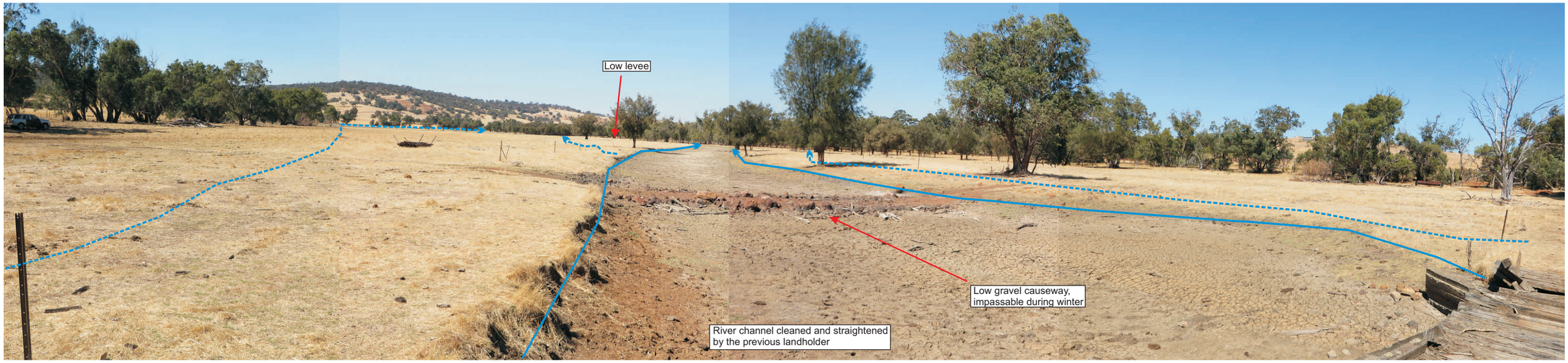
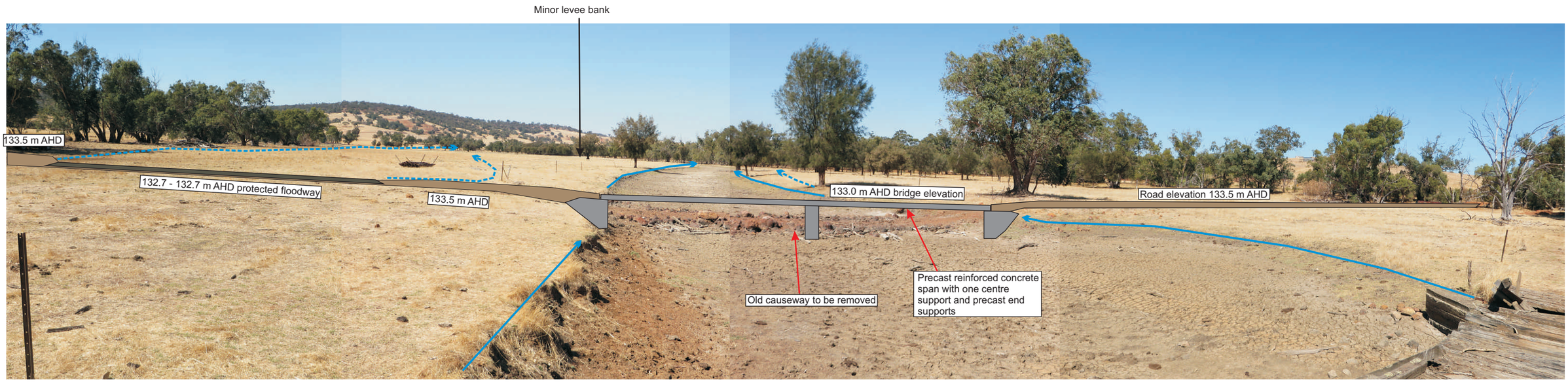


Existing crossing of the Brockman River

Normal winter water flows

Flood flow paths from aerial photography. 0.5 metre contour mapping, local observations and field assessment



Concept proposed upgrade to the crossing of the Brockman River. (NOTE the distortions of elevation and level are caused by the photographic lenses).
Bridge and causeway design to be subject of engineered design and drawings

BRIKMAKERS

PROPOSED CLAY EXCAVATION LOT 7. TOY ROAD, BINDOON	
BROCKMAN RIVER CROSSING	
Landform Research	January 2015
Scale See Plan	
Basemap Landgate	**Figure 9A**

Normal winter water flows

Flood flow paths from aerial photography. 0.5 metre contour mapping, local observations and field assessment

South western corner of Lot 7 generally above the flood elevations

View south across the flood plan showing the old bridge on Lot 7 that can no longer be used

BRIKMAKERS

PROPOSED CLAY EXCAVATION LOT 7. TOY ROAD, BINDOON	
BROCKMAN RIVER CROSSING	
Landform Research	January 2015
Scale See Plan	
Basemap Landgate	**Figure 9B**

Appendix 1

DUST MANAGEMENT PLAN

PROPOSED CLAY QUARRY
LOT 7 TOY ROAD, BINDOON

CONTACT DETAILS

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BRIKMAKERS

August 2015

Landform Research
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EXECUTIVE SUMMARY

The findings of the Dust Management assessment and management procedures are summarised below.

Summary

- A total of 9 hectares of excavation and stockpile area will be required.
- Access will be from Toy Road.
- Excavation is for clay which carries no known health risks.
- The operations comply with the Department of Health Guidelines and Queensland Primary Industries Guidelines.
- Buffers to are the three closest dwellings are 450, 750 and 800 metres. The closest dwelling is occupied by the landowner of Lot 7.
- Clay excavation must comply with the *Mines Safety and Inspection Act* for Health and Safety.
- Officers from the DMP will regularly inspect the site and the site must be registered under the DMP SRS system.
- Consultation with the residents in Toy Road has already taken place to explain the small and temporary nature of the operations. As a result of the discussions the scale of the project has been reduced. Appendix 5 of the Excavation and Management Plan.
- Assessment using *DEC 2011 Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Sites Remediation and other Related Activities* shows that the proposed operations have a Negligible Risk for all but the dwelling to the west which has a Low Risk.
- The main risk from dust is the crushing of clay on trafficked areas. Prior to excavation the clay stays moist and when dug from the face is not dusty.
- The clay is stored in stockpiles and being clumped does not pose a dust risk.
- A risk analysis shows a Low Risk for dust impacting offsite.

