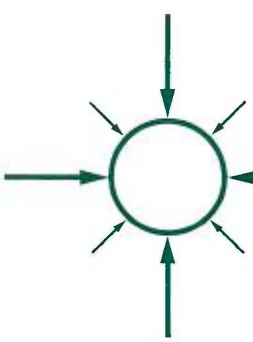
EIS 1569

AA067842

Environmental impact statement, sand, clay & pebble extraction

Lot 1 & 2, DP 228308, Lot 2, DP 312327 Maroota. Volume 3,

Appendices 11 to 16



NEXUS

Environmental Planning

ENVIRONMENTAL IMPACT STATEMENT

SAND, CLAY & PEBBLE EXTRACTION

LOT 1 & 2, DP 228308, LOT 2, DP 312327

MAROOTA

VOLUME III - APPENDICES 11 to 16

November, 1999

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CONTENTS

VOLUME III

Appendix 11

NOISE IMPACT ASSESSMENT REPORT
For Proposed Sand Extraction and Processing Operation at Cnr of Old Northern Rd and Roberts Rd, Maroota

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Nexus Environmental Planning

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Issue 3
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"Making the world a healthier place for the future!"

CONTENTS PAGE

1. INTRODUCTION

This report presents the findings of a noise impact assessment for the proposed operations of a sand extraction and processing quarry at Lot2, DP312327 and Lots 1 & 2, DP228308, at the corner of Old Northern Road and Roberts Road, Maroota.

This report has been carried out for submission with the Environmental Impact Statement (EIS) for the development prepared by Nexus Environmental Planning Pty Ltd.

The noise impact assessment determines the potential noise impact of the proposed operations within the surrounding area. A dam is currently being constructed on the site under a Court Order issued by the Land and Environment Court. Baulkham Hills Shire Council issued consent for an extractive industry in conjunction with the dam construction in 1990. The requirements for water for sand washing purposes dictates that the extraction is dependent on completion of the dam. A development application will be lodged seeking approval for extraction of sand from the total parcel of land and the construction of a revised dam design. The EIS will assess the impacts from this proposal.

The current operations on the site include the excavation of sand materials from a pit located near the northern boundary of the site. The slurry is pumped to a diesel powered processing plant where the sand is separated and stockpiled. A front end loader is used to load the sand on to trucks to be transported off-site. The residue clay slurry is pumped into sedimentation ponds and then into clay drying beds located to the north of the dam. The clay is then dredged and stockpiled separately. This application will seek to amend these operations in conjunction with extraction operations across the total parcel of land. The extraction will be carried out using scrapers and dozers. The existing plant will be used to process the sand.

The proposed site operating hours are from 6am to 6pm Monday to Friday and 6am to 1pm on Saturday.

The site is located within a predominantly rural residential area. However, there are several other operating or proposed sand extraction sites in the Maroota area. The nearest residences to the site are located directly adjacent to the site boundaries.

Background noise measurements were conducted at the nearest residences in order to establish the existing background noise environment. Current traffic noise measurements along Old Northern Road and Wisemans Ferry Road have also been carried out.

The predicted noise impacts have been assessed against the criteria outlined in the Baulkham Hills Shire Council Development Control Plan No. 500 for Extractive Industries (DCP No. 500) and the New South Wales Environment Protection Authority (NSW EPA) Environmental Noise Control Manual.

Road traffic noise has been assessed against criteria outlined in the NSW EPA Environmental Criteria for Road Traffic Noise.

Figures 1.1 and 1.2 show the site locality and the site layout.

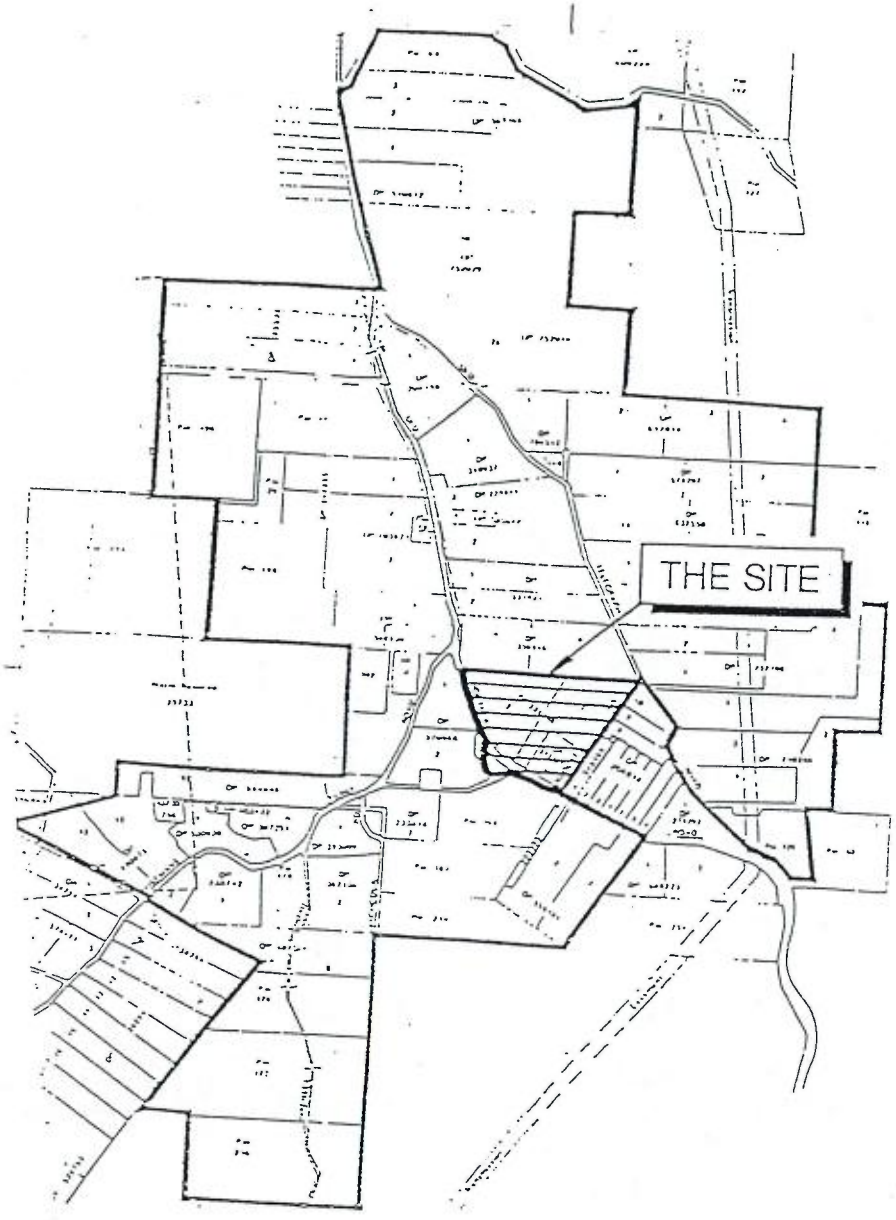

FIGURE 1.1: SITE LOCALITY PLAN

FIGURE 1.2: SITE LAYOUT

LEGEND

BENCH MARK	△	PIPE INVERT	
COMMUNICATIONS PIT		POWER POLE	○
DUST GAUGE			
GAS MARKER		TREE	
MANHOLE			
MONITORING WELL		WATER SERVICE	

DETAIL SURVEY
LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327.
OLD NORTHERN ROAD
MAROOTA
IN THE LOCAL GOVERNMENT AREA OF
BAULKHAM HILLS
RE: NEXUS ENVIRONMENTAL PLANNING

RATIO NTS	SURVEYED BA, DM & PC.
LEVEL DATUM AHD	DRAWN BW
DATE 14.01.1999	CAD FILE CH3160B1.DWG
SHEET 1 OF 1	REFERENCE CH3160

WILLIAM L. BACKHOUSE Pty. Limited
REGISTERED SURVEYORS, PLANNERS & DEVELOPMENT CONSULTANTS.
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2. GLOSSARY OF TERMS

This section provides an explanation of the terms used throughout the report.

