10051

APPENDIX M

Sky View Impacts

UNSW Unisearch

COMMERCIAL-IN-CONFIDENCE
Report prepared on behalf of Unisearch Expert Opinion Services
A business of the University of New South Wales

BARANGAROO SOUTH PROJECT
SYDNEY OBSERVATORY SKY VIEW LOSS ASSESSMENT
CONCEPT PLAN MODIFICATION 10

for

Mr Jim Betts
Secretary
NSW Department of Planning, Industry and Environment
320 Pitt Street
SYDNEY NSW 2000

by

Dr George Georgevits
Consulting Engineer and Astrophysicist

Date of Issue: 12 December 2019
Our Reference: J085821

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1. TERMS OF REFERENCE

1.1 QUALIFICATIONS

1 This report was prepared by George Georgevits, managing director of and principal consulting engineer for Power and Digital Instruments Pty Ltd (**PDI**).

2 I have an honours degree in electrical engineering and 40 years experience as an engineer, specialising in the fields of communications, electronics and power.

3 I also hold a PhD in Astrophysics.

4 My PhD work in astrophysics has entailed the use of the 1.2 metre UK Schmidt Telescope and the 0.5 metre Automated Patrol Telescope, both located at Siding Spring Observatory, Coonabarabran NSW.

5 I have conducted presentations of my work in astrophysics at a number of overseas and Australian conferences.

6 An article referencing my work has appeared in Science magazine (see Appendix 4), and it has also been cited in a paper appearing in Nature.

7 I have also co-authored a Chapter in a text book on the outer solar system.

8 I have owned and operated a number of small astronomical telescopes over the years.

9 I am thus very familiar with observational astronomy and also the astronomical objects that are the subject of this matter.

10 A brief CV for George Georgevits is provided in Appendix 1 and a brief capability statement for PDI is provided in Appendix 2.

1.2 TERMS OF ENGAGEMENT

11 I have been engaged by Lendlease to provide astronomical advice in relation to this matter.

12 The matter concerns an assessment of the loss of sky view from Sydney Observatory (south dome) due to the proposed construction of residential tower R4B (**R4B**), this building being part of the Barangaroo South project.

13 In particular, the matter concerns the proposed change in height of R4B from RL 210 to RL 235 (RL stands for Reduced Level - the height above mean sea level, measured in metres).

14 In response to an instruction from Lendlease, I prepared a report dated 23 September 2014 (my **first report**).

15 That report assessed the loss of sky view from Sydney Observatory due to the proposed construction of the Crown Hotel and Residential Towers R4A and R4B (R4B was proposed with RL 210 at that time) in accordance with the Barangaroo South Project, Mod 8 Concept Plan.

16 I also prepared a report dated 11 August 2015 that provided a point by point response to the issues raised in Sydney Observatory's submission to NSW Planning and Environment in relation to the possible sky view obstruction by the various proposed Barangaroo South buildings.

1.3 INSTRUCTIONS

17 The present report has been prepared in response to the following instructions:

18 *Lendlease are requesting George to undertake a review of the Sky View Impact of a proposed change in height of one of our approved buildings (Residential Tower R4B) from RL 210 to RL 235. This is likely to involve:*

- *Review of the existing Lendlease reports to confirm that the analysis and conclusions contemplate or include the potential for the increase in height of the building.*

- *Preparation of an Addendum Report to support a conclusion of "no additional impact" from the previous conclusions (if appropriate) or Preparation of an Addendum Report that describes the additional impacts if these are found to exist.*

19 Part of the earlier briefs received from Lendlease included a set of drawings that depict viewing angles from Sydney Observatory towards the Barangaroo South development, with possible areas of view obstruction.

20 They also contained information relating to the make, model and location of the telescope used by Sydney Observatory for night time astronomical observing, plus the opening hours for the observatory (refer Appendix 3).

21 At that time, I also made my own enquiries in relation to certain aspects of the matter, and I have included the findings from my enquiries in this report.

22 Where I have used material from other sources, I have provided the relevant references.

23 On 11 December 2019 I received from Lendlease an updated drawing that depicts viewing angles from Sydney Observatory (south dome) towards the Barangaroo South development (see Fig 4).

24 I also received information stating that the footprint of building R5 has been increased slightly, with an additional ~1.9m added in width to the footprint. The building height remains unchanged at RL107.

25 Due to its low altitude, this will have no effect on the sky view from Sydney Observatory.

2. OBSERVATIONAL ASTRONOMY – A PRIMER

26 The following information is provided to enable the reader who is not conversant with astronomical concepts to gain a basic understanding of the issues associated with this matter.

27 As such, is considered essential reading for readers not familiar with astronomical concepts.

28 In the southern hemisphere, the night sky appears to rotate clockwise around a point in the sky known as the South Celestial Pole (see Fig.1).

29 This point represents the intersection of the extension of the southern end of the Earth's axis of rotation with the sky plane.

30 Thus the sky plane completes one rotation every 24 hours, which means it rotates at a constant angular velocity of 15^{o} per hour.

31 Thus, in order to observe a sky plane object, a telescope must first find the object and then track it as the sky rotates.

32 In addition to this, the Earth moves in its orbit around the sun, completing one revolution approximately every 365.25 days.

33 Thus, at any particular time (e.g. 8:00pm), and at any particular altitude and azimuth (**alt/az**) co-ordinate in the sky plane (e.g. 26^{o}, 210^{o}), a different part of the sky will appear at that co-ordinate location at 8:00pm on each day of the year.

34 Another way of looking at this is that the same part of the sky will be at a different location every night of the year.

35 For example, on the 1st September, at 8:00pm, α Centauri is at alt/az 43°, 216°.

36 On 1 October, at 8:00pm, it is at alt/az 23°, 213°, this change being due to the fact that the Earth has moved further along in its orbit around the sun.