Management - Commitments

- Extensive Dust Management Procedures are committed to.
- Dust will be treated with water. A water cart will be available on site at all times when there is a dust risk.
- Water will be used to wet down all roads and active areas, as well as stockpiles and/or the excavation face as required to ensure the loading and movement of clay can be completed without significant gust generation.
- A visual monitoring trigger and action plan is proposed. This type of system is used at all quarries and has been found to be the most effective when combined with a complaints and action procedure which is also committed to.
- The Operational Management Actions listed in Section 3.2 Excavation and Management Plan are committed to.

CONTENTS

1.0 Summary of the Proposed Operations

1.1 Site and Proposal

All excavation is to be undertaken on a south facing valley side in the central part of Lot 7 near the western boundary. Excavation of gravel has been conducted on the eastern portion of Lot 7 for some time.

An area of clay comprising 9 hectares is proposed to be excavated with a stockpile area of 4 hectares for support. Excavation is to be undertaken on a south facing valley side in the central part of Lot 7 near the western boundary. Excavation of gravel has been conducted on the eastern portion of Lot 7 for fifteen years.

The clay resource occurs in weathered schist that extends to depth with a resource of 10 - 12 metres, at which depth other issues such as the quality of the resource and the costs of excavation may preclude efficient extraction.

It is anticipated that 50 000 – 100 000 tonnes will be removed each year. The amount of material extracted will depend on the nature of the local and export brick markets and public demand for particular colours of bricks but is anticipated to be nearer 50 000 tonnes per annum in the early years rising in later years.

Excavation will largely occur below natural ground level. Earth bunds of 5 or 7.5 metres in height will be constructed along the south and north of the extraction and stockpile areas and planted with trees.

Hours of operation will be restricted to 7.00 am to 5.00 pm Monday to Saturday with no work on Sundays and public holidays.

Clay will be excavated intermittently throughout the year in a number of campaigns, and stockpiled for use at other times of the year. On the calculated truck movements, clay is proposed to be transported from this site on between 25 and 30 days per year.

A variety of excavation methods are used depending on the configuration of the pit, the complexity of blending and the weather conditions. At various times excavators, loaders may be used to excavate, load or form stockpiles. Much of the excavated clays are loaded directly into road trucks for haulage to the Hazelmere factory. The balance is stockpiled using dump trucks for later use.

See the Excavation and Management Plan for more details.

1.2 Equipment

The excavation methods are detailed in Section 4 of the Excavation and Management Plan.

Summary of Equipment	Comment
Maintenance vehicles	Brikmakers has mobile maintenance truck based facilities that access the site as required.
Bulldozer	A Komatsu 375-5 or similar dozer will be used to reform the landscape and open various stages of the pit. Apart from land restoration, operates on the floor of the pit.
Excavator	A 45 tonne excavator PC450 or similar will be used to extract clay from the face and low load the trucks in the pit.
Water tanker	An 8 wheel water tanker or similar will be available on site during excavation transport operations to provide for dust suppression.
Loader	Used to recover clay from stockpiles and load road trucks. A Komatsu WA500 or similar loader will be used for loading and handling products.
Off Highway Dumpers	CAT 740 or similar off highway dumpers work with the excavator to transport resource from the face to the stockpiles.
Drill rig	Brikmakers has its own drill rig that is used to test the clays to depth. natural ground level where the resource is harder. The site has already been drilled.

Access will be from Toy Road in the south, crossing the Brockman River via the existing causeway, which will have to be updated as it is indisrepair in the location shown on the attached figures in the Excavation and Management Plan.

The number of road truck movements will vary throughout the year depending on whether the resource is being transported or not.

Road transport will use a variety of trucks such as semi-trailers or rigid (8) wheeler trucks to a 5 axle dog trailer.

It is anticipated that up to 3 000 tonnes per day will be transported, generally in truck and trailer combination. That is approximately 10 laden trucks per hour.

At other times there will be no activity on site.

1.3 Climate

Climate data is supplied in 2.1 of the Excavation and Management Plan. It shows that the stronger easterly summer morning winds will move from the east travelling in a south westerly direction down slope across the excavation site to the valley of the Brockman River, generally blowing away from dwellings.

Afternoon sea breezes are from the south to south west, generally blowing away from dwellings to the south.

The wind roses for Pearce are attached as Attachment 2. These show that there is a pronounced easterly wind at 9.00 am on summer mornings, but this has to be balanced by the afternoon winds which blow from the south west at 3.00 pm. The data collected at Pearce has to be viewed with caution and can only be used as a general indication for this site and must be subject to interpretation.

The wind data for Pearce is attached and shown for summer, typified by January, when the risks of dust are greatest and also for the yearly average.

Pearce lies at the base of the Darling- Gingin Scarp and is subject to strong katabatic winds on summer mornings. The Scarp is immediately east of Pearce and produces the easterly spike at 9.00 am. This causes the windshear at Pearce and Perth Airport.

The issue of katabatic effects is well explained in *Mitchell, K, 1979, The Effect of the Darling Scarp on Easterly Air Flow, Geowest No 15 University of Western Australia.* Katabatic effects result from the variations in air temperature, topographic effects and the air flow from the Darling Plateau down to the base of the Darling Scarp. The winds are significantly affected and directed by landform.

It can be seen that an easterly wind travelling from the excavation area towards the west will be deflected down the slope of the Brockman Valley and the associated hills and scarps. The proportion of wind travelling from the excavation area to the dwelling or the sandalwood is reduced, and the Pearce summer morning data cannot simply be applied. The area that appears to be planted to sandalwood lies to the north of the gravel excavations. See Attached Figure showing wind directions.