In order to characterise the noise levels measured over a period of time the following noise descriptors are used:

- L_{A1}
  The L_{A1} is the level of noise exceeded for 1% of the time and is, therefore, the average peak level of noise experienced during the measurement period.

- L_{A10}
  The L_{A10} is the level of noise exceeded for 10% of the time and is, therefore, the maximum level of noise experienced during the measurement period.

- L_{Aeq}
  The L_{Aeq} is the equivalent continuous level of noise and is a single number that is equivalent to the fluctuations of noise level that are occurring based on the energy contained within the noise signal. The L_{Aeq} is determined by an integration of the noise level with respect to time.

- L_{A90}
  The L_{A90} is the level of noise exceeded for 90% of the sample time and is therefore the minimum level of noise experienced during the measurement period. The L_{A90} is referred to as the background noise level.

The following descriptors are used to assess road traffic noise:

- $L_{Aeq(1hr)}$
  Represents the highest 10th percentile L_{Aeq} noise level during the period 7am to 10pm or 10pm to 7am as relevant.

- $L_{Aeq(15hr)}$
  Represents the L_{Aeq} noise level for the period 7am to 10pm.

- $L_{Aeq(9hr)}$
  Represents the L_{Aeq} noise level for the period 10pm to 7am.

- **Daytime, Evening and Night time periods**
  For the existing criteria outlined in the NSW EPA Environmental Noise Control Manual, daytime is defined as from 7.00am to 10.00pm, Monday to Saturday, and 8am to 10pm on Sunday and Public Holidays. Night time is defined as 10pm to 7am, Monday to Friday, and 10pm to 8am on Sundays and Public Holidays.

- **Freeway / arterial**
  Includes sub-arterial roads and refers to roads handling through traffic, with characteristically heavy and continuous traffic flows during peak periods. Through traffic is traffic passing through a locality bound for another locality.

- **Collector road**
  Refers to a road situated in a built-up area that collects local traffic leaving a locality and connects to a sub-arterial road.

- **Sound Pressure Level** (abbreviated SPL)
  Is the instantaneous measurement of pressure variations in the ambient air compared to a reference pressure. A precision sound level meter measures SPL and measurements are expressed as dB(A).

- **Tonal Noise**
  Noise containing a prominent frequency and characterised by a definite pitch.

- **Low frequency noise**
  Containing major components within the low frequency range (20Hz – 250 Hz) of the frequency spectrum.

- **Impulsive noise**
  Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.

- **Fluctuating noise**
  Noise that varies continuously and to an appreciable extent over the period of observation.

- **Intermittent noise**
  The level suddenly drops to that of the background noise several times during the period of observation.

- **Adjustment for duration**
  Applied where a single – event noise is continuous for a period of less than two and a half hours in any 24-hour period.

3. ACOUSTIC CRITERIA

The noise emissions from the sand extraction and processing operations are required to satisfy specific Baulkham Hills Shire Council and NSW EPA acoustic criteria.

3.1 BAULKHAM HILLS SHIRE COUNCIL DCP NO. 500

Section 2.9 of DCP No. 500 outlines the acoustic criteria for extractive industries. The objectives of the criteria are:

- *"To maintain the acoustic quality of the Shire;*
- *To protect and maintain the acoustic environment of residents, Public & Community facilities and other receivers in the Shire; and*
- *To limit the potential offensiveness of noise from specific sources."*

The key prescriptive measures outlined in Section 2.9 include:

- *"Proponents should ensure that the maximum average noise emission level of extraction is no more than 5 dB(A) above maximum average background noise levels;*
- *Extraction activities should not occur within 100 metres of a residence not associated with the activities;*
- *Proponents should ensure that noise emissions meet all minimum acoustic standards defined in Chapters 19, 20 and 21 of the Environmental Noise Control Manual, 1994"*

3.2 EXISTING NSW EPA ASSESSMENT CRITERIA

The EPA has overall responsibility for setting noise quality objectives from industrial premises. The primary aim of environmental noise control is to minimise the occurrence of offensive noise in the community. It is considered that to be both effective and equitable, the determination and application of environmental noise control must take into account many factors, including:-

- the variation in response between individuals to any noise;
- the inherently noisy characteristics of many activities;
- the circumstances within which noise occurs;
- potential for annoyance and reduction in acoustic amenity;
- the technical and economic feasibility for noise control, and;
- social worth of the activity.

The broad environmental noise objectives are two-fold:

(i) that noise from any single source does not intrude greatly above the prevailing background noise level; and

(ii) that the background noise level does not exceed the level appropriate for a particular locality or land use.

The normal EPA noise criteria for continuous industrial type noise are stated in Table 3.1. The criteria of most relevance to the proposed quarry are shown in bold.

Table 3.1 : Recommended Outdoor Background Noise Levels

Predominant Land use of Receiver Area	Time Period	L_{A90} Background Acceptable Limit	Noise levels (dB(A)) Extreme Limit
Residential, Rural (approx R1 AS1055)	**Day** **Night**	**45** **35**	50 40
Residential, Church, Hospital, School - near busy road or industry (approx R2-R3 AS1055)	**Day** **Night**	**50** **40**	55 45

Source: EPA Environmental Noise Control Manual

NOTE: From Monday to Saturday, daytime is defined as 7.00 am to 10.00 pm and night time is 10.00 pm to 7.00 am. On Sundays and Public Holidays daytime is 8.00 am to 10.00 pm and night time is 10.00 pm to 8.00 am.

In order to ensure that environmental noise levels do not steadily increase above the recommended outdoor background noise levels set out in Table 3.1, the manual sets out criteria for the formulation of design objectives based on the measured existing background noise level. Table 20 - 1 of the Environmental Noise Control Manual is reproduced in Table 3.2 below.