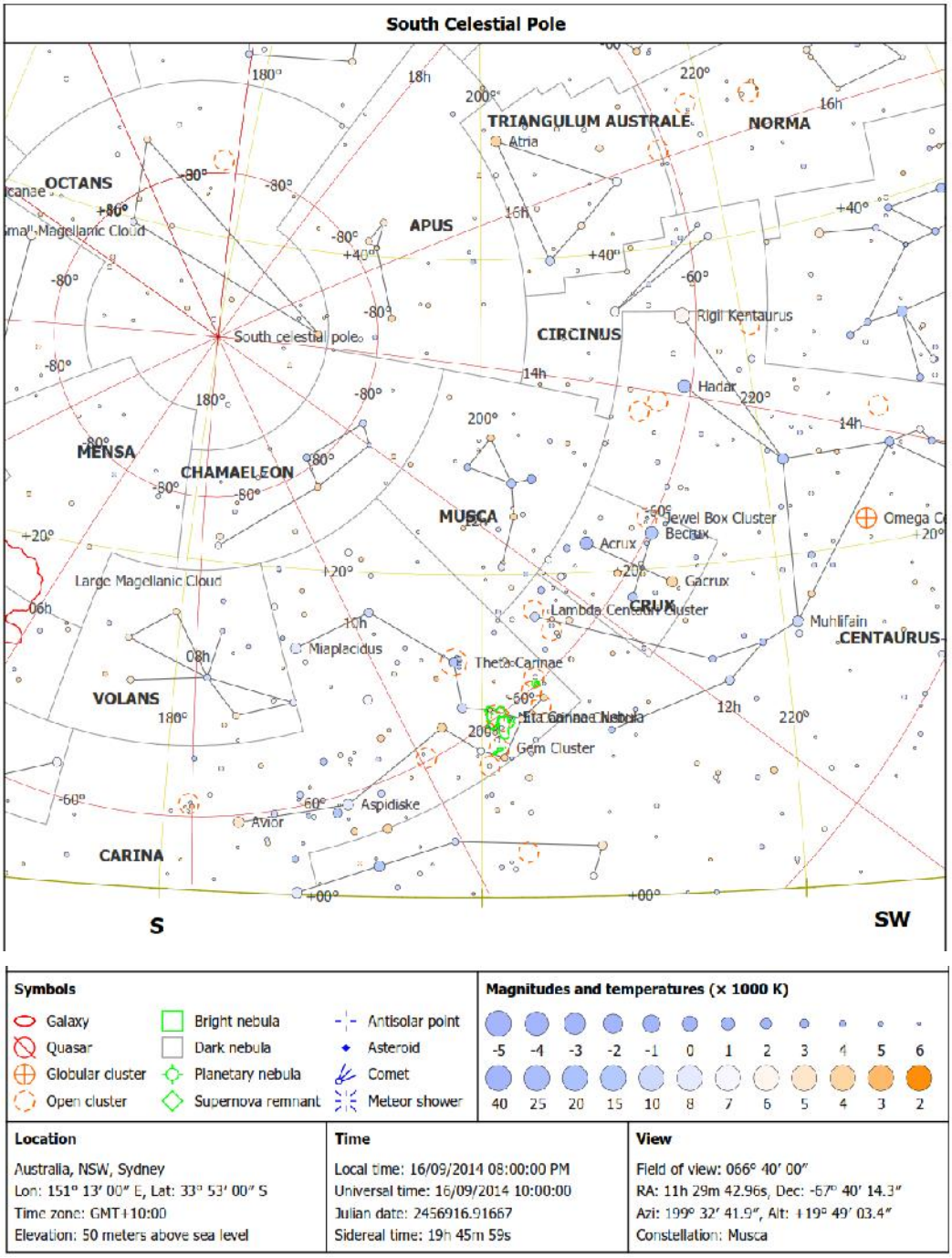

Fig.1 - Map of the night sky showing the location of the South Celestial Pole and the target objects of interest, as they appeared on 16 September, 2014 at 8pm.

3. OBSERVING ISSUES AT SYDNEY OBSERVATORY

37 A number of factors affect the viability of conducting astronomical observations from any particular location.

38 These factors determine whether observing is even possible, and if so, the quality of the image likely to be seen through a telescope.

3.1 CLOUD COVER

39 Depending on the nature of the clouds, this can degrade the transparency of the atmosphere to the point where it becomes opaque, making observing impossible.

40 With translucent clouds, observing is possible, but scattered light from the various bright city light sources (e.g. Harbour Bridge) will degrade the observed images by degrading the contrast and altering the colours.

41 The Bureau of Meteorology statistics state the following for the weather station at Observatory Hill:

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Mean number of clear days	6.8	5.3	7.1	9.1	9.5	9.1	12.0	13.4	10.9	8.1	6.0	6.6	103.9	56	1955 2010
Mean number of cloudy days	13.4	13.0	12.8	10.7	10.8	10.9	8.7	7.7	8.5	11.4	12.5	12.8	133.2	56	1955 2010

Fig.2 - 56 year average BOM weather data for Observatory Hill

42 From this, we can assume that there will be a roughly ~50% chance of cloud at any particular time/date.

3.2 SMOG AND PARTICULATE POLLUTION

43 Smog and particulate pollution affects the transparency of the atmosphere.

44 It causes selective absorption of the short wavelengths of light (blue end of the spectrum), making images look redder (hence the bright orange sunsets during bushfire season).

45 Smog is worse looking at low altitude across the western suburbs of Sydney, and it tends to be worse in summer under certain weather pattern conditions.

46 It can also be bad during bushfires, and during ground cover burn off activities in winter and spring.

47 Smog will also scatter light from nearby bright ground based sources (e.g. Harbour Bridge), thereby increasing the overall sky brightness.

48 These effects will degrade the observed image because the image contrast is reduced and the colours are changed.

3.3 SCINTILLATION

49 Scintillation is caused by air density variations due primarily to air movement (turbulence).

50 It results in image distortions that fluctuate with time.

51 Scintillation is also a function of the air mass.

52 The minimum column of air through which the light has to pass occurs for targets directly overhead (i.e. at zenith).

53 As we move away from zenith towards the horizon, the column of air we have to look through (and the turbulence it contains) increases.

54 The air mass at 30^{o} altitude is twice that at zenith (90^{o}altitude), and therefore the scintillation effects are much worse.

55 These effects then worsen rapidly as the horizon is approached.

56 Scintillation effects also worsen with increasing air temperature (heat haze) and with increasing humidity.

3.4 OBSERVATORY OPENING TIMES

57 Sydney Observatory is only open at specific times on specific days (refer Appendix 3).

58 Thus in order to assess the impact on viewing caused by any particular obstruction, the required target object locations must be tracked throughout the year so as to determine when or even if they intersect with the obstructed area of sky, and if so, for what proportion of the observatory's opening hours on the days it is open.

4. SYDNEY OBSERVATORY SKY VIEW LOSS ASSESSMENT

4.1 BACKGROUND

59 The Sydney Observatory site is located on Observatory Hill at The Rocks, Sydney NSW, about 600m south west of the Sydney Harbour Bridge.

60 The observatory building was built between 1857 and 1859. It is now part of the Powerhouse Museum.

61 Due to the glare of the city lights (the nearby Harbour Bridge in particular), the low altitude of the site and the proximity to water, seeing conditions are poor at the observatory even on the best nights.

62 Research astronomy has not been conducted at the site for many years now.

63 The observatory does, however, conduct public astronomical observing sessions from the north dome building using a 16" Meade Schmidt Cassegrain telescope.

64 The observing times vary, depending on the time of year.

65 A complete list of observatory opening hours is provided in Appendix 3.

66 The aim of this report is to independently quantify the observatory's concerns in relation to the concerns they have expressed.

4.2 SYDNEY OBSERVATORY SKY VIEW LOSS CONCERNS

67 Sydney Observatory had indicated that their area of concern covers the azimuth angle between 210^{o} and 218^{o} and altitudes between 18^{o} to 26^{o}.

68 In addition, they indicated that the view of the following night sky objects of interest is likely to be obstructed by the buildings at certain times of the year.