The 100 metres change in elevation from the plateau to the north east is sufficient to deflect the katabatic winds. Based on katabatic effects the interpreted flow paths of the wind will be from the east and north east channelled west along the valley of the Brockman River away from nearby dwellings to the north, east and south.

The proposed tree belts will assist in reducing local wind speeds in operational areas.

The sea breezes, which are from the south west, blow across the Brockman River valley, being partially reduced by the hills to the south, trees on site and tree belts to be planted. The closest dwelling to the north will be out of line of the afternoon seabreezes.

The influence of slopes and trees is recognised in the *South Australian EPA Guidelines for Separation Distances, December 2007.* The South Australian EPA Guideline recommends a buffer distance of 300 metres and then for decreases of
x 0.68 for significant “hills and valleys” and x 0.85 for “level wooded country”.

Both these factors will reduce the buffer requirements down to 173.4 metres. The EPA of Victoria uses a generic buffer of 200 – 300 metres for extractive industries of this type.

Buffer distance and the impact of trees was considered by the Department of Natural Resource in Queensland in a study at Emerald. This showed that a tree buffer of 20 metres was sufficient to provide fine particulate management and barrier in the form of spray drift; Primary Industries Standing Committee, 2002, Spray Drift Management, CSIRO Publishing, Report 82. The trees within the flow path will help break up the wind.

The weather data therefore shows that for the time of greatest risk from dust, in summer, the prevailing winds and location of the pit will provide significant protection to all surrounding dwellings. The greatest risk is to the dwelling to the west, which the landowner rents and occupies.

2.0 Dust Risk

2.1 Sources of Dust

The main risk from dust is the disturbance of clay on trafficked areas, particularly the pit floor and stockpile areas. Prior to excavation the clay stays moist, and when dug from the face is not dusty.

The clay is stored in stockpiles and, being clumped, does not pose a dust risk.

Disturbance by repeated vehicle movements may cause the clay to develop into a fine "floury" dust, that could have the potential for dust generation.

Treatment by water eliminates the generation of fine dust and keeps the clay aggregated and crusted.

A lesser risk is the gravel access road which will also be treated with water.

The frequency of watering will be adjusted to suit the operating conditions, weather and vehicle movements.

2.2 Occupational Dust Risk

Excessive dust also has the potential to impact on workers if untreated.

Occupational dust associated with the quarrying processes falls under the *Mines Safety and Inspection Act 1994 and Regulations 1995* overseen by the Department of Mines and Petroleum.

The proponent will provide induction and protective equipment for all persons on site.

The DMP require personal dust monitoring to ensure dust levels comply with health risk guidelines.

The dust management procedures used on site will comply with these guidelines.

The management of environmental and occupational dust requires the same techniques and actions. If occupational dust is managed, then there will be minimal risk of dust impacting on the external or onsite environment.

2.3 Environmental Dust Risk

The potential impacts are assessed for the sensitive premises to the west and south, under the worst possible scenario.

The risk in winter will be substantially lower.

- ***Nearby Dwellings***

These are shown in Figure 2 of the Excavation and Management Plan.

- ***Calculation***

Dust emissions fall under the *Guidance for the Assessment of Environmental Factors, EPA, March 2000*. Assessments of the potential dust risk are normally made using the Land development sites and impacts on air quality, *Department of Environmental Protection and Conservation Guidelines, November 1996.* These are still in place but are incorporated into the *DEC 2011 Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Sites Remediation and other Related Activities.*

The *DEC (DER) in 2008* released a *draft Guideline for the Development and Implementation of a Dust Management Plan.*

The key Environmental Objectives for the operations are;

- Manage the potential for the generation of dust.

- Visually monitor dust levels and take steps to reduce the potential impact of dust on occupational and environmental aspects of the operation and local area.

The category of dust risk is included in *DEC 2011 Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Sites Remediation and other Related Activities.*

This document is not really applicable to mining because it is to be used to assess the management required prior to any dust suppression measures being implemented. Effective dust management measures are already used on this site.

When making the assessments using the DEC (DER) Guideline there are four key points;

- Only the premises subject to the prevailing winds from the pit are used for the DER Methodology but in the example below all dwellings are used.

- Dust risk is generally only in the dry summer months

- The clay readily crusts and is stabilised. It is only trafficked areas of dry clay and the gravel roads that develop fine dust from the action of wheels.

- The perimeter bunds and vegetation provide effective wind breaks and wind screening.

- Water treatment of the clay is to be used to maintain moisture levels and manage dust risk.

2.4 Calculated Dust Risk Assessment from DEC (DER) 2011

PART A Number	Item	Score	
		With no dust management in place	**With effective management in place**
1	Nuisance potential of the material	High when disturbed and trafficked and untreated – 6	Low with effective water sprays and wetting down - 2
2	Topography and vegetation screening	Medium screening - 6	Medium screening - 6
3	Area of site activities	Trafficked areas are 1 to 5 - 3	Trafficked areas are 1 to 5 - 3
4	Type of work being undertaken	Bulk earthworks - 6	Bulk earthworks - 6
	Summer total without dust measures	21	17

PART B Number	Item	Score (With no dust management in place)	
		Clay excavation	**Loading and stockpiling**
1	Distance to sensitive premises	100 – 500 metres – 12 (1 dwelling) 1 km – 500 m (other dwellings) - 6	100 – 500 metres – 12 (1 dwelling) 1 km – 500 m (other dwellings) - 6
2	Effect of prevailing wind	Dwelling west - Isolated land use affected by one wind direction – 6 (1 dwelling) Not affected (other dwellings) - 1	Dwelling west - Isolated land use affected by one wind direction – 6 (1 dwelling) Not affected (other dwellings) - 1
	Summer total without dust measures	18 or 7	18 or 7

Activity	Calculated Score	Allocated Risk of Dust
Land Clearing and excavation without dust suppression.	147 - 378	Classification 1 - 2 Negligible Risk for all but the dwelling to the west which has a Low Risk. Dust management will be required for pit best practice and worker environment.