Table 3.2: Recommended Planning Levels

Existing background noise level at the most sensitive point in an affected residential area	Recommended maximum noise level, for planning approval purposes, at that point as a result of a proposed new noise source
A. Background is above relevant acceptable level	- preferably, set maximum planning level 10 dB(A) or more below acceptable level - at least, set maximum planning level 10 dB(A) below existing background level
B. Background is at acceptable level	- set maximum planning level 10 dB(A) below acceptable level
C. Background is below acceptable level by 1 dB(A) 2 dB(A) 3 dB(A) 4 dB(A) 5 dB(A) 6 dB(A) or more	- set maximum planning level 9 dB(A) below acceptable level 5 dB(A) below acceptable level 3 dB(A) below acceptable level 2 dB(A) below acceptable level 2 dB(A) below acceptable level 5 dB(A) above background level

3.2.1 Sleep Disturbance

The emission of peak noise levels for an instant or very short time period may cause sleep disturbance to residents. A method accepted by the EPA is to limit these extreme levels of noise to below 15 dB(A) above the measured L_{A90} level.

3.3 NSW EPA Draft Stationary Noise Source Policy

The NSW EPA released its Draft Stationary Noise Source Policy in July, 1998. The policy will eventually replace the existing guidelines set out in the NSW EPA Environmental Noise Control Manual.

The new policy is aimed at assessing noise sources scheduled under the new Protection of the Environment Operations Act, 1997. However, the policy may also be used by local government to assess noise from stationary sources.

The new policy presents significantly different methods for assessing noise impacts. There has been considerable debate over these methods and it is anticipated that there may be several changes made to the draft policy before it is finalised. Therefore, until the final policy is released, noise impacts should continue to be assessed under the existing guidelines. It should also be noted that the existing guidelines are generally regarded as being more conservative than the proposed policy.

3.4 Road Traffic Noise Criteria

Table 1 of the NSW EPA Environmental Criteria for Road Traffic Noise sets out the road traffic noise criteria for proposed land use developments with the potential to create additional traffic on existing roads. The criteria that apply to this study are as follows:

Land use developments with potential to create additional traffic on existing freeways / arterials

Day: $L_{Aeq(15hr)}$ = 60 dB(A)

Night: $L_{Aeq(9hr)}$ = 55 dB(A)

Where the criteria are already exceeded, the table states:

"Where feasible, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads, times of use, use of clustering, use of 'quiet' vehicles, and use of barriers and acoustic treatments.

In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB(A)."

It should be noted that the proposed transport routes as presented in Section 5.2 show that truck movements to and from the site will travel south along Roberts Road and then along Old Northern Road and Wisemans Ferry Road only. Trucks will not pass any residences along Roberts Road. It is unlikely that trucks will travel north along Old Northern Road past the intersection with Wisemans Ferry Road and will therefore not pass by Maroota Public School.

Whilst the main transport routes will be arterial roads, it is considered appropriate to also assess the $L_{Aeq(1hr)}$ noise impacts due to the potential sensitivity of rural residences. Therefore, the increase in $L_{Aeq(1hr)}$ road traffic noise levels during the proposed operating periods should also be limited to 2 dB(A).

4. EXISTING ACOUSTIC ENVIRONMENT

4.1 MONITORING LOCATIONS AND METHODOLOGY

Existing ambient noise levels were measured at the three nearest potentially affected residential receivers (refer to Figure 4.1):-

Location A: Residence at 155 Roberts Road, Maroota. This residence is approximately 15 metres north of the northern boundary of the site. The logger was placed adjacent to the northern boundary of the site and in line with the façade of the residential dwelling.

Location B: Residence at 2a Roberts Road, Maroota. This residence is located approximately 60 metres east of the eastern boundary of the site. The logger was positioned on the resident's northern boundary, approximately 5 metres from the residential façade.

Location C: Residence at 156 Old Northern Road, Maroota. This residence is located approximately 140 metres north of the northern boundary of the site. The logger was positioned approximately 10 metres from the façade of the residential dwelling.

Existing traffic noise levels along Old Northern Road and Wisemans Ferry Road were measured at the following two locations:

Location D: Premises at Maroota Motors Pty Ltd, Corner of Old Northern Road and Roberts Road, Maroota. The premises are setback approximately 20 metres from Old Northern Road. The logger was placed within 0.5 metres from the front façade of the building.

Location E: Residence at the corner of Wisemans Ferry Road and Haerses Road, Maroota. This residence is setback approximately 25 metres from Wisemans Ferry Road. The logger was positioned within 0.5 metres of the front façade of the building.

At all of the above locations measurements were carried out using a statistical Environmental Noise Logger, type EL-215. The loggers were set to monitor noise levels continuously over 15 minute statistical intervals for a period of seven days. The instrument sets were calibrated using a Bruel & Kjaer type 4230 acoustic calibrator before and after the measurement period to ensure the reliability and accuracy of the instruments. Wind socks were applied to the microphones, which were set at 1.2 metres above the ground at each location.

There were no excessive variances observed in the reference signal between the pre-measurement and post-measurement calibration.

A weather logger was established in an open area approximately 10 metres from the amenities buildings on the site. The weather logger monitored wind speed and direction, rainfall and temperature during the noise monitoring period.

There were no periods of significant rainfall or periods of high wind (in excess of 5 m/s) and therefore it was not necessary to exclude data from the noise monitoring periods.

SCALE:

REFERENCE: CH3160B2

DATE: 28.01.1999

RE: NEXUS ENVIRONMENTAL PLANNING

W. L. Backhouse B.Surv. M.I.S. Aust. A.I.M.M.
M. R. Stapleton B.Sc (Surv.) M. Plan. M.I.S. Aust
A. Moras B.Surv. Grad.I.S.Aust.
B. Anderson Assoc.Dip Eng.(Surv.)

LOCATION C

LOCATION A

LOCATION B

DP356946 Pt.A

DP356946 B

DP732708 2

DP732708

Abt.140m

Abt.190m

Abt.130m

Abt.10m

Abt.50m

Abt.60m

Abt. 40m

Abt. 50m

DP570966 1

DP228308 2

DP228308 1

DP206018 10

DP206018 9

DP206018 8

DP548169 2

Abt.30m

Abt.50m

Abt.20m

ROAD

PROPOSED OLD ROAD

DP570966 2

DP228308 2

ROAD

ROAD

Abt.110m

NORTHERN WIDENING

DP312327 2

ROBERTS

DP548169 1

Abt.25m

Abt.30m

Abt.35m

DP206018 2

Abt.50m

Abt.70m

Abt.90m

DP542117 1

Abt.200m

ROAD

DP555184 1

DP223323 1

DP555184 2

POR.168

N

LEGEND

BUILDINGS

DUST GAUGES

FENCE LINES

MONITORING WELLS

NOTES:

THE PURPOSE OF THIS SURVEY WAS TO OBTAIN TOPOGRAPHICAL DETAIL AS REPRESENTED ON THIS PLAN.

BOUNDARIES SHOWN HEREON HAVE BEEN COMPILED FROM PUBLIC RECORDS AND ARE SUBJECT TO A BOUNDARY SURVEY.

ADJACENT BUILDINGS SHOWN HAVE BEEN DIGITISED FROM AERIAL PHOTOS AND OFFSETS TO PROPERTY BOUNDARIES ARE APPROXIMATE ONLY.