- The Southern Cross
- The Pointers (Alpha and Beta Centauri)
- The Jewel Box Cluster (open star cluster)
- Omega Centauri (globular star cluster)

69 See Fig.1 above for a sky map showing the location of all of these objects.

70 For the preparation of my first report, Lend Lease provided a set of drawings that depict viewing angles from Sydney Observatory towards the Barangaroo South development (see Fig below) for the drawing relevant to the matter at hand).

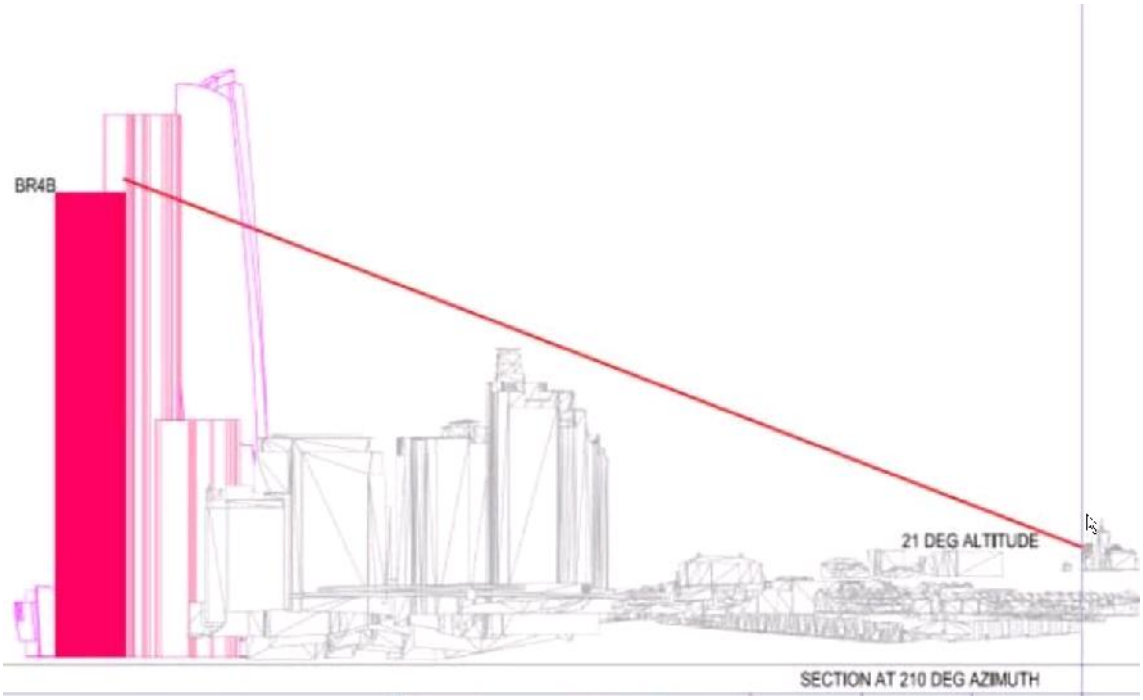

Fig 3 – Altitude angle of 21^{o} from Sydney Observatory to R4B for RL 210 (see my first report)

71 Fig 3 and the other documentation provided by Lendlease at the time did not contemplate an increase in height of R4B to RL 235.

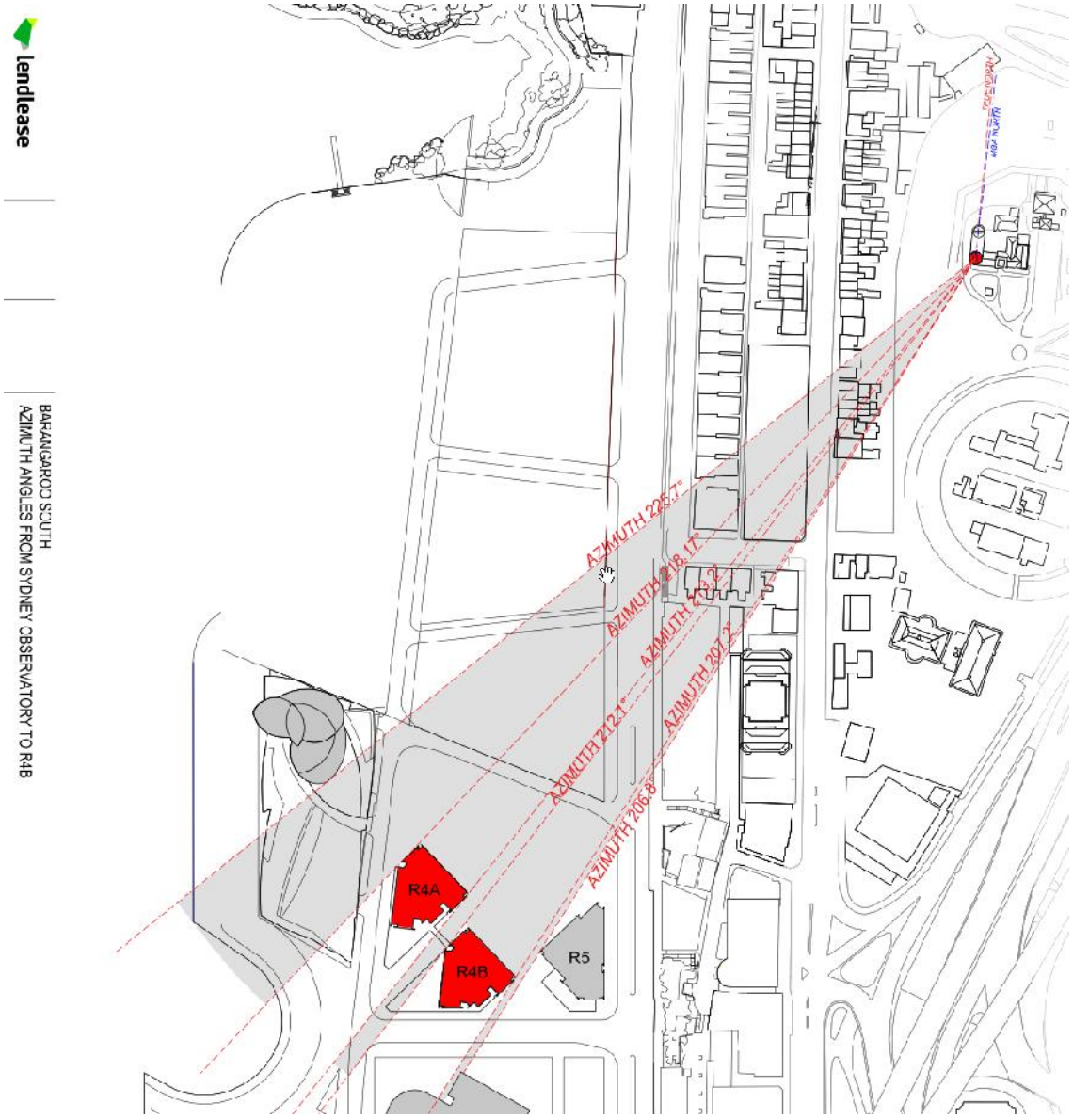

Fig 4 – Azimuth angles from Sydney Observatory south dome to residential towers R4A and R4B, as per information provided by Lendlease on 11 December 2019.