With dust suppression	119 - 306	Classification 1 - 2 Negligible Risk for all but the dwelling to the west which has a Low Risk. Dust management will be required for pit best practice and worker environment.

3.0 Dust Management

3.1 Non Operational Management

- ***Screening Tree Belts and Buffers***

Dust particles are readily stopped by tree belts and distance, with which the site complies. Tree belts slow the wind and allow the dust to settle. See *Planning Guidelines Separating Agricultural and Residential Land Uses, Department of Natural Resources Queensland 1997(Pages 65 – 111) and Department of Health WA, 2012, Guidelines for Separation of Agricultural and Residential Land Uses which uses the same criteria (Pages 112 – 118).*

The Queensland Guidelines predominantly relate to agricultural spray drift, but based on particle size also relate to dust.

The Guidelines provide for a buffer of 300 metres for open agricultural land, dropping down to 40 metres where an effective tree belt is in place. The Western Australian Department of Health also uses the same guidelines. The Guidelines are based on field studies and demonstrate the effectiveness of tree belts in providing screening against particulate travel.

There is a discussion of the desirable buffers in Section 5.2.1 Surrounding Landuses and Buffers of the Excavation and Management Plan where all the data, and generic buffer distances from Western Australia and other States, suggest that 300 metres is an effective buffer distance for dust for such an operation.

The excavation has good buffers of over 700 metres to all dwellings apart from the dwelling to the west, which is 450 metres from the excavation area and stockpiles. All dwellings comply with a 300 metre buffer distance.

These distances are within the EPA generic buffer guidelines and Shire of Chittering Guidelines with the exception of the dwelling to the west. The Shire of Chittering Local Law provides some discretion for Council with respect to buffers.

There are some existing trees and further more will be planted.

Earth bunding will be located around the south and west of the active areas and planted with local trees.

3.2 Operational Management

- ***Actions***

There are a number of management actions that are used in quarries to minimise dust generation or travel and these are used wherever possible. These are generic management designed to prompt staff to take action as the opportunity presents, rather than using unchanging dust management procedures.

The actions are used where applicable and as the opportunity presents to minimise dust on this site.

A dedicated water truck is retained on site for the wetting down of roads and other dust suppression activities. In addition the access road is sealed and maintained.

Methods that are available, and will be selected from, are listed below. The most effective by far is the use of water management from a water truck, sprinklers, water canon or other such mechanism.

DESIGN AND SITE

1. Minimising the amount of ground open.
2. Minimising the amount of ground being subject to traffic.
3. Locating access roads away from sensitive premises.
4. Design of the pit to reduce wind speed and potential dust lift off.
5. Maintaining effective setbacks.
6. Constructing perimeter bunds to reduce wind speed.
7. Planting and maintaining tree buffers.
8. Providing wind break fencing generally and on top of bunds as required.
9. Maintaining a secure, fenced site, to prevent illegal access.
10. Rehabilitate and stabilise all completed areas as soon as practicable.
11. Clearing and replacing topsoil and overburden during wetter times; April to October.

OPERATIONS

12. Locate active areas away from windy locations.
13. Locate active areas away from sensitive premises.
14. Working on the floor of the pit.
15. Operate some parts of the pit only when conditions are suitable.
16. Locating mobile plant and stockpiles in sheltered areas.
17. Design staging to minimise dust risk.
18. Conduct higher dust risk operations such as topsoil clearing and placement during more favourable conditions.
19. Shut down equipment that is not required.

ACCESS AND HARDSTAND

20. Constructing the access roads from hard materials that resist dust generation.
21. Maintaining a water truck on site for road and other wetting down.

22. Using a sealant such as a polymer, chemical or emulsified oil or bitumen on the access road to reduce water use.
23. Using sprinklers and water canon on roads, traffic areas and stockpiles.

STOCKPILES

24. Minimise the number of stockpiles.
25. Maintain stockpiles in sheltered areas.
26. Reduce the elevation of stockpiles.
27. Limit the drop height to stockpiles and loading.
28. Locate finer products inside or screened by stockpiles of coarse materials.
29. Locate stockpiles away from sensitive premises.

TRANSPORT

30. Cover all loads.
31. Ensure all trucks are dust free and not carrying pebbles and other materials outside the tray.
32. Choose the best transport routes.
33. Wet down or sweep the cross over and access roads.

HEALTH AND COMMUNITY

34. Maintain air conditioned cabins on all vehicles.
35. Implement a trigger of no visible dust to cross the property boundary from site activities in line with DER Licence and best practice in WA.
36. Implement visual monitoring for all activities.
37. Conduct effective site induction and awareness training for all staff.
38. Training should include observation and mitigation where possible of all dust emissions.
39. Providing a complaints investigation, mitigation and recording procedure.
40. Liaising with the owners/operators of the two nearby sensitive premises.
41. Ceasing operations when conditions are not favourable or when visible dust is crossing the boundary.
42. Obtain the latest weather conditions to increase the awareness of dust risk.
43. Cease operations during adverse weather conditions.
44. Operate during wetter months or when the soils are moist.

Normally the stripping or re-instatement of overburden and topsoil and their subsequent use in rehabilitation will be undertaken during the wetter months if possible.

Completed sections of the quarry are to be stabilised and not subject to traffic as soon as practical to reduce the area of open ground and help reduce wind speed.

In the event of dust management not being able to be achieved, and to minimise impact on adjoining land holders, the dust generating activities will be stopped until conditions improve.

A record of all dust complaints is retained together with the mitigation measures used to reduce the dust impacts.