FIGURE 4.1: NOISE MONITORING LOCATIONS

4.2 NOISE MONITORING RESULTS

The results of the noise monitoring are presented in the following sections. The purpose of the monitoring at Locations A, B and C was to assess existing ambient noise levels during the period of proposed operations on the site. Therefore, the statistical analysis includes measured L_{A10} and L_{A90} noise levels during day period, 7am to 6pm, and the shoulder period, 6am to 7am.

The purpose of the noise monitoring at Locations D and E was to determine existing road traffic noise levels. Therefore the statistical analysis includes $L_{Aeq,9hr}$, $L_{Aeq,15hr}$, and $L_{Aeq,1hr}$ noise levels.

The results of the monitoring are presented graphically in the attachments.

4.2.1 Location A

Table 4.1: Measured Background Noise Levels – Location A (dB(A))				
Date	Shoulder Period (6am – 7am)		Daytime Period (7am – 6pm)	
	Average L_{A10}	90th percentile L_{A90}	Average L_{A10}	90th percentile L_{A90}
Monday 19/7/99	-	-	61.8	50.3
Tuesday 20/7/99	48.5	41.4	62.5	54.8
Wednesday 21/7/99	50.8	42.3	60.0	52.6
Thursday 22/7/99	53.3	46.5	59.6	52.0
Friday 23/7/99	50.1	42.1	58.1	50.1
Saturday 24/7/99	46.6	38.3	57.0	48.2
Sunday 25/7/99	46.9	36.6	55.4	45.7
Monday 26/7/99	50.3	43.0	58.2	48.8
Median [1]	**50.1**	**42.1**	**58.9**	**50.2**

1 Median values are calculated for Monday to Saturday only as the site will not operate on Sundays.

4.2.2 Location B

Table 4.2: Measured Background Noise Levels – Location B (dB(A))				
Date	Shoulder Period (6am – 7am)		Daytime Period (7am – 6pm)	
	Average L_{A10}	90th percentile L_{A90}	Average L_{A10}	90th percentile L_{A90}
Monday 19/7/99	-	-	52.0	42.3
Tuesday 20/7/99	47.1	37.6	59.9	51.8
Wednesday 21/7/99	47.8	38.4	62.3	51.2
Thursday 22/7/99	51.0	42.4	61.4	52.9
Friday 23/7/99	47.8	35.3	57.0	48.3
Saturday 24/7/99	45.8	33.5	51.3	40.6
Sunday 25/7/99	42.8	31.9	51.3	40.5
Monday 26/7/99	49.1	37.6	56.0	46.3
Median [1]	**47.8**	**37.6**	**56.5**	**47.3**

1 Median values are calculated for Monday to Saturday only as the site will not operate on Sundays.

4.2.3 Location C

Table 4.3: Measured Background Noise Levels – Location C (dB(A))				
Date	Shoulder Period (6am – 7am)		Daytime Period (7am – 6pm)	
	Average L_{A10}	90th percentile L_{A90}	Average L_{A10}	90th percentile L_{A90}
Monday 19/7/99	-	-	53.0	41.4
Tuesday 20/7/99	53.9	40.1	60.0	48.5
Wednesday 21/7/99	55.3	40.5	56.9	46.8
Thursday 22/7/99	57.1	46.5	55.8	46.0
Friday 23/7/99	56.0	43.4	52.7	42.4
Saturday 24/7/99	50.9	38.1	50.1	37.7
Sunday 25/7/99	43.6	30.8	55.8	42.9
Monday 26/7/99	53.4	42.0	52.6	43.1
Median [1]	**53.9**	**40.5**	**54.4**	**43.0**

1 Median values are calculated for Monday to Saturday only as the site will not operate on Sundays.

4.2.4 Location D

Table 4.4: Measured Road Traffic Noise Levels – Location D (dB(A))			
Date	$L_{Aeq,9hr}$	$L_{Aeq,15hr}$	$L_{Aeq,24hr}$
Friday 20/11/98	48.7	54.0	52.7
Saturday 21/11/98	48.1	56.5	53.4
Sunday 22/11/98	47.3	55.3	52.3
Monday 23/11/98	49.4	56.2	53.7
Tuesday 24/11/98	50.4	55.9	53.8
Wednesday 25/11/98	50.1	55.3	53.3
Thursday 26/11/98	51.0	56.2	54.2
Friday 27/11/98	49.2	55.4	53.0
Saturday 28/11/98	49.1	54.4	52.4
Sunday 29/11/98	44.5	54.8	50.9
Monday 30/11/98	47.8	54.5	52.0
Tuesday 1/12/98	47.6	-	47.6
Median[1]	**48.9**	**55.3**	**52.9**

1 The median values have been calculated for the entire monitoring period in order to assess the traffic noise model calibration.

4.2.5 Location E

Table 4.5: Measured Road Traffic Noise Levels – Location E (dB(A))			
Date	$L_{Aeq,9hr}$	$L_{Aeq,15hr}$	$L_{Aeq,24hr}$
Friday 20/11/98	44.3	53.5	51.2
Saturday 21/11/98	47.4	55.2	52.3
Sunday 22/11/98	45.2	54.6	51.0
Monday 23/11/98	47.1	55.3	52.2
Tuesday 24/11/98	46.8	54.8	51.8
Wednesday 25/11/98	46.9	55.1	52.0
Thursday 26/11/98	48.9	56.2	53.5
Friday 27/11/98	47.5	56.4	53.1
Saturday 28/11/98	48.9	55.9	53.3
Sunday 29/11/98	46.7	54.3	51.5
Monday 30/11/98	47.2	55.1	52.1
Tuesday 1/12/98	48.4	-	48.4
Median[1]	**47.1**	**55.1**	**52.1**

1 The median values have been calculated for the entire monitoring period in order to assess the traffic noise model calibration.

4.2.6 Comments

Measured ambient L_{A90} noise levels exceed NSW EPA recommended planning levels at Locations A and B. The graphical presentation of the results for these two locations show that noise levels fluctuate considerably throughout the day. Observations during logger establishment and retrieval found that the dam construction and processing activities were clearly audible at both locations.

The ambient noise levels at Locations A and B increase significantly during the daytime, approximately during the times that the site operations commence and cease. Ambient noise levels at these locations are also influenced by intermittent road traffic noise along Roberts Road.

Whilst the site is the most significant contributor to ambient noise levels, discussions with the residents found that they are generally not annoyed by the noise emissions. However, noise design objectives for the proposed operations should aim at reducing the overall noise emissions from the site.

Measured ambient L_{A90} noise levels at Location C were below the NSW EPA recommended planning levels. The site was inaudible during logger establishment and retrieval. The graphical presentation of the results are typical of a location in a rural residential environment.

Measured noise levels at Locations D and E were primarily influenced by road traffic noise. The median noise levels are well below the objectives for arterial roads. However, the noise logger graphs presented in the attachments shows that the measured L_{Aeq} regularly exceeds 55 dB(A) during the 7am – 6pm period. The criterion for local roads, as outlined in the NSW EPA Environmental Criteria for Road Traffic Noise, is an $L_{Aeq,1hr}$ of 55 dB(A) during the daytime. Whilst neither Old Northern Road or Wisemans Ferry Road could be considered local roads; measured L_{Aeq} noise levels exceeding 55 dB(A) for extended periods of time could have the potential for annoyance. The potential for annoyance is amplified by the prevalence of low background noise levels resulting in minimal masking of traffic noise.