72 Thus a revised calculation of the impact of R4B with RL 235 on the observatory's sky view is necessary.

4.3 IMPACT OF THE RESIDENTIAL TOWER R4B AT RL 235 ON SYDNEY OBSERVATORY SKY VIEW

73 From the original Lendlease drawings, using a worst case horizontal distance of 435 metres and RL of 39 metres for ground level at Observatory Hill, I calculate a worst case altitude angle of 24.3^{o} for R4B with RL 235.

74 Sky view below altitude 18^{o} in the direction of the Barangaroo South development is obstructed by heritage listed trees in the park adjacent to the observatory.

75 Thus, using these values, the silhouette of R4B, where it obstructs the sky view from the observatory, as projected onto the sky plane, is azimuth 207^{o} to 212^{o} with altitude 18.0^{o} to 24.3^{o}.

76 However, it is also necessary to allow a margin of an additional ~3^{o} in both altitude and azimuth to take into account the effects of light spillage and the field of view of the observatory's Celestron telescope (5.7^{o}).

77 This increases the effective size of the R4B building silhouette on the sky plane to azimuth range to 204^{o} to 215^{o} and the altitude range to 18.0^{o} to 27.2^{o}.

78 The silhouette for R4B with RL 235 with the calculated margins incorporated is shown projected onto the sky plane in Fig 5 below.

79 Fig 5 depicts the sky at the time of year when the sky objects of interest are in the vicinity of the calculated R4B silhouette area, and as an example, shows the time of night when the view of the Southern Cross and the Jewel Box Cluster is completely obstructed by R4B.

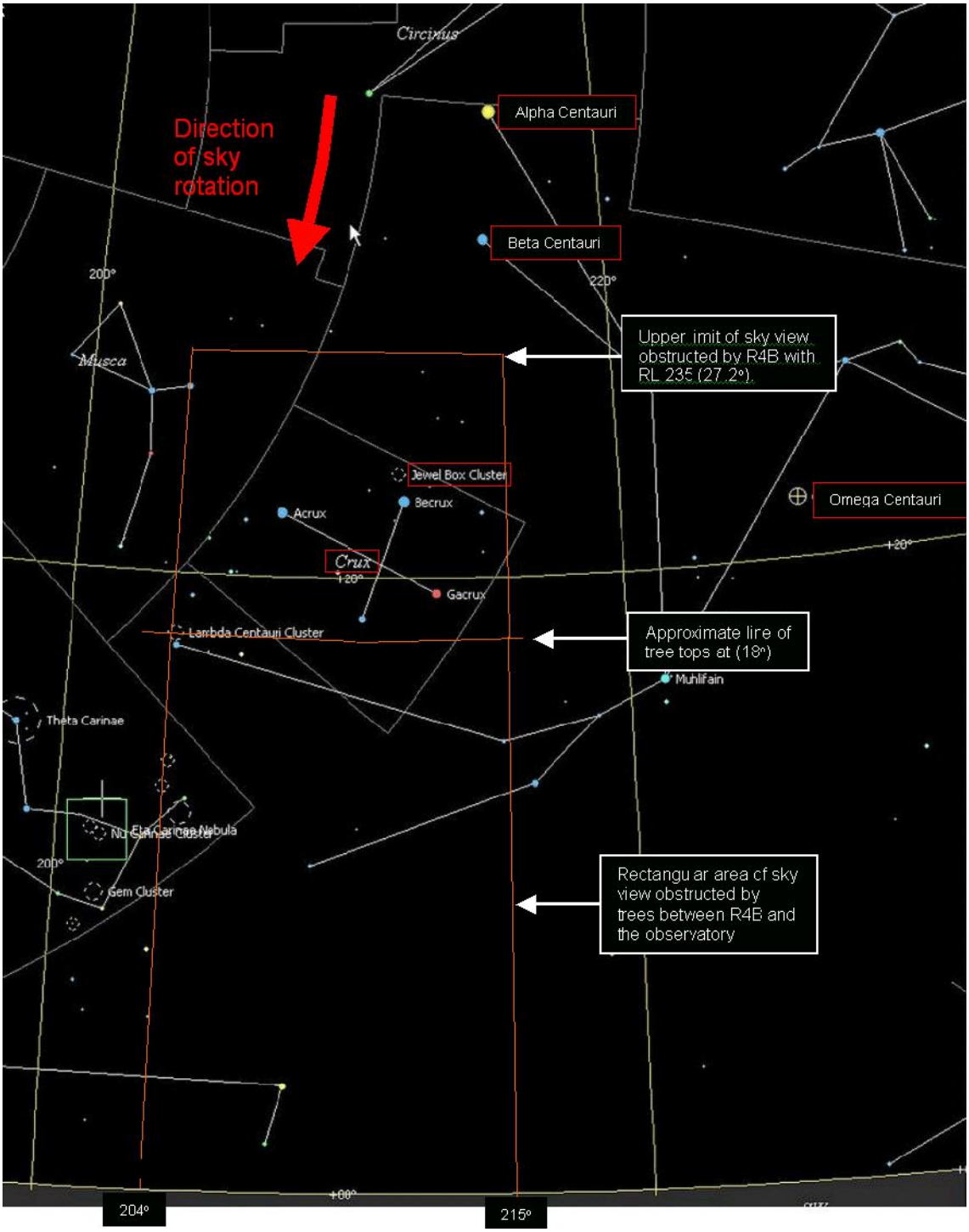

Fig 5 – Area of sky on 7 September, 2018 at 8:24pm, with view obstructed by R4B with RL 235 shown by the upper red rectangle. Sky objects obstructed by R4B are Southern Cross and Jewel Box cluster, with Omega, Alpha and Beta Centauri in the clear.

80 Fig 6 shows the same area of sky one month later, at approximately the same time of night, when R4B obstructs the view of Alpha and Beta Centauri, with the other sky objects of interest below 18^{o} elevation being obstructed by the trees that surround the observatory.