- ***Management***

ACTIVITY	POSSIBLE RISK SEVERITY and FREQUENCY	COMMITMENTS ON ACTIVITIES CONDUCTED ON SITE	RISK AFTER MANAGEMENT
GENERAL			
Legislation	----	• Brikmakers will comply with the Mines *Safety and Inspection Act 1994 and Regulations 1995*.	----
Buffers	----	• Research and generic buffers in Western Australia and other States show that at 300 metres distance, potential dust impacts are minimal eg Department of Health Guidelines. • The dwelling occupied by the owner of Lot 7 lies at a distance of 450 metres, which complies with the EPA generic buffer guidelines and is just less than the Shire guideline of 500 metres, a buffer over which the Shire has discretion.	----
Footprint and Excavation Screening/ Vegetation	---	• The operations are partially protected by vegetation. • Activities are located behind natural barriers, landform and vegetation where possible. • Vegetated bunds will be formed around the perimeter of the pit. • Additional tree belts are proposed. These will be maintained and replanted as necessary.	----
	---	• Working below natural ground surface is proposed with excavation up to 12 metres below natural ground level behind 5 – 7.5 metre vegetated perimeter bunding. • Benching will be used in deeper locations to maximise efficiency and minimise impacts.	----
	---	• The excavation is designed to provide enhanced landform and constructed dust screening. • See above and Excavation and Management Plan.	----
	----	• The resource is proposed to be excavated in two stages excavating from south to north to maximise screening.	----
	Screening and vegetation	• The existing vegetation and trees provide dust screening. • Existing trees outside the current excavations are in place. • Bunds of 5 to 7.5 metres are to be constructed along the south and west of the operations and planted with trees to provide visual and noise screening. • See figures in the Excavation and Management Plan.	----
MANAGEMENT			
Staff	----	• All mobile plant will have air conditioned closed cabins.	----
Monitoring	----	• A monitoring training and supervision system is proposed. see below “Trigger Conditions”.	----
Trigger	----	• Trigger conditions are used to determine when	----

conditions		additional dust management is required. • Most dust generated from excavation is visible. • The trigger for dust management is the generation of visual dust. • A site supervisor is present at all times when excavation is occurring. At other times if not present the supervisory duties are allocated to a mobile plant operator, who is in the best position to assess dust generation and to direct remediation. • A commitment is made that no visible dust will cross the lot boundaries as a result of activities conducted in the pit. • All on site operators are to be instructed to visually monitor dust, report and treat any visible dust.	
Adverse weather	Low - Uncommon in winter, more common in summer.	• When winds are sufficiently strong, or other weather conditions are unacceptable, to negate the effects of dust management, operations will cease until conditions improve and compliance can be achieved. • This policy is to be implemented and is normal company policy to minimise impact on adjoining land holders.	Low
Equipment failure	Low to moderate - Uncommon	• In the event of dust management not being able to be achieved through equipment failure, operations will cease until full capability is restored.	Low
Training	----	• The proponent will use on site induction and training on dust minimisation to all personnel at all operations.	----
Complaints	----	• A record of all dust complaints is to be maintained together with the mitigation measures to be used to reduce the dust impacts. The records will either be paper or digital and will be available to the Shire for review. • All complaints relating to dust are to be investigated immediately on receipt of a complaint. • Appendix 3 of *Land development sites and impacts on air quality*, Department of Environmental Protection Guidelines, November 1996, will form the basis of the methods on which a complaint on dust is dealt with.	----
EARTHWORKS			
Land Clearing	Low Clearing each stage with a large clearing prior to excavation to provide for stockpile areas	• Minimal clearing is required but topsoil and overburden will require relocation. • Where possible, activities such as vegetation removal or topsoil stripping on exposed ridgelines will be conducted at times when the materials are less likely to become airborne or during suitable wind conditions.	Low
Overburden removal	Low Timing as above	• Minimal clearing is required but topsoil and overburden will require relocation. • Where possible, overburden removal and placement will be completed at times when the materials are less likely to become airborne or during suitable wind conditions.	Low

Land restoration	Once at the end of the pit and where possible progressively during the operation	• Where possible progressive rehabilitation will be undertaken. • Activities such as ripping, overburden and topsoil spreading will be scheduled for times when the materials are less likely to become airborne or during suitable wind conditions. • This will normally occur only when each section of the pit has been completed and no more frequently than once every two years.	Low
EXCAVATION			
Excavation	Low to Moderate - In campaigns	• Excavate from the face using techniques that minimise the crushing of dry matter. • Excavation will normally be completed by excavator and will be intermittent. Other mobile plant may also be required such as a bulldozer or loader. • It has been found that the resource stays relatively moist through summer and that excavation of the raw material does not generate significant amounts of dust. • A water tanker will be maintained on site during excavation in summer when the risk of generating dust is greater. It will also be used to water any of the internal access roads as required. • The movement of topsoil and overburden and the traffic disturbance are the main risks.	Low
Loading at Face or from stockpiles	Low to Moderate - In campaigns	• Products to be loaded are to be moist and the hardstand on which the loading occurs wetted down or moist. • Loading from the face will be intermittent in campaigns. • A water tanker will be maintained on site during excavation in summer when the risk of generating dust is greater. It will also be used to water any of the internal access roads as required.	Very low
Haulage To create stockpiles etc	Moderate to Low - In campaigns	• Maintain haul road and hardstand surfaces in good condition (free of potholes, rills and product spillages) and with suitable grades. • Haul routes are to be made as short as possible. • Dust is more likely to be generated by traffic across the excavated floor and internal access roads. These roads and active areas are regularly watered during dry times to minimise dust lift off. • Reduce the length of the internal roads by maximising internal servicing efficiency. • Excavation will normally be carried out on the quarry floor, below the existing land surface. This will lead to a reduction in wind speed on the quarry floor and thus help to prevent the generation of dust. • Speed limits will be imposed on the haul and access roads as normal quarry practice.	Low

STOCKPILES and PROCESSING			
Hardstand traffic	Moderate	• As noted above most dust is created by traffic on the stockpile area. • Maintain hardstand surfaces in good condition (free of potholes, rills and product spillages) and with suitable grades. • A water truck is to be retained on site when operations are occurring.	Low
Processing	Nil	• There will be no processing of clay on site.	Nil
Mobile and static plant Operation	Low - In campaigns	• The proponent will use modern equipment that is maintained in good condition including the maintenance of dust minimisation measures.	Low
		• Ensure mobile and static plant is provided with dust extraction, shielding or filtration systems or wetting down as appropriate. • Operators are to be instructed to visually monitor dust, report and treat any visible dust. • Dust management and monitoring forms part of the site induction programs.	
Loading and Stockpile Creation	Moderate - In campaigns	• Mobile and static plant are to be shut down when not in use. • Drop heights from loaders and dump trucks are to be limited. • Locate coarser material stockpiles around the perimeter to limit wind impacts on fine materials. • The length of vehicle movements is to be minimised.	Low
TRANSPORT			
Road condition	Moderate	• Maintain access roads in good condition (free of potholes, rills and product spillages). • Treat access roads, hardstand and stockpile transport and loading areas with dust suppression sealant, water or seal coat. • Even though excavation will be intermittent, water treatment of the access roads will be used during all operations. • The main cross over to Toy Road will be sealed with a 50 metre seal.	Low
Road Transport	Very Low	• All loads will be covered. • New trucks often have automatic tarpaulins fitted to cover the clay during transport. • Transport through all public areas will be along bitumen roads.	Very low
		• A site code and induction system is proposed for the quarry.	
		• Road trucks are to be maintained in a clean condition. • Individual contractors are required to do likewise.	
Road Transport	Low	• Avoid spillages on roads and clean up promptly. • Ensure that during loading, product does not become lodged on the sides of trucks from where it can fall off during transport. • Drivers are to inspect trucks prior to leaving site. Any product not correctly located and secured is to be removed prior to exit from the site.	Low

DISCUSSION OF THE TYPES OF DUST

- **Dust Types**

There are a number of key aspects to dust impacts;

- What is the source of particles?
- What is the potential for the particles to be disturbed?
- What is the nature of the particles and how are they likely to behave?
- What types of impacts are the particles likely to have if they move?
- What management actions can be used to mitigate or reduce dust impacts?

Fine particles are a natural part of our environment and are present in soils, pollens, fragments of vegetation and many other sources. It is when the fine particles are excessively disturbed that there becomes concern for the potential impacts, whether they are nuisance or health risks.

The most common form of disturbance is by human impacts. In this local area disturbance of agricultural soils by cultivation and travel along gravel roads have the most potential to expose fine particles to disturbance by machinery and vehicles.

In many situations the fine particles are stablised by vegetation, soil microbial materials and reactions and interactions between particles. Once disturbed however dust can be generated and may continue to be a problem until the fine particles are wetted down or return to a relatively stable condition.

For the proposed excavation of clay the site specific conditions of vehicle movements during excavation, operation at stockpiles and transport are the main risk areas.

The risk of dust assumes no treatment. With effective treatment of dust by water, which is proposed, the risks of onsite, and consequently offsite, dust are minimised.

- **Nature of the Fine Particles**

Dust can originate from a number of operations and may impact on onsite workers, or travel offsite. Potential dust impacts are addressed by reducing the dust generated from the quarrying, processing and transport operations.

The same situation arises for excavation of clay or other materials. There is little generation of dust unless the soil, clay or road surfaces are allowed to dry out and are then disturbed by vehicle movements.

As only natural soil materials will be moved the dust will consist of only natural materials. The exception is any particles generated from the exhausts during transport or operation of machinery.

Most large scale studies of dust have been conducted in the coal mining industry of New South Wales.

The New South Wales Minerals Council Ltd and the New South Wales Government Health Fact Sheet, lists the following components of dust in quarrying and mining.

Fine particles PM <2.5 microns only account for 2 – 5% of the emissions from mining and mainly relate to vehicle emissions.

"Coarse particles" as PM 2.5 – 10 um in diameter account for 55% (50% - 70%) of quarry dust.

Dust particles of >10 um form the nuisance coarser dust that quickly settles. These account for 40% of all emissions from quarries and result from the breaking of rock or disturbance when not controlled by water.

1. PM< 2.5 are invisible and called "fine particles". They are the main health issue and are caused by vehicle emissions whether they are along roads or on private land from farming vehicles and cars. Vehicle emissions will not occur at night or at other times when the site is not active. The most common form of particulate arises from diesel motors that are not correctly tuned. Increasingly modern vehicles are fitted with better combustion techniques and particulate filters which significantly reduce risk resulting in very large reductions in concentrations of these particles on quarries and minestites in Australia including underground operations.

2. PM <10 are invisible and called "coarse particles". They can be breathed in, but are removed by alveoli and mucous. *(NSW Health).* This dust may be generated when land is cleared and topsoil disturbed or the site is subject to traffic in summer. This size dust might be fine clay and soil particles that could be expected to occur on site or from any agricultural activity.

3. PM>10 is visible dust and will, based on the resource, be the vast majority of the particles, consisting of fine clay particles or, if limestone or gravel roads are used, crushed road materials. These particles are the same as those generated from any travel on such roads.

4. Coarser particles such as sand may bounce but do not normally bounce above knee height unless by very strong gale force winds. Sand particles are normally >50 microns. DEC 2011 (below) lists particle sizes of >50 um as not normally becoming airborne. That is the sand grains which move by saltation (bouncing) and are retained by the wall of the pit. Sand sized particles are either only a minor component of the clay materials or are not present.

As all sizes of dust are likely to be generated together, there will be visible dust being generated when invisible dust is being formed. Therefore any visible dust present is a good sign and early indicator of a dust risk.

On this site the main dusts will be fine clay particles of the "coarse particle" size and above. The same type of dust is common on rural properties and all rural roads.

- **Health Risks**

The main health risks relate to PM <2.5 which can be breathed in and are less likely to be breathed out. The source of these is predominantly vehicle exhausts, which is most likely to impact on workers on site. In other words it is an occupational health and safety issue controlled under the *Mines Safety and Inspection Act 1994 and Regulations 1995.* Regular assessments are made of all quarries and mine sites by officers from the Department of Mines and Petroleum. If onsite dust is managed for worker safety then offsite dust will also be managed.

As noted above vehicle emissions have improved significantly in the last 20 years through the use of better engine management and filters and consequently the health risk from such vehicles is now regarded as low on and off site in open small operations such as this.

Particles greater than PM 10 microns constitute over 95% of the particles likely to be generated on site without dust mitigation measures.

From the proposed operations, the main component of dust is clay. Clay is predominantly kaolin and smectite. Clay has no known health risk and is even used in some medicines.

WIND PATTERN - EASTERLY WIND

Winds are typically easterly on summer mornings and south west on summer afternoons. Winter winds are more variable.

The only wind data is from Pearce which is subject to strong katabatic influences caused by the Darling Scarp, which gives a stronger easterly component.

Locally the easterly winds will be influenced by the topography which will cause the wind to flow down slope, rather than continuing on a straight easterly path. (Yellow arrows).

The winds are less strong on the plateau and pick up speed flowing down slope due to katabatic effects. The winds get stronger as they flow down slope and across the valley floors, and slow down travelling upslope. They are deflected by landform and slow down across and through trees.

The arrows represent the interpreted flow paths and relative speed of the 9.00 am katabatic winds in summer.

Note that this pattern only occurs on summer mornings. At other the wind is blowing from other directions.

Dwelling
Shed?
Dwelling
Dwelling
MOOLIABEENEE
SWAN
CHITTERING, SHIRE OF
BINDOON
LOT 7
Summer mornings
Sea breezes
Dwelling occupied by the applicant
Current excavations
Dwelling
Dwelling
Dwelling
Dwelling
Dwelling
Dwelling
Dwelling
Dwelling
Dwelling
Dwelling
Shed? Dwelling?
Dwelling
0 400m

Proposed pit and stockpiles

Prevailing summer morning easterly winds

Prevailing winds blowing across the active footprint easterly summer morning winds and afternoon summer sea breezes

BRIKMAKERS

PROPOSED CLAY EXCAVATION LOT 7. TOY ROAD, BINDOON	
WIND DIRECTIONS	
Landform Research	January 2015
Scale See Plan	
Basemap Landgate	**Figure 1D**

Australian Government
Bureau of Meteorology

Climate statistics for Australian locations

Monthly climate statistics

All years of record

Site information

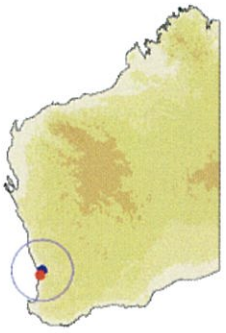
Site name: PEARCE RAAF
Site number: 009053
Latitude: 31.67 °S **Longitude:** 116.02 °E
Elevation: 40 m
Commenced: 1937 **Status:** Open
Latest available data: 25 Mar 2015

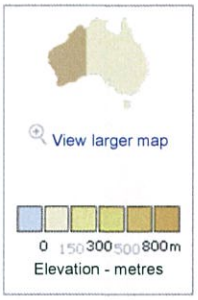
Additional information

Additional site information

Nearest alternative sites

1. 009067 UPPER SWAN RESEARCH STATION (9.9km)
2. 009022 GUILDFORD POST OFFICE (26.0km)
3. 009178 GINGIN AERO (26.9km)





View: Main statistics All available | Period: Use all years of data | Text size: Normal Large

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	33.5	33.3	30.5	26.4	22.0	18.8	17.8	18.4	20.0	23.4	27.2	30.3	25.1	54	1940 2015
Mean minimum temperature (°C)	17.0	17.6	16.0	13.4	10.8	9.4	8.4	8.2	8.8	10.1	12.5	14.5	12.2	54	1940 2015
Rainfall															
Mean rainfall (mm)	7.6	12.2	14.9	34.5	85.3	133.4	134.4	104.2	70.1	36.2	23.7	10.4	677.9	60	1937 2015
Decile 5 (median) rainfall (mm)	1.1	4.4	6.2	31.7	80.6	130.3	135.6	105.5	66.8	33.9	18.8	4.9	646.4	60	1937 2015
Mean number of days of rain ≥ 1 mm	0.7	1.1	1.6	3.5	6.5	8.9	9.9	9.0	6.9	4.4	2.9	1.3	56.7	59	1937 2015
Other daily elements															
Mean daily sunshine (hours)															
Mean number of clear days	8.4	10.4	9.4	6.2	6.2	4.2	4.6	5.4	5.8	6.7	8.0	5.9	81.2	50	1940 2011
Mean number of cloudy days	1.7	2.9	3.8	6.0	7.5	7.9	8.1	8.1	7.4	5.6	5.4	1.9	66.3	50	1940 2011
9 am conditions															
Mean 9am temperature (°C)	24.1	24.0	21.8	18.9	15.6	13.2	12.1	12.7	14.6	17.3	20.5	22.6	18.1	52	1940 2011
Mean 9am relative humidity (%)	48	50	56	64	72	78	79	76	71	61	53	48	63	47	1944 2011
Mean 9am wind speed (km/h)	17.9	17.8	16.3	13.3	11.0	11.2	10.5	11.3	13.0	14.9	16.7	16.7	14.2	44	1940 2011
3 pm conditions															
Mean 3pm temperature (°C)	31.4	31.5	28.7	24.8	20.9	17.7	16.6	17.2	18.9	22.1	25.5	28.4	23.6	50	1940 2011
Mean 3pm relative humidity (%)	30	31	35	43	50	60	61	57	54	46	39	33	45	45	1944 2011
Mean 3pm wind speed (km/h)	20.4	19.0	17.8	15.8	13.9	15.3	15.5	16.6	17.7	18.5	20.5	21.1	17.7	41	1940 2011

red = highest value blue = lowest value

Product IDCJCM0030 Prepared at Thu 26 Mar 2015 02:06:38 AM EST

Monthly statistics are only included if there are more than 10 years of data. The number of years (provided in the 2nd last column of the table) may differ between elements if the observing program at the site changed. More detailed data for individual sites can be obtained by contacting the Bureau.

Related Links

- This page URL: http://www.bom.gov.au/climate/averages/tables/cw_009053.shtml
- About climate averages: http://www.bom.gov.au/climate/cdo/about/about-stats.shtml
- Bureau of Meteorology website: http://www.bom.gov.au

Page created: Thu 26 Mar 2015 02:06:38 AM EST

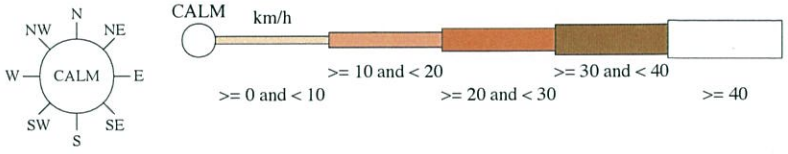
This page was created at **on**

istorn times selected, refer to attached note for details

EARCE RAAF

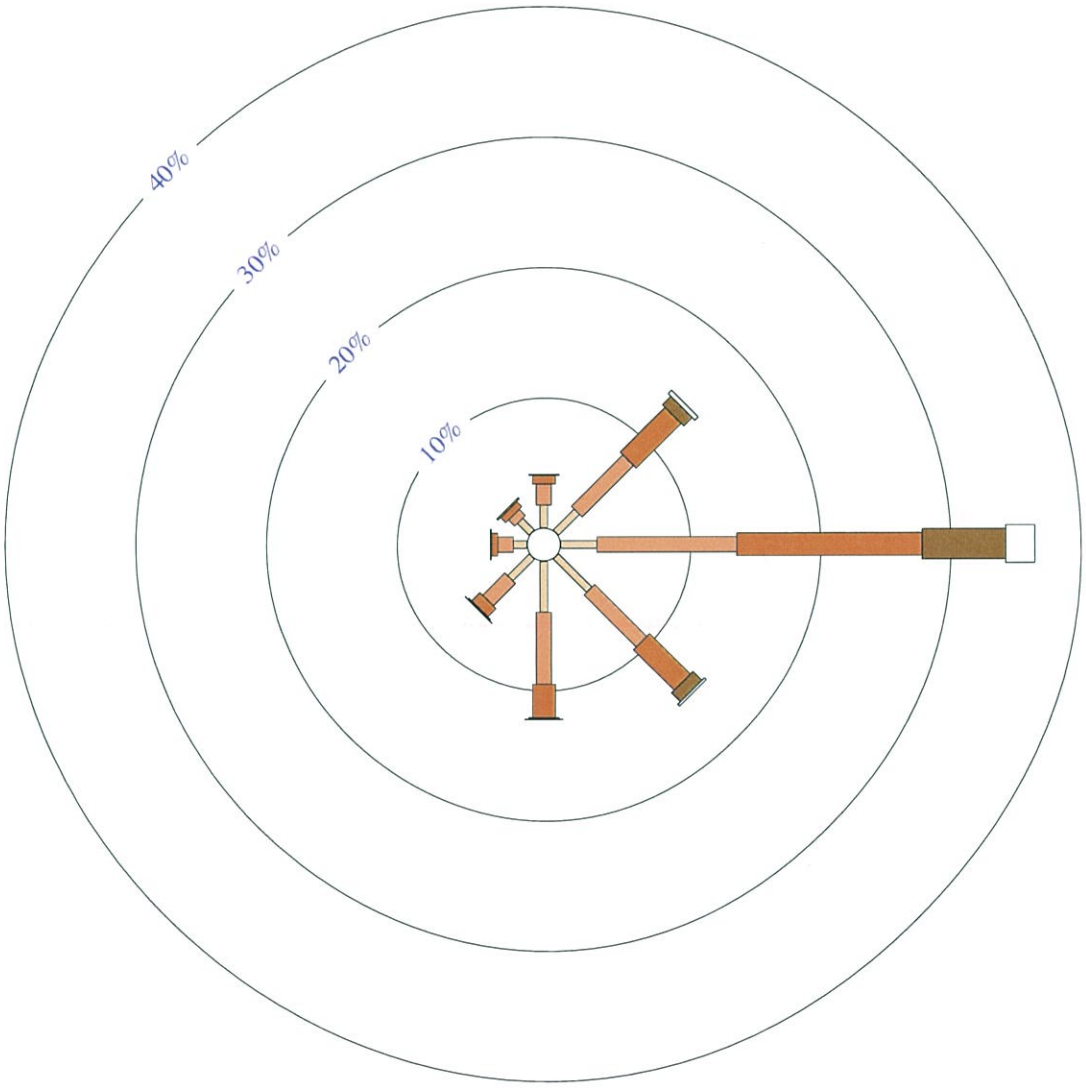
e No: 009053 • Opened Jan 1937 • Still Open • Latitude: -31.6669° • Longitude: 116.0189° • Elevation 40m

n asterisk (*) indicates that calm is less than 0.5%.
ther important info about this analysis is available in the accompanying notes.



9 am Feb
1203 Total Observations

Calm 6%



istorn times selected, refer to attached note for details

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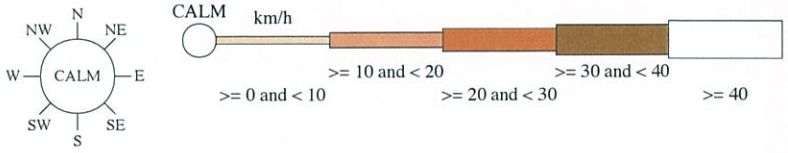

3 pm Feb
1116 Total Observations

Calm 3%