These assumptions are verified by discussions with residents that revealed traffic noise is a major concern.

The criteria setout in the NSW EPA guidelines involves averaging noise levels over 15 hour periods during the daytime. This criteria may not adequately protect the amenity of residents along Old Northern Road and Wisemans Ferry Road where traffic volumes are high during the 6am to 6pm period only. Therefore, as outlined in Section 3, the objective that will be used to assess traffic noise impacts for this study will be to limit the hourly increase in L_{Aeq} noise levels to not more than 2 dB(A) above existing L_{Aeq} noise levels.

4.3 Site Noise Design Objectives

As stated in Section 3, the NSW EPA's broad environmental noise objectives are two-fold:

(i) that noise from any single source does not intrude greatly above the prevailing background noise level; and

(ii) that the background noise level does not exceed the level appropriate for a particular locality or land use.

Current ambient noise levels at Locations A and B exceed recommended planning levels. Therefore, noise design objectives shall aim to reduce overall noise emissions from the site. However, the design objectives should not be so low as to be practically unachievable. The restriction of activities so as to make the proposal not economically viable would be against the objectives of the NSW EPA guidelines.

The results of the noise modelling presented in Section 5 show that current noise emissions from the site are approximately 60 dB(A) at Locations A and B. This is supported by the unattended noise monitoring results and the observations during logger establishment and retrieval.

An L_{A10} noise design objective of 45 dB(A) at the nearest residences during the 7am to 6pm period and 40 dB(A) at the nearest residences during the 6am to 7am period will provide a significant improvement in the ambient noise environment. These objectives are expected to ensure that the potential for residential annoyance is minimal.

The noise emissions from the site are a primary contributor to noise levels at the residential locations. Therefore, maintaining the objectives presented above shall ensure that the NSW EPA planning levels are not exceeded. The noise management plan for the site shall also aim at maintaining ambient noise levels below the planning levels.

5. PREDICTED NOISE IMPACT

5.1 OPERATIONAL SITE NOISE

The proposed operations on site include the extraction and processing of sand as well as the construction of a water storage dam. There are several operations with the potential to generate excessive noise.

A detailed summary of the plant layout, equipment specifications and processes is provided in the environmental impact statement for the development and therefore has not been reproduced in this report. However, the basic operations are described.

The existing sand / soil slurry from the dam location is removed by using sluicing and dredging methods and is pumped to the processing plant.

Future extraction of sand will be carried out using a scraper to extract the sand and transport it to the processing plant. The sand will then be processed through the existing wet sieving system before being placed into stockpiles. Front end loaders (FELs) are used to load the sand into trucks for transport off site.

A dozer may be used on occasions where a scraper cannot adequately extract portions of sand. However, based on geotechnical sampling and previous experience in this area, it is unlikely that the dozer will be used for significant periods of time.

The plant is currently powered by a diesel generator. However, during the preparation of this report, the plant was being modified to support electrical power.

Noise source data was obtained from each of the mobile and stationary sources during normal operations. Noise source levels for the extraction operations were measured at similar sand quarries. The measurements were carried out using a Rion NA27E Precision Sound Level Meter. The instrument was calibrated before and after use with a Rion calibrator. There were no significant variances between pre and post measurement reference signals. Weather conditions were satisfactory for noise measurement.

The noise source data is summarised in Table 5.1. The data will be used to model noise emissions from the site at the nearest sensitive receivers.

Table 5.1: Noise Source Data
Sound Power Levels (dB(A))

Descriptor	dB(A)	Octave Band Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Scraper										
L_{A10}	**108.8**	71.2	82.4	91.5	97.2	104.5	102.7	102.0	97.4	87.7
Front End Loader										
L_{A10}	**104.7**	62.5	88.6	87.3	95.6	99.0	99.9	97.3	90.7	83.0
Dozer										
L_{A10}	**108.7**	65.0	87.8	93.1	98.7	102.7	105.0	101.0	97.1	85.5
Road Transport Truck										
L_{A10}	**103.4**	87.9	86.9	87.9	97.9	99.9	94.9	88.9	82.9	75.1
Dredging Excavator										
L_{A10}	**106.9**	57.6	81.3	86.3	89.9	97.4	99.3	101.0	101.5	98.1
Water Pump										
L_{A10}	**104.6**	88.6	87.9	90.3	86.8	100.1	99.9	96.3	91.3	80.5
Diesel Generator										
L_{A10}	**106.5**	67.1	79.5	96.2	95.9	101.4	99.8	99.4	95.2	88.9
Processing Plant										
L_{A10}	**99.4**	66.6	81.9	80.4	84.9	90.5	93.5	94.2	92.3	86.3

5.1.1 Predicted Noise Levels

Noise level predictions for the current and proposed operations have been undertaken.

The predicted noise levels have been calculated on the following basis:

- Use of the environmental noise model ENM Version 3.06. This model is recommended by the NSW EPA for noise modelling.
- Ground contours developed from the site survey plans included in the Conceptual Mine Plan (Woodward-Clyde, 1999) and the CMA Topographic Map for Lower Portland (1:25,000).
- L_{A10} octave band noise source data presented in Table 5.1.
- Meteorological conditions consisting of:

    * Still wind;
    * moderate relative humidity and moderate air temperature;
    * stability class D;

  providing neutral to slightly adverse conditions.

Several scenarios were modelled with the aim of providing a comprehensive assessment of all likely situations during the development of the quarry. Furthermore, extraction scenarios were modelled with mobile equipment operating at the natural surface level (designated 'A') and at depth (designated 'B'). Extraction scenarios include operations at various areas of the site. The cells were developed in the extraction plan (Woodward – Clyde, 1999). Extraction will only occur in one cell at a time.

Modelling was carried out for typical normal operations and maximum operations. Whilst it is unlikely that all noise sources will be operating at peak capacity and simultaneously, it is necessary to assess this situation.

The details of each scenario are presented in Table 5.2 on the following page.

Table 5.2: Noise source allocation for each modelling scenario	
Noise Source	**Location**
Scenario 1 : Existing Operations	
Processing plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Front end loader	Plant area
Pump	Adjacent to dam
Scenario 2: Extraction in Cell 1B (Normal Operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 1B
Scenario 3: Extraction in Cell 1B (Maximum operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 1B
Truck	Plant area
Front end loader	Plant area
Dozer	Centre of Cell 1B
Scenario 4: Extraction in Cell 1D (Normal operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 1D

Table 5.2 (Continued): Noise source allocation for each modelling scenario	
Noise Source	**Location**
Scenario 5: Extraction in Cell 1D (Maximum operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 1D
Truck	Plant area
Front end loader	Plant area
Dozer	Centre of Cell 1D
Scenario 6: Extraction in Cell 1K (Normal Operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 1K
Scenario 7: Extraction in Cell 1K (Maximum operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 1K
Truck	Plant area
Front end loader	Plant area
Dozer	Centre of Cell 1K
Scenario 8: Extraction in Cell 2B (Normal Operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 2B

Table 5.2 (Continued): Noise source allocation for each modelling scenario	
Noise Source	**Location**
Scenario 9: Extraction in Cell 2B (Maximum operations)	
Processing Plant	Plant area
Diesel generator	Plant area
Dredging excavator	Existing dam
Pump	Adjacent to dam
Scraper	Centre of Cell 2B
Truck	Plant area
Front end loader	Plant area
Dozer	Centre of Cell 2B
Scenario 10: Shoulder Period Operations	
Truck	Plant area
Front end loader	Plant area

The results of the point to point modelling are presented in Table 5.3.