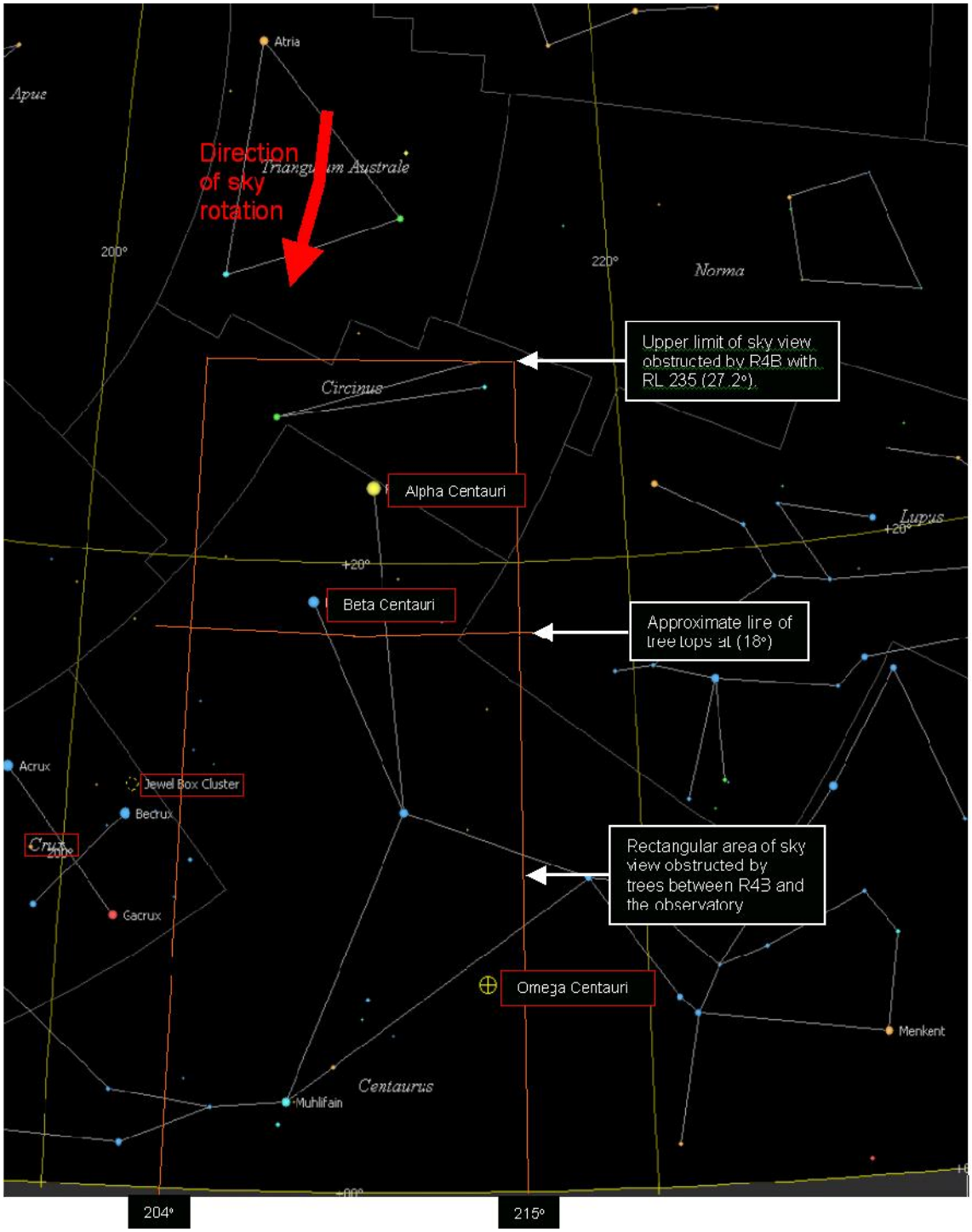

Fig 6 – Same area of sky on 7 October, 2018 at 8:31pm, with view obstructed by R4B with RL 235 shown by the large red rectangle. Sky objects of interest now obstructed by R4B are Alpha and Beta Centauri, with Omega Centauri, Southern Cross and Jewel Box cluster obstructed by trees.

5. FINDINGS

81 The sky view obstruction analysis in my first report used a conservative 26^{o} maximum altitude for R4A and R4B, this being based on Sydney Observatory's stated area of concern.

82 For this report, the maximum obstruction altitude for R4B with RL 235 with allowances for light spillage and telescope field of view has increased to a calculated 27.2^{o}.

83 The proposed extremities of R4A and R4B have also changed slightly, and Fig 4 shows the currently proposed azimuth angles as projected from the observatory's south dome.

84 Using these parameters for calculations, some sky objects of interest pass through the area of sky that is obstructed by R4B with RL 235 during times when the observatory is open for viewing in the months of August, September and the beginning of October each year.

85 It should be noted that the observatory opening times vary throughout the year, as they are governed in part by when the sun sets and the sky turns dark (see Appendix 3 for the schedule of observatory opening hours during various parts of the year).

86 The observatory's viewing opportunities the following sky objects of interest will be reduced during these three months on the nights when the objects of interest enter the obstruction area:

- The Jewel Box Cluster (open star cluster)
- The Southern Cross
- The Pointers (Alpha and Beta Centauri)

87 Table #1 below summarises, on a weekly basis, the calculated times that these sky objects will be obstructed by R4B in the year 2020.

Sydney Observatory Telescope Specifications:						Observatory															
Make:	Meade					Opening Times															
Model:	LX200					Monday to Saturday	Open	Close	Open	Close											
Type:	Schmidt Cassegrain					6th Apr - 4th Oct	6.15pm	10pm	18:15	22:00											
F ratio	f/10					5th Oct - 30th Nov	8.15pm	10pm	20:15	22:00											
Focal length	4064mm					1st Dec - 31st Jan	8.30pm	10pm	20:30	22:00											
Clear aperture	406mm					1st Feb - 4th Apr	8.15pm	10pm	20:15	22:00											
Field of view	5.7 deg.																				
	Obstructed Area:																				
	Altitude range	18	27.2	degrees																	
	Azimuth range	204	215	degrees																	

TARGET OBJECT	Obstructed Area:	enters	leaves	enters	leaves	enters	leaves	enters	leaves	enters	leaves	enters	leaves	enters	leaves	enters	leaves	enters	leaves	enters	leaves
Sydney Observatory Target Objects of Concern:																					
Jewel Box cluster	**Date:**	11/08/2020		18/08/2020		25/08/2020		01/09/2020		08/09/2020		15/09/2020		22/09/2020		29/09/2020		06/10/2020		13/10/2020	
NGC 4755	**Times:**	>22:00	>22:00	21:16	>22:00	20:49	>22:00	20:21	21:47	19:54	21:20	19:29	20:52	18:58	20:25	18:32	19:57	<20.15	<20:15		
	Obstruction time (mins)		0		44		71		86		86		83		87		85		0		
Southern Cross	**Date:**	11/08/2020		18/08/2020		25/08/2020		01/09/2020		08/09/2020		15/09/2020		22/09/2020		29/09/2020		06/10/2020		13/10/2020	
Crux	**Times:**	21:09	>22:00	20:42	21:54	20:14	21:27	19:47	20:59	19:19	20:32	18:52	20:04	18:24	19:37	18:15	19:09	<20:15	<20:15		
	Obstruction time (mins)		51		72		73		72		73		72		61		54		0		
Pointers	**Date:**	11/08/2020		18/08/2020		25/08/2020		01/09/2020		08/09/2020		15/09/2020		22/09/2020		29/09/2020		06/10/2020		13/10/2020	
alpha & beta Centauri	**Times:**					21:59	>22:00	21:32	>22:00	21:04	>22:00	20:37	>22:00	20:10	21:35	19:42	21:07	19:14	20:39	<20:15	<20:15
	Obstruction time (mins)						1		28		56		83		85		85		25		0
Other Targets Suggested by Lend Lease:																					
Ring Nebula	**Date:**																				
M57	**Times:**	never enters the obstructed area																			
Omega Centauri	**Date:**																				
NGC 5139	**Times:**	obstructed by trees before it enters the building silhouette																			
Albireo	**Date:**																				
Beta Cygni	**Times:**	never enters the obstructed area																			
Sun, moon, planets	**Date:**																				
	Times:	never enter the obstructed area																			

Table #1 - Sky targets of interest showing, on a weekly basis, the periods of time during which each enters and leaves the area of obstruction.

88 Table #1 also shows for each object of interest, on the Monday night of each week, the duration of the obstruction in minutes.

89 The week to week changes in obstruction times are immediately apparent from the table, and the daily changes may be derived by interpolating the weekly data.

90 It should be noted that on most nights, the sky objects of interest are only obscured for part of an observing session.

91 These nights are not necessarily problematic because if the viewing schedule is appropriately arranged by the observatory, the required sky objects could be viewed first, while they are still unobstructed, with no real inconvenience to the observatory.

92 For example, on 25th August, the Jewel Box Cluster is obscured from 9:17 to 10:00pm, at which time the observatory closes.

93 This should not present a problem, because the late observing session starts at 8:15pm, and it could be scheduled for observation before the time of obstruction.

94 Only those nights where the sky objects are not accessible for at least 10 minutes during any observing session should be considered as problematic.

95 Once a sky object passes through the obstruction area, there is no further viewing opportunity, since the trees surrounding the observatory obstruct viewing as each object progressively sets.

96 If a particular object enters the obstructed area before the start of an observing session, up to 90 minutes of potential viewing time may be lost, depending on the object and the time of year.

97 Table #1 finishes at the beginning of October.

98 After this, all objects of interest have set behind the trees during observatory opening times and are thus not available for viewing.

99 In situations where the observatory runs two observing sessions on the same night, each session needs to be considered separately, as some objects of interest may sometimes not be visible for one entire session.

100 R4B with RL 235 does not affect the observatory's view of Omega Centauri as this object sets well to the east of the obstruction area.

101 The following other sky objects of interest originally suggested are similarly unaffected, as they do not pass through the obstruction area of R4B:

- Ring Nebula (in Cygnus)
- Sun, moon and planets
- Star Albirio

102 The adjacent R4A building with RL 235 has been approved and is located in close proximity (see Fig 4).

103 However, all objects of interest set into the area obstructed by trees before they move west sufficiently to be in the obstruction area of building R4A.

104 Finally, I have been asked to comment, for context only, on whether the Central Barangaroo buildings obstruct the observatory's sky view.

105 The current approved massing envelopes for Central Barangaroo are maximum RL 35 or less.

106 Given that the ground level at the observatory has an RL of ~39 metres, it is higher than the tops of the Central Barangaroo buildings, and hence there is no possibility for them to obstruct the sky view from Sydney Observatory.

6. CONCLUSIONS

107 For the four sky objects of interest flagged by Sydney Observatory as having possible problems, three are generally not observable for part of the night from approximately mid-August to the beginning of October due to the obstruction caused by R4B with RL 235.

108 In addition to the four objects noted by Sydney Observatory, I have conducted a search for other well known sky objects that may be of interest to the general public that may pass through the area of obstructed sky during certain times of the year.

109 I have found no other such objects.

110 The seeing conditions for the part of the sky immediately above the buildings will generally be poor due to its low altitude, the large air mass through which it is viewed, the light pollution from nearby bright sources such as the Harbour Bridge, the effects of smog, scintillation, humidity and so forth.

111 Consequently, observing objects in the vicinity of the area obstructed by R4B would be done under observing conditions that are far from ideal, and the image quality would be relatively poor on most nights.

112 Based on Bureau of Meteorology weather data for Observatory Hill for September:

- on average, there will be some cloud cover for about half of the time
- there will be 10.9 clear days
- there will be 8.5 days when it is totally clouded over.

113 This, plus some Sydney entertainment night events (e.g., fireworks from the Harbour Bridge), imposes additional restrictions on the observatory's ability to conduct viable night sky observation sessions.

114 These issues reduce the viable observing opportunities for Sydney Observatory by an estimated 40%.

115 Thus the times when obstruction by R4B prevents viewing an object of interest, as listed in Table #1, will be similarly reduced due to conditions being unsuitable for observing.

116 Building R4A (with RL 250) does not obstruct any of the observatory's stated objects of interest.

117 Due to their low elevation, there is no possibility for the Central Barangaroo buildings to obstruct the sky view from Sydney Observatory.

George Georgevits
B.E. (Hons), PhD

APPENDIX 1

Brief Curriculum Vitae for George Georgevits

1 In 1972 I was awarded a cadetship with the then Postmaster General's Department to complete my Bachelor of Electrical Engineering degree at University of NSW.

2 I graduated in 1974 with honours.

3 I have 40 years experience as an electrical engineer, specialising in the fields of telecommunications, electronics and power.

4 During the first eight years of my career, I worked as an engineer for the PMG's Department, later known as Telecom Australia and then as Telstra.

5 In 1981 I founded Power and Digital Instruments Pty Ltd. (PDI) with a view to establishing a consulting engineering practice specialising in communications and electronics. A brief capability statement for PDI appears in Appendix A2.

6 Through PDI, I have successfully completed thousands of engineering projects for some 300 corporate and government clients.

7 PDI also owns and operates a test and measurement laboratory. The primary function of this laboratory is to conduct a wide variety of electrical tests on various types of active and passive components and equipment using sophisticated laboratory test equipment.

8 In addition, I regularly write technical articles on topical communications and power technology issues for *Cabling Connections, Cabling Home Solutions and Electrical Connections* magazines, these being Australian trade journals.

9 Although my formal qualifications relate primarily to electrical engineering, I also have extensive experience with the concepts of physics, electromagnetic waves, advanced mathematics and errors in measurements.

10 I hold PhD in Astrophysics from the University of NSW.

11 I have given presentations of my work in astrophysics at a number of international and Australian conferences.

12 I have co-authored a chapter in a textbook on the outer solar system.

13 My work in astrophysics has been cited in an article in the internationally recognised journal *Science* and also referenced in an article appearing in *Nature.*

APPENDIX 2

Capability Statement for PDI

POWER AND DIGITAL INSTRUMENTS PTY LTD.

PDI

Electronics and Communications Consulting Engineers

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ROSEVILLE NSW 2069

BUSINESS OFFICE:
66A FINDLAY AVE
ROSEVILLE NSW AUSTRALIA

TEL: +61 2 9411 4442

ABN 21 002 065 769

Jun'19

CAPABILITY STATEMENT

FIELDS OF EXPERTISE:

- Voice and data communications, mobile and fixed line telephony technology
- Radio communications, HF, VHF, UHF and microwave
- Power systems, power distribution networks and service providers, power equipment
- Assessment of damages claims - communications, power, gas & water Infrastructure and electrical equipment, including industrial equipment and domestic appliances
- Lightning protection, earthing systems and surge protection
- Electrical fire investigations and equipment testing to determine source of ignition
- Electronics design, manufacturing, troubleshooting and test & measurement
- Computer networks and computer technology
- Reliability engineering
- Electrical equipment and component testing and certification - analogue, digital and RF
- Balanced pair data cabling systems and components - design, testing and certification
- Communications equipment and service suppliers and Carriers
- Project management and specification
- Regulatory and legal aspects of power and communications systems, networks and equipment, and standards compliance, particularly electrical safety standards
- Patent specification technical preparation and advice
- Astronomy and astrophysics

SOME SPECIFIC AREAS OF WORK:

- Power systems, LV reticulation networks and equipment
- 50Hz magnetic field radiation surveys
- Lightning and surge protection - system design and testing
- Earthing system design, testing for standards compliance and power co-ordination
- Testing and certification of balanced pair Cat 7A, 7, 6A, 6, 5e, 5 LAN cabling systems and components to EIA, ISO & Australian standards
- Balanced pair data cabling connector design - Cat 6A, Cat 6 and Cat 5e
- Fibre optic communications cabling technologies
- Troubleshooting installed communications cabling systems
- RF test and measurement (PDI has a well equipped test lab)
- Radio interference, noise, EMC investigations, RF sweeps for covert devices
- Troubleshooting electronics and computer circuits and systems
- Specialised software development and interface
- Process control, automation, instrumentation and data acquisition

METHODOLOGY

Dr Georgevits is managing director and principal consulting engineer for PDI (established 1980). Dr Georgevits has an honours degree in Electrical Engineering, a PhD in Astrophysics, and over 35 years experience industry experience as a consulting engineer.

PDI has a proven track record in engineering consultancy, test & measurement, electronics design and troubleshooting, and computer technology.

PDI operates a well-equipped test and measurements laboratory and has successfully completed thousands of engineering projects for some 500 corporate and government clients.

ENGAGEMENT

Engagement to perform consultancy work is carried out on a contract basis. Fees may be structured on a fixed lump sum basis for clearly defined tasks, or on an hourly rate for other work, as required and mutually agreed with the Client.

PDI offers a completely independent advisory service. PDI has no affiliations with suppliers of equipment or services.

BRIEF LIST OF REFERENCES

Some Current Clients:

- Amphenol Canada Corporation - connector manufacturer
- Coffey Testing Services/Acciona – Eastern Suburbs Light Rail project – electrical testing
- Expert Consulting Pty Ltd. – ongoing, various projects requiring expert opinion
- Experts Direct – ongoing, various projects requiring expert opinion
- Expert Experts – ongoing, various projects requiring expert opinion
- Unisearch Expert Opinion Services – ongoing, various projects requiring expert opinion
- Fire Forensics – ongoing, various fire related electrical investigations
- Omega Power Eqpt Pty Ltd. - electrical wholesalers and importers – cable testing
- Piper Alderman (solicitors) – large damages claim - industrial equipment
- PRYSMIAN Cables Australia Pty Ltd - cable manufacturer and importer – cable testing
- Saunders CivilBuild – Civil engineers – bridge construction, precast concrete structures
- Voltex Pty Ltd. - electrical wholesalers and importers – cable & connector testing

Some Completed Assignments:

- Acheron Project – Deepsea Challenger submarine, James Cameron (Terminator fame)
- Australian Astronomical Observatory – SSO lightning protection design and testing
- Australian National University (ANU) – Mt Stromlo lightning protection design & testing
- Barry Nielsson Lawyers – various litigated damages claims
- Barangroo South Crown Hotel – obstruction of sky view from Sydney Observatory
- Clayton Utz Lawyers – Master Home Improvements – Infinity power cable safety recall
- Crawford & Co (Loss Adjusters) – various damages claims
- Lantek Electronics – Taiwan (connector manufacturer)
- Leighton Contractors (major projects contractors) - M2 tunnel widening instrumentation
- NSW Crown Solicitor's Office – mining site fatality involving PLC controlled equipment
- QBE Insurance (Aust) Ltd (all states) – many damages claims
- Surtec Industries Inc. – Taiwan (connector manufacturer)
- Technical Assessing Pty Ltd (loss adjusters) – various damages claims
- Tenix Group (major projects construction & defence) – 132KV power cable damage
- Thiess Ltd. – QCLNG Project – troubleshooting power cabling problems
- UNSW Sydney, Communications Services Group – lightning protection all UNSW sites

APPENDIX 3

Sydney Observatory Public Viewing Schedule

sydney observatory
PART OF THE POWERHOUSE MUSEUM

Hours and charges

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NIGHT VISIT

Open nightly Monday to Saturday except Good Friday, Christmas Day and Boxing Day holidays. Open Sunday nights during school holidays.

Bookings are necessary for night sessions (of approximately 90 minutes duration). Phone (02) 9921 3485 or **book online**.

Night telescope/3D theatre session times
April to September – 8.15pm and 8.15pm
October and November – 8.15pm
December and January – 8.30pm
February and March – 8.15pm

Night charges for telescope/3D theatre sessions
Adult – $18
Child (4 to 15 years) – $12
Concession – $14
Family (1 adult and up to 3 children;
or 2 adults and up to 2 children) – $50
Member (adult) – $16
Member (child) – $11
Member (family) – $43

Sessions are held regardless of weather. If viewing through the telescopes is not possible due to sky conditions, a fun digital planetarium session is provided instead.

All night visits must be booked and prepaid prior to arrival at the Observatory. Payment for night tickets is not refundable. However if you notify us by phone on 9921 0485 by noon on the day you are scheduled to attend your night visit, we can either transfer your booking to another available night; or offer you a 'rain check' ticket, valid for three months from first booking, to the same value as your original booking.

Debit and credit card fees: As part of a NSW Government requirement, Sydney Observatory applies a surcharge on all transactions made by debit or credit cards. Surcharge rates are determined on a cost-recovery basis only. No surcharge is incurred when paying with EFTPOS, cheque or cash. Payments made on VISA and Mastercard attract 0.40%

Review your visit on facebook
Would you like to tell others about your visit to Sydney Observatory? Then you might like to **review your visit on facebook.**

DAY VISIT

Open 10am – 5pm daily
except Good Friday, Christmas Day and Boxing Day holidays
Open 10am – noon New Years Eve

Day telescope/3D theatre session times
Monday to Friday (school term) – 2.30pm, 3.30pm and 4.00pm
Weekends and school holidays – 11am, noon, 2.30pm and 3.30pm
Bookings are not required for day sessions.

Day charges for telescope/3D theatre sessions
Adult – $10
Child (4 to 15 years) or concession – $8
Family (1 adult and up to 3 children;
or 2 adults and up to 2 children) – $26
Member adult – $6
Member child (4 to 15 years) or concession – $4
Member family (1 adult and up to 3 children;
or 2 adults and up to 2 children) – $16

Daytime admission for a self-guided visit to the gardens and the Observatory exhibitions is free – but does not include visits to the telescope towers, telescope viewings and 3D theatre sessions.

Debit and credit card fees: As part of a NSW Government requirement, Sydney Observatory applies a surcharge on all transactions made by debit or credit cards. Surcharge rates are determined on a cost-recovery basis only. No surcharge will be incurred when paying with EFTPOS, cheque or cash. Payments made on VISA and Mastercard will attract 0.40%

The Powerhouse Museum is an Affiliate of the NSW Government's Department of Ageing, Disability and Home Care's Companion Card program. This means that carers who accompany a person with a disability will be eligible for free entry on presentation of their Companion Card. For more information visit **www.companioncard.org.au**

Visit the Powerhouse Museum

1003 Upper Fort St, Millers Point, NSW, 2000.
Bookings / enquiries: PH: (02) 9921 3485
NSW Government

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APPENDIX 4

Science Article

ASTRONOMY

Twinkling Stars May Reveal Stuff of Early Solar System

Australian researchers say dips in the brightness of stars may tell of a vast array of objects beyond the planets, but others aren't so sure

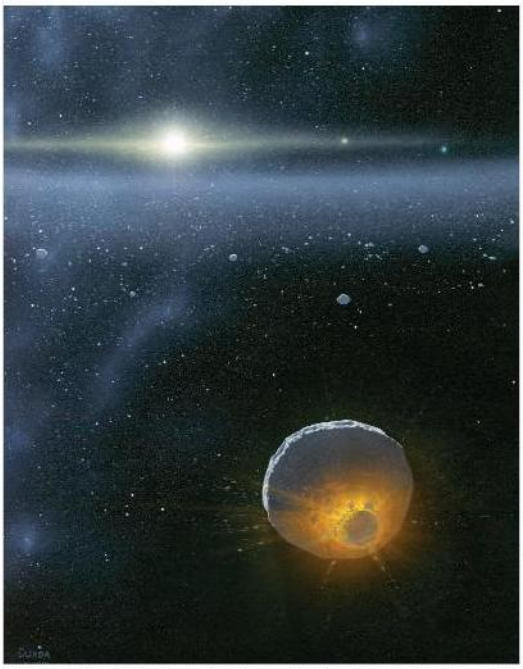
CATANIA, ITALY—The Kuiper Belt, resting place of much of the detritus left over from the creation of the solar system, may contain many more small objects than previously thought. Australian astronomers scanned the outer reaches of the solar system by looking for a brief dimming of the light of distant stars as subkilometer-sized bodies passed in front of them. Preliminary results presented at a workshop here earlier this month* suggest that huge numbers of such objects lurk beyond the orbit of Neptune. Although most Kuiper Belt researchers are cautious, studies by some other teams suggest the Australians may be onto something. "If this is true, it would be fantastic," says Alessandro Morbidelli of the Observatoire de la Côte d'Azur in Nice, France, because information about the smaller denizens of the Kuiper Belt cannot be found any other way.

Astronomers have found more than 1000 bodies in the Kuiper Belt, including an object known as 2003 UB_{313} (nicknamed Xena) that is slightly larger than Pluto. But because they are several billion kilometers away, even the most powerful telescopes can't see Kuiper Belt objects smaller than about a hundred kilometers across. Researchers are keen to know more about their size distribution, as it would shed light on the early youth of the solar system.

An effort to fill that gap has been going on since last year. The Taiwanese-American Occultation Survey (TAOS) operates three automated 50-centimeter telescopes at Lu-Lin Observatory, Taiwan, which scan starlight for telltale dimming that signals a Kuiper Belt object passing in front of, or "occulting," the star. So far, the survey has drawn a blank. Team member Federica Bianco of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts, says TAOS can't observe very brief dips in brightness, so it is capable of spotting only the relatively rare objects larger than a few kilometers in diameter.

But George Georgevits and Michael Ashley of the University of New South Wales in Sydney and Will Saunders of the Anglo-Australian Observatory in Siding Spring say the Kuiper Belt may teem with objects too small for TAOS to see. Using a fast detector at the 1.2-meter U.K. Schmidt Telescope in Siding Spring, they saw well over a thousand brief brightness dips, each lasting for a tenth of a second or less, while monitoring dozens of stars for about 2 weeks.

"It's very important work, and they should certainly continue," Morbidelli says. "But the results so far are very strange," because current theories of the evolution of the solar system do not predict huge numbers of small Kuiper Belt objects. Michael Brown of the California Institute of Technology in Pasadena, who discovered 2003 UB_{313}, adds that "the believability factor [of these results] isn't very high. Unfortunately, you can never go back and check." But Georgevits counters that he has checked and ruled out every other possible cause of the stellar winks.



When worlds collide. Two icy bodies crash in the Kuiper Belt in this artist's depiction. Could such collisions have populated the belt with tiny objects?

CREDIT: DAN DURDA/FAAA

So are the results real? "Well, it seems they are observing *something*," says David O'Brien of the Planetary Science Institute in Tucson, Arizona, although he adds that no one has yet carried out a detailed statistical analysis of the Australian results. According to O'Brien, collisions in the Kuiper Belt may have produced hordes of small objects. "If confirmed, these results could tell us something about the strength properties of Kuiper Belt objects," he says.

Some other studies support the Australian results. Taiwanese astronomers have uncovered similar brief occultations of the well-known x-ray source Scorpius X-1 in data from NASA's Rossi X-ray Timing Explorer satellite. A team led by astronomer Ping-Shien Wu of the National Tsing Hua University in Hsinchu presented the finding in April at the Chinese Astronomical Society Taiwan's meeting in Taichung and is due to publish it in *Nature* next month. And at the Catania workshop, Françoise Roques of the Paris Observatory described three brief occultations detected with the 2-meter Bernard Lyot Telescope in the French Pyrenees, which Roques says may also represent small Kuiper Belt objects.

Not everyone is convinced. "They have to do more checks on possible false alarms," says Matthew Lehner of CfA. For instance, the dips might be caused by unknown effects in Earth's atmosphere. To avoid these, you need to observe from space, says Lehner, who is part of a team that has pitched to NASA a $425 million occultation mission called Whipple, which would detect Kuiper Belt objects as well as comets in the much more distant Oort Cloud.

Meanwhile, Georgevits hopes to raise half a million dollars for a purpose-built ground-based telescope equipped with a very fast video camera. Such a device could survey the whole Kuiper Belt for a fraction of the cost of a space mission, he says. And although his team's preliminary results raised some eyebrows, everyone agrees on the need for a more comprehensive search. Says O'Brien: "Small Kuiper Belt objects will never be observed directly. Occultation surveys have a lot of potential to fill in this gap."

–GOVERT SCHILLING

Govert Schilling is an astronomy writer in Amersfoort, the Netherlands.

* Trans Neptunian Objects: Dynamical and Physical Properties, Catania, Italy, 3–7 July.