples of how existing environmental levels can be reduced include:
- Vibration isolation of rotating mechanical plant or structural modifications to buildings or spaces to reduce vibration levels.
  - Prevention of vehicles using access roads and hence reduced DC EMI fluctuation and/or vibration.
  - Modification or enclosure of noise sources and/or improved façade construction.
54. Noise and vibration baseline levels in the EES should hence be taken as indicative only.

55. Equipment specifications and the associated measurement methodology should be used for comparing specifications with existing levels. It should be noted that equipment specifications are often presented as RMS vibration levels, indicating that short-term peak or maximum vibration events do not necessarily compromise use of the equipment.
56. Baseline testing I have carried out for UoM indicates that there are areas on campus where RMS vibration levels are low (< 1 micro-m/s). Noise levels vary considerably depending on the location on campus. DC EMI levels are heavily influenced by the existing trams and are generally higher than 2 to 3 mG peak-peak.

**Review of EES**

57. To support my expert witness statement, I have (a) completed a comparison of Environmental Performance Requirements in the EES and (b) completed a risk assessment to quantify the key risks related to noise, vibration and EMI and potential mitigation measures.
58. Given the delivery method of the MMRP being PPP and CA the actual construction methods are not known as this will be determined in conjunction with the appointed consortium.
59. I understand that the noise, vibration and EMI levels will need to comply with relevant contractual requirements which are assumed to be based on the Environmental Performance Requirement (EPR) listed in the EES.
60. To determine the impact on the UoM the anticipated noise, vibration and EMI levels from the likely construction and operation need to be assessed along with the EPR's to determine if the EPR's can be practically achieved.
61. In a PPP delivery method the EPR's will govern the mitigation requirements rather than EES predicted levels.
62. The anticipated levels of noise and vibration are presented for the whole project and include levels in the Parkville and Tunnels precinct around the UoM.
63. The outcomes from my review are summarised in the following table.

**Table 1 Summary of EES Review and Recommendations**

Issue	Reason why it is an issue for UoM	Recommended Action
EES does not address Electromagnetic Interference	EMI may render existing equipment non operable. It may also prevent future development in areas of the campus. Of particular concern is the PDI TEM, Engineering FIB and potential sterilisation of other development areas.	EMI impact assessment to be carried out. Mitigation to be incorporated into design and/or compensation for lost development potential. Comprehensive EPR to be developed.
Hierarchy of control should be at source and if not practicable then at receiver (or transmission path)	Minimise impact and disruption to UoM.	Enforce hierarchy of Noise, Vibration or EMI mitigation firstly at source and then at UoM if required.
EES construction noise limits not listed for UoM	No criteria to address excessive construction noise at the UoM. Day to day operations including use of teaching spaces may not be possible without further mitigation.	Day time construction noise limits and mitigations methods for the UoM to be addressed. EPR to be based on a tolerance above AS/NZS 2107 or space specific limits.

Issue	Reason why it is an issue for UoM	Recommended Action
Generic criteria are used for UoM equipment	Sensitive equipment at UoM has well defined manufacturer limits that are more relevant than generic criteria. The assessment should be based on specific criteria.	Assessment to be updated comparing equipment specification with predicted levels (with mitigation)
Blasting impact on bio resources not fully addressed	Bio resource license conditions may be exceeded.	Blasting impact to be re-assessed based on structure-borne noise and updated vibration assessment.
Ground borne noise to be limited at specialist spaces	Currently no structure or ground borne noise limit into sensitive areas	Update assessment to consider structure borne noise for critical spaces. Particular care to be taken to assess impact on bio resource areas.
Construction likely to prevent or limit operation of PDI TEM for months or years	It is possible that the PDI TEM will not be able to be operated during construction and/or operation of the MMRP.	Impact on PDI to be more comprehensively assessed given likely impact on operation of PDI (TEM in particular) during construction and/or operation. This relates to EMI, vibration and structure borne noise.
Vibration less than 10 Hz not addressed	This is a critical frequency range and UoM equipment is sensitive in this range.	Updated assessment required.
Vibration contours not presented for UoM	Levels of operational vibration along the corridor will enable the level of impact to be defined, particularly for future development or master planning requirements.	Updated assessment required.
Audiology structure borne noise through construction not specifically addressed	Audiology may not be able to operate during construction of the tunnel and/or operation.	Updated assessment. Contingencies to be established.
Predicted vibration and noise levels not compared with specific equipment specifications	It is unclear what impact will occur on actual equipment.	Assessment to be updated so that manufacturers of equipment can be consulted.
Environmental noise limits from ventilation/ air conditioning systems do not apply at UoM	Slight risk that noise will be excessive from ventilation systems with no defined limit.	Noise limits based on meeting relevant standards within the UoM buildings and external amenity. A limit based on AS/NZS 2017 should be applied.



Issue	Reason why it is an issue for UoM	Recommended Action
Impact on future development not assessed	May preclude future development.	Compensation and/or mitigation to not significantly alter existing conditions during operation.

**Updated EPRs**

64. Based on the review of the EES I have collated the EES EPR's and outlined recommended changes to address the particular requirements of the UoM. The following Tables outline these proposed changes to the EPR's.

**Table 2 EES EPR's and recommendations – Construction Phase**

Stage	Source	Receptor	EES EPR	Recommendation
Construction	Tunnel Vibration	Bio Resource	No specific EPR. Refer impact assessment. VC-A vibration criteria proposed.	Formal EPR to address vibration from construction and shall be consistent with VC-A.
		Sensitive Equipment	NV10	Update EPR to address sensitive equipment specific requirements.
		Occupied areas	NV 9	NV 9
	Tunnel Structure Borne Noise	Bio Resource	NV 13	NV 13
		Sensitive Equipment	NV 5	NV 5 to be expanded to address specific sensitive equipment
		Occupied areas	NV11	Update NV 11 to address day time noise at UoM. NV11 currently only applies at residential receptors.
	Blast vibration	Bio Resource	NV 12 "minimise adverse impact", Assessed 3mm/s not acceptable.	Update NV12 to achieve acceptable vibration levels for bio resources.
		Sensitive Equipment	NV 12 "minimise adverse impact" and avoid damage to sensitive equipment	Address equipment specific vibration requirements.
		Occupied areas	NV 12	NV 12
	Blast noise	Bio Resource	NV 13	NV 13
		Sensitive Equipment	NV 12	NV 12
		Occupied areas	NV 12	NV 12
Excavation/ Civil Works/ etc vibration	Bio Resource	No specific EPR. Refer impact assessment. VC-A.	Formal EPR to address vibration from construction and shall be consistent with VC-A.	
	Sensitive Equipment	NV10	Update EPR to address sensitive equipment specific requirements.	
	Occupied areas	NV 9	NV 9	
	Buildings	NV 6	NV 6	
Excavation/ Civil Works/ etc noise	Bio Resource	NV13	NV 13	
	Sensitive Equipment	No specific EPR.	Formal EPR to address sensitive equipment noise requirements.	
	Occupied areas	NV1 does not address UoM. Expand NV 5 to address UoM	Expand EPR to address construction noise at UoM. EPR to be based on AS/NZS 2107 and location specific requirements.	
Construction EMI	Sensitive Equipment	Not assessed	EPR to be developed to address sensitive equipment EMI impacts	
			Significant risk to UoM. EPR to be introduced or significantly varied.	
			Refinement to the EPR to be made to reduce risk to UoM.	
			EPR as proposed in the EES likely to be acceptable to UoM.	

**Table 3 EES EPR's and recommendations – Operational Phase**

Stage	Source	Receptor	EES EPR	Recommendation
Operation	Metro train noise	Bio Resource	NV13	NV 13
		Sensitive Equipment	NV 17 does not specifically address sensitive equipment.	Update EPR to address equipment specific requirements.
		Occupied areas	NV 17	NV 17
	Metro train vibration	Bio Resource	No specific EPR. Refer impact assessment.	Update NV18 to address bio resources.
		Sensitive Equipment	NV10	Update EPR to address sensitive equipment specific requirements.
		Occupied areas	NV 18	NV 18
	Metro train EMI	Sensitive Equipment	Not assessed	EPR to be developed to address sensitive equipment EMI impacts
	Metro station ventilation noise	Bio Resource	Not defined for non residential usage.	EPR NV 16 to be expanded to apply at UoM
		Sensitive Equipment	Not defined for non residential usage.	EPR NV 16 to be expanded to apply at UoM
		Occupied areas	Not defined for non residential usage.	EPR NV 16 to be expanded to apply at UoM
		Residential areas	NV 16	NV 16
				Significant risk to UoM. EPR to be introduced or significantly varied.
				Refinement to the EPR to be made to reduce risk to UoM.
			EPR as proposed in the EES likely to be acceptable to UoM.	

**Possible Mitigation**

65. The EES refers to potential mitigation at both the MMRP and at the UoM. There are a number of limitations to mitigation at the UoM. In some cases, there are significant restrictions to what mitigation can be applied. A few of these restrictions, based on my experience, are outlined below:

EMI

- Magnetic shielding is not effective for DC magnetic field fluctuations and should not be considered as a substitute mitigation method for the MMRP.
- Active magnetic field cancellations may be effective for some installations. They are however not effective for tall column electron-beam instruments such as taller TEM and or equipment with a high static magnetic field.

Bio-resources

- Scheduling of work which may impact bio-resources areas is not possible as they are sensitive 24 hours in the day.
- The relocation of bio resources is not practical without significant expense and/or risks to ongoing research.

Vibration

- Vibration isolation tables may be able to isolate some smaller instruments.
- Isolation of any larger instrument that is sensitive to low frequency is unlikely to be practical and may actually amplify vibration levels making interference worse.

#### Structure-borne noise

- Structure borne noise transmission is not able to be effectively shielded at the receiver location given that many surfaces (walls, floor and ceilings) need to be addressed. Reduction at the source is the only practical method of reducing structure borne noise.

#### Audiology

- Structure borne noise may be excessive for the Audiology department. It is most likely not practical to provide further attenuation for the Audiology booths without full replacement.

#### Scheduling

- Scheduling of construction activities outside normal working hours may be possible however the bio-resource areas may preclude scheduling. Some research equipment (such as scanning electron microscopes) may be used to image samples over days or weeks.

66. Mitigation strategies will need to be carefully reviewed and agreed with the UoM. The hierarchy of control should be firstly be at the source of noise, vibration or EMI. Where this source mitigation is not reasonable and practicable then mitigation at the UoM could then be considered. In some cases (as noted above) this may not be possible and relocation of receiver(s) with associated operational requirements may be necessary.

#### **Monitoring and Control Mechanisms**

67. The UoM research relies on controlled experimental conditions. In addition, the bio resources require noise levels that meet licensing requirements. A rigorous monitoring and control program is required to address risks.

68. The EES references a series of Environmental Performance Requirements. It is recommended that the following requirements be added to help ensure that the interests of the UoM are protected:

- Established “notification levels” and “stop work limits” for UoM infrastructure.
- Provide real time monitoring of noise, vibration and EMI with open and transparent data access.
- Establish agreed locations for compliance monitoring.
- Measure long term baseline levels at those compliance locations to establish existing exposure and to refine notification and/or stop work limits to minimise chance of false exceedances.
- It is recommended that this compliance monitoring occurs at a minimum at:
  - Medical Building 181 (noise and vibration)
  - Peter Doherty Institute Building 248 (noise and vibration)
  - Vibration sensitive equipment (confocal and multi photon microscopes) in Medical Building 181 (vibration)
  - Vibration sensitive equipment (confocal and multi photon microscopes) Peter Doherty Institute Building 248 (vibration)
  - Noise exposure for PDI, Medical Building and Alan Gilbert Building 104.
  - Vibration sensitive Helium Ion Microscope in the Centre for Neural Engineering Building 261 (vibration)
  - Audiology Building 246 (noise)

- Robust processes for acting on exceedances of notification levels to ensure Stop Work levels are not exceeded.
- Regular reporting required during construction & operations. Reporting procedure to be approved by UoM to enable recall of historical levels to correlate with research findings.
- Soft start and/or ramp up to be required for higher impact noise and vibration sources.

#### **MMRP EMI Levels**

69. The DC EMI has been measured by others near the Flagstaff Station (part of the City Circle Loop).
70. The mapping demonstrates that very high DC EMI levels are possible even though the rail is underground. DC EMI levels above the existing levels at the UoM campus could extend more than 200 m from the MMRP.
71. High EMI will need to be mitigated to prevent operational impact on the existing and future operations of the UoM.
72. It is recommended that EMI impact be assessed and mitigation be applied as reasonably appropriate.

#### **Summary of Opinions**

73. The MMRP presents a number of significant risks for the UoM associated with EMI, noise and vibration. Without rigorous environmental management there may be significant potential impacts from the MMRP project on the UoM operations, and potential significant ramifications for research outcomes.
74. In my opinion the key recommendations to address risks on UoM from the MMRP are to develop:
- A clear set of tailored EPR criteria for the UoM existing and future equipment be established.
  - New EPR's to be included to address:
    - EMI
    - Vibration and noise in bio resources based on VC-A vibration levels and Code of Conduct noise limits.
    - Day time construction noise limits within the UoM with particular attention to teaching and learning, offices, laboratories and normally occupied spaces.
  - Updated blast vibration limits to a level which will not impact on bio resources nor license requirements.
  - Holistic cumulative review of impact on PDI TEM including operational EMI as, based on my experience, it is likely the TEM will need to be relocated.
  - Holistic cumulative review of the impact on additional sensitive equipment such as confocal microscopes.
  - Process to allow relocation of sensitive equipment where impacts are found to be too high based on operational requirements such as commercial and time critical usage.
  - Ensure that assumptions related to the design (of "at project" mitigation) be fully tested including site specific geology and site propagation of noise, vibration and EMI.
  - Construction methodology be adopted which recognise the very specific requirements of the UoM including daytime usage of assets.
  - Construction management methodology which incorporates notification and stop work trigger points.

- A control and monitoring program to be implemented with management plans with UoM approval.
- Further consultation on reasonable and practicable mitigation measures and what measures are not possible.
- Consideration of future UoM developments and potential for development through minimisation of operational EMI and vibration in particular.

#### **Areas Outside My Expertise**

75. The levels of noise and vibration that would affect bio resources is outside my expertise. I am experienced in interpreting noise and vibration criteria for bio resources prepared by others. In preparing this statement I have relied on research by others to form a view on likely noise and vibration criteria.
76. The prediction of EMI levels from rail systems is outside my expertise. I am experienced in the measurement and assessment of EMI levels against objective criteria. I am also experienced in mapping and describing EMI levels from measurements and the relevance of those levels.

#### **Completeness and Provisional Opinions**

77. The actual construction methodology and final design for the MMRP is not known. This witness statement is based on the information contained in the EES.
78. In this statement I have recommended updated and new specific EPR's to address requirements of the UoM. Additional detailed assessment is required to ensure that the EPR's address all sensitive equipment, bio resources, research and occupied areas.
79. In this statement I have presented a measurement and control methodology. This should be expanded and refined potentially into an EPR to ensure it addresses all UoM requirements.
80. Blast vibration limits applicable to bio resources should be further researched and defined a EPR developed which will not impact on research outcomes or licencing requirements.

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

Matthew James Stead



Date: 12<sup>th</sup> August 2016