Table 5.3: Predicted Noise Levels from Site Operations (dB(A))

Scenario	Location A	Location B	Location C
Daytime Design Objective	*45.0*	*45.0*	*45.0*
1	55.4	64.0	45.4
2A	64.5	69.3	48.1
2B	51.4	52.9	40.9
3A	66.9	73.0	50.2
3B	52.9	54.1	42.2
4A	58.8	65.0	48.3
4B	52.4	64.2	42.5
5A	61.2	66.1	51.3
5B	52.5	64.2	44.4
6A	55.5	64.2	41.7
6B	52.2	61.2	42.3
7A	62.0	66.0	48.6
7B	52.2	61.2	43.0
8A	56.5	64.5	46.5
8B	50.9	64.2	42.0
9A	58.9	65.0	49.2
9B	51.2	65.4	43.7
Shoulder Period Design Objective	*40.0*	*40.0*	*40.0*
10	37.4	51.5	35.0

The results shown shaded in Table 5.3 exceed the noise design objectives. Although the modelling scenarios are based on peak operations and conservative modelling factors have been used, the results demonstrate that there is potential for adverse noise emissions if the operations are not adequately managed.

The predicted noise levels for the existing operations are close to the measured noise levels during the unattended monitoring at each location. However, the predicted levels are only reached on some occasions. This demonstrates the conservative nature of the modelling.

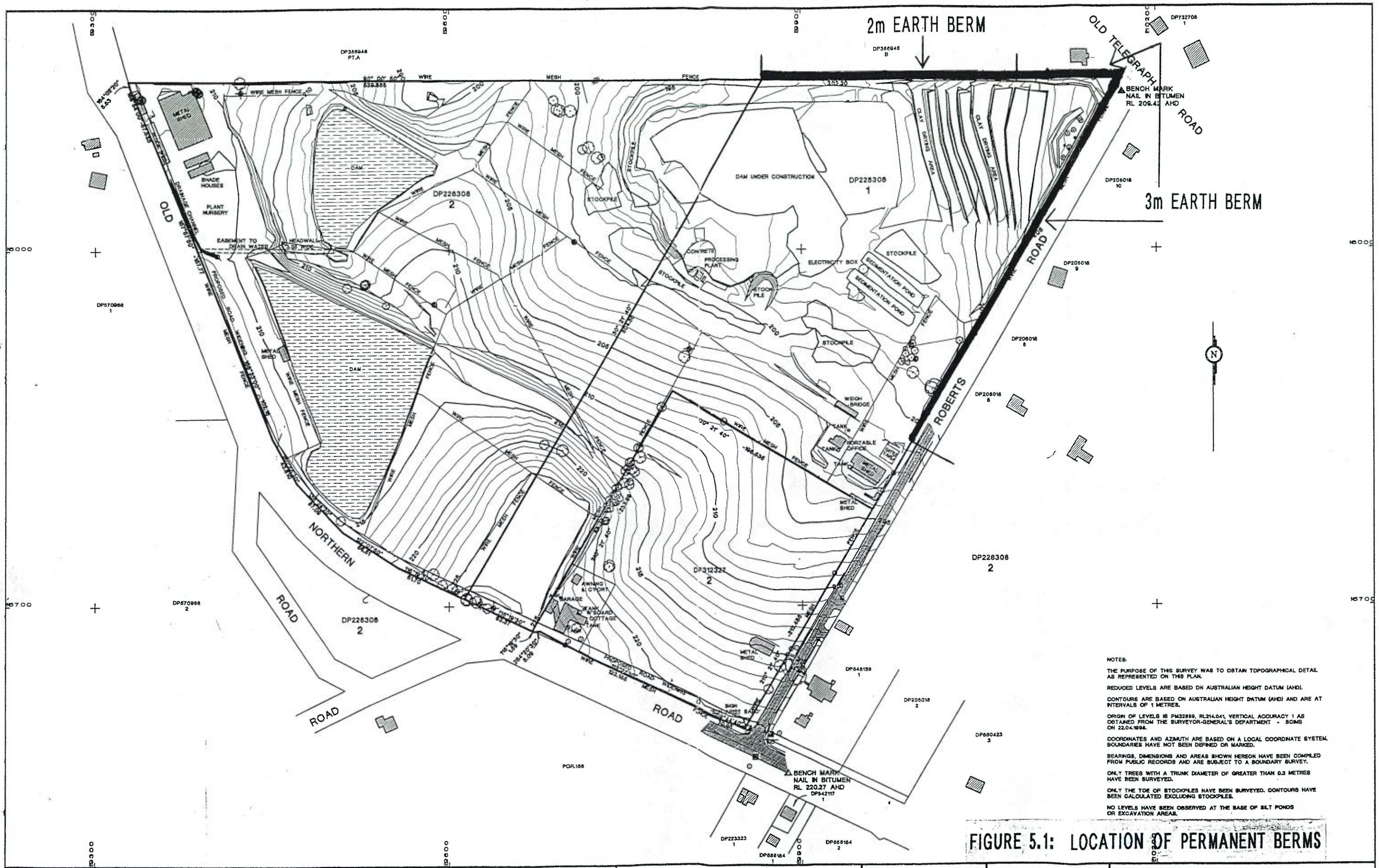
In order to reduce predicted noise emissions, the design of noise controls have been carried out. Using the ENM model, the effect of constructing several permanent earth berms along the site boundaries and temporary earth berms around active extraction cells has been assessed.

The following earth berms have been included in the noise model:

- ⇒ 3 metre permanent earth berm around the north-eastern boundary corner and extending along the eastern boundary to the site entrance.
- ⇒ 2 metre permanent earth berm along the north-eastern section of the northern boundary.
- ⇒ 3 metre temporary earth berms around the active extraction cell.

The figure on the following page shows the location of the proposed permanent earth berms.

Furthermore, the current diesel generator used on the site will no longer be used following commencement of extraction operations. Electrical power will be used for the plant and therefore, the diesel generator has been removed from this second round of modelling.



NOTES:

THE PURPOSE OF THIS SURVEY WAS TO OBTAIN TOPOGRAPHICAL DETAIL AS REPRESENTED ON THIS PLAN.

REDUCED LEVELS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD).

CONTOURS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD) AND ARE AT INTERVALS OF 1 METRES.

ORIGIN OF LEVELS IS PM32899, RL214.041, VERTICAL ACCURACY 1 AS OBTAINED FROM THE SURVEYOR-GENERAL'S DEPARTMENT - SCIMS ON 22.04.1998.

COORDINATES AND AZIMUTH ARE BASED ON A LOCAL COORDINATE SYSTEM. BOUNDARIES HAVE NOT BEEN DEFINED OR MARKED.

BEARINGS, DIMENSIONS AND AREAS SHOWN HEREON HAVE BEEN COMPILED FROM PUBLIC RECORDS AND ARE SUBJECT TO A BOUNDARY SURVEY.

ONLY TREES WITH A TRUNK DIAMETER OF GREATER THAN 0.3 METRES HAVE BEEN SURVEYED.

ONLY THE TOE OF STOCKPILES HAVE BEEN SURVEYED. CONTOURS HAVE BEEN CALCULATED EXCLUDING STOCKPILES.

NO LEVELS HAVE BEEN OBSERVED AT THE BASE OF SILT PONDS OR EXCAVATION AREAS.

FIGURE 5.1: LOCATION OF PERMANENT BERMS

LEGEND

- BENCH MARK
- COMMUNICATIONS PIT
- DUST GAUGE
- GAS MARKER
- MANHOLE
- MONITORING WELL
- PIPE INVERT
- POWER POLE
- SIGN
- TREE (APPROXIMATE EXTENT OF FOLIAGE, APPROXIMATE TRUNK DIAMETER)
- WATER SERVICE

DETAIL SURVEY
LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327.
OLD NORTHERN ROAD
MAROOTA
IN THE LOCAL GOVERNMENT AREA OF
BAULKHAM HILLS
RE: NEXUS ENVIRONMENTAL PLANNING

RATIO NTS	SURVEYED BA, DM & PC.
LEVEL DATUM AHD	DRAWN BW
DATE 14.01.1999	CAD FILE CH3160B1.DWG
SHEET 1 OF 1	REFERENCE CH3160

WILLIAM L. BACKHOUSE Pty. Limited
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Point to point calculations were again carried out using the ENM model with the inclusion of the noise controls. The results of the revised modelling are presented in Table 5.4.

Table 5.4: Predicted Noise Levels from Site Operations with controls in place (dB(A))

Scenario	Location A	Location B	Location C
Daytime Design Objective	*45.0*	*45.0*	*45.0*
1	43.2	45.2	43.1
2A	43.6	46.4	37.5
2B	42.8	44.8	36.0
3A	45.8	54.7	43.8
3B	44.8	49.1	39.2
4A	45.5	47.8	47.6
4B	40.7	43.3	38.7
5A	47.9	52.2	51.1
5B	42.4	45.2	42.5
6A	41.1	45.8	36.8
6B	40.8	42.5	36.5
7A	42.8	47.9	39.7
7B	42.4	45.6	39.3
8A	45.4	45.1	45.4
8B	40.5	42.3	38.4
9A	48.0	48.5	48.7
9B	42.4	45.5	41.2
Shoulder Period Design Objective	*40.0*	*40.0*	*40.0*
10	34.6	39.7	34.3

The shaded results exceed the design objectives.

The results presented in Table 5.4 demonstrate that, following the construction of the earth berms, noise emissions will be significantly attenuated. Whilst the predicted levels do not comply with the design objectives for several scenarios, the objective is only exceeded by 1 – 2 dB(A) for the majority of these cases. There are several points that should also be considered:

a) the modelling scenarios for maximum operations are based on all equipment operating at peak output. This would only occur on rare occasions and therefore designing for compliance with the L_{A10} noise objective may be overly stringent.

b) The modelling results for existing operations with no controls demonstrated that the model is conservative. The results of the unattended monitoring show that the predicted L_{A10} noise levels are only reached occasionally. Therefore, the predicted noise levels for the proposed operations may also be considered as conservative and actual noise levels may only reach the predicted values occasionally.

c) The predicted noise levels show that the total noise impact from the site will be significantly reduced. Discussions with residents have found that they are not annoyed by noise emissions from the current operations. Although the design objectives may be slightly exceeded, a reduction in noise levels will ensure that potential for annoyance is further minimised.

d) As detailed in Table 5.2, a dozer was included in each of the maximum operation scenarios. Analysis of the model outputs has found that the dozer contributes significantly to the combined predicted level. For example, in Scenario 3A, the predicted combined noise level was 54.7 dB(A) at Location B; the highest predicted noise level of all scenarios. However, the predicted noise level from the dozer alone was 53.6 dB(A). All other sources were below 46 dB(A).

   The dozer will only be used when the material cannot be excavated using a scraper. Discussions with site management have found that this will be rare.

The results of the modelling for the 6am to 7am period comply with the design objective. The modelling assumes that a truck and front end loader will operate during this period only. The plant and other mobile equipment will not commence operations until after 7am.

The predicted noise levels show that there is a need for a detailed noise management plan for the proposed operations. Increasing the height of the earth berms above 3 metres or restricting operations would not be practical or economically viable. The design objectives can be satisfied by managing noise emissions practically. A noise management plan for the site should be prepared prior to commencement of operations. The plan should address issues such as:

a) efficient use of the cell extraction technique where the working face is used to provide additional screening,
b) maintenance of all equipment,
c) training of staff in environmental noise awareness,
d) establishment of procedures to accept and respond to community complaints,
e) regular community consultation,
f) regular noise compliance monitoring.

The plan should ensure that noise levels from the site do not cause annoyance within the community.

5.2 Road Traffic Noise

This section details the predicted impact of road traffic noise from the proposed quarry. Details of the proposed transport movements and routes was extracted from the traffic investigation carried out by Lyle Marshall & Associates Pty Ltd.

The maximum daily loaded truck movements from the site will be 50 (100 total movements). The average daily loaded truck movements from the site will be 30 (60 total movements).

The maximum and average hourly truck movements are presented in Table 5.5.

Table 5.5: Maximum and Average Hourly Truck Movements

Time	Average Movements		Maximum Movements	
	In (empty)	Out (loaded)	In (empty)	Out (loaded)
6am – 7am	7	7	10	10
7am – 8am	3	3	8	8
8am – 9am	2	2	5	5
9am – 10am	2	2	3	3
10am – 11am	2	2	3	3
11am – 12pm	2	2	3	3
12pm – 1 pm	2	2	3	3
1pm – 2pm	2	2	3	3
2pm – 3pm	2	2	3	3
3pm – 4pm	2	2	3	3
4pm – 5pm	2	2	3	3
5pm – 6pm	2	2	3	3
Total	30	30	50	50

The main transport routes for the proposed operations are as follows :

⇒ Trucks will exit the site onto Roberts Road (heading south).

⇒ At the intersection of Roberts Road and Old Northern Road, approximately 40% of trucks will turn left and travel along Old

Northern Road (heading south-east). The remaining 60% of trucks will turn right at old Northern Road and then left at Wisemans Ferry Road to head west.

5.2.1 Traffic Counts

Traffic counts were carried out along the proposed transport routes. The traffic counts provide information regarding total vehicles and percentage of heavy vehicles for each hour of the day. The counts were carried out over a seven day period. The Average Daily Traffic (ADT) flows for Monday to Sunday for each count location are presented in Table 5.6.

Table 5.6: Existing Average Daily Traffic Flows

Location	ADT	Heavy Vehicle Percentage
Old Northern Road – South of Roberts Road	2019	10.4 %
Wisemans Ferry Road	1624	15.5 %

5.2.2 TNOISE Modelling

The traffic noise computer model - TNOISE which is based on the "Calculation of Road Traffic Noise" by the UK Department of Transport, 1988, was utilised to predict the impact of proposed increases in truck movements along the two proposed routes. The predicted impact is based on modelling of semi-trailer trucks, which are typical for quarried product transport.

Traffic noise levels have been predicted based on the measured traffic flows at the two residential locations where existing traffic noise levels were monitored. These are:

Location D: Residence at Maroota Motors Pty Ltd, Corner of Old Northern Road and Roberts Road, Maroota.

Location E: Residence at the corner of Wisemans Ferry Road and Haerses Road, Maroota.

The purpose of the traffic noise modelling for existing flows is to calibrate the model. Several site specific factors need to be calibrated for each location. Predicted $L_{Aeq(15hr)}$, $L_{Aeq(9hr)}$ and $L_{Aeq,24hr}$ noise levels were used to assess the calibration against the measured noise levels.

The results of the calibration are presented in Table 5.7.

Table 5.7: Calibration of the traffic noise model (dB(A))

Location	Measured Noise Level			Modelled noise level		
	$L_{Aeq(15hr)}$	$L_{Aeq(9hr)}$	$L_{Aeq,24hr}$	$L_{Aeq(15hr)}$	$L_{Aeq(9hr)}$	$L_{Aeq,24hr}$
D	55.3	48.9	52.9	54.5	50.6	53.2
E	55.1	47.1	52.1	52.4	50.1	51.5

A reasonably accurate calibration of the traffic noise model has been achieved. All modelled noise levels are within 3 dB(A) of the measured noise level.

The TNOISE model can now be used to predict the hourly increase in L_{Aeq} noise levels due to the increase in traffic movements from the site. The existing hourly L_{Aeq} noise level was modelled for each location using the calibrated TNOISE model. The hourly L_{Aeq} noise levels were then modelled again with the inclusion of the anticipated truck movements from the site. The maximum hourly movements, have been used in the modelling in order to provide a conservative assessment. The results are presented in Tables 5.8 and 5.9.

Table 5.8: Modelled hourly L_{Aeq} noise levels – Location D (dB(A))			
Period	Modelled existing L_{Aeq}	Modelled proposed L_{Aeq}	Increase
6am – 7am	53.7	54.0	0.3
7am – 8am	54.6	54.9	0.3
8am – 9am	54.7	55.0	0.3
9am – 10am	54.2	54.3	0.1
10am – 11am	54.3	54.4	0.1
11am – 12pm	54.6	54.8	0.2
12pm – 1pm	54.3	54.4	0.2
1pm – 2pm	54.7	54.8	0.1
2pm – 3pm	55.1	55.2	0.1
3pm – 4pm	55.2	55.3	0.1
4pm – 5pm	55.9	56.0	0.1
5pm – 6pm	55.5	55.6	0.1

Table 5.9: Modelled hourly L_{Aeq} noise levels – Location E (dB(A))			
Period	Modelled existing L_{Aeq}	Modelled proposed L_{Aeq}	Increase
6am – 7am	52.4	52.9	0.5
7am – 8am	53.6	53.9	0.3
8am – 9am	53.1	53.3	0.2
9am – 10am	53.0	53.1	0.1
10am – 11am	52.3	52.5	0.2
11am – 12pm	52.3	52.5	0.2
12pm – 1pm	52.6	52.8	0.2
1pm – 2pm	52.3	52.5	0.2
2pm – 3pm	52.6	52.8	0.2
3pm – 4pm	53.3	53.4	0.1
4pm – 5pm	53.8	54.0	0.2
5pm – 6pm	53.6	53.7	0.1

5.2.3 Assessment of Traffic Noise Impact

A recognised road traffic noise model has been used to predict traffic noise impacts from the proposed development. The model was calibrated for each of the two locations using site specific data and the calibration was checked against measured traffic noise levels.

The model was then used to predict the hourly increase in L_{Aeq} noise levels from the proposed development. The criterion used to assess the impact was to limit the hourly increase by no more than 2 dB(A). Whilst it could be argued that this objective is overly stringent, it will ensure that the potential for adverse impact is minimised.

The modelling was carried out based on the maximum anticipated truck movements. Average truck movements would generate lower road traffic noise levels. The results of the modelling show that the increase in hourly L_{Aeq} noise levels is well below 2 dB(A) for both locations.

It should be noted that there are no residential premises located in Roberts Road between the site entrance and Old Northern Road. The traffic noise assessment has therefore been limited to residences along Old Northern Road and Wisemans Ferry Road.

6. SAFEGUARDS

The noise modelling that has been carried out has been based on conservative factors, adverse conditions and maximum operations. The construction of earth berms and the management of site noise should ensure that the site noise emissions will not cause annoyance.

However, strict environmental management and procedures are required in all extractive industry developments. There are several safeguards that can be recommended aimed at eliminating unnecessary noise emissions:

a) Extraction techniques

Section 2.9 of Baulkham Hills Shire Council DCP 500 states that "Proponents are encouraged to use the extraction cell technique as a means of facilitating acoustic shielding around worked extraction sites". Dick Benbow & Associates were involved in the development of this technique and have observed the effectiveness of the method on reducing noise from extraction equipment. The technique was developed primarily for extraction using an excavator. It is difficult to implement the method when a dozer and scraper are used. However, it will be possible to develop the extraction process in a manner, which maximises the use of the working face for shielding.

Extraction should be oriented such that the working face provides some shielding for the residences adjacent to the site. This may also ensure that the exhaust of the dozer and scraper will rarely point towards the residences.

b) Auxiliary mobile equipment

Assessment of noise from other quarry operations have found that the temporary use of auxiliary equipment such as a grader or water cart can significantly contribute to the noise emissions from the site when operating on exposed haul roads. Therefore, the use of this equipment should not be carried out early in the morning where possible.

c) Driver education

Truck drivers entering and leaving the site will be contractors. However, site management should encourage drivers to consider the community where possible. Particular attention should be given to the limiting of exhaust braking when travelling during the 6am to 7am period.

d) Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA)

The adoption of BMP and BATEA practices are encouraged by the NSW EPA and specifically addressed in the Draft Stationary Noise Source Policy. BMP includes some of the factors discussed above but also includes the encouragement of a general staff attitude to reducing noise emissions. All staff should be aware of the problems associated with noise and the proximity of residences to the site.

BATEA involves the incorporation of the most advanced and affordable technology to minimise noise emissions. All future plant should be selected after considering noise emissions from the item.

It is recommended that as part of the safeguards, a noise compliance study is conducted following the commencement of operations on the site. Once the noise compliance study has been presented, the noise management plan for the site should be updated to include any recommendations for noise control or procedures.

7. CONCLUSION AND RECOMMENDATIONS

The sand mining industry in this area has been able to operate by using specific measures to reduce noise nuisance and enable rehabilitation of land back to viable market gardens.

The proposed extraction of sand would also be able to satisfy acceptable acoustic criteria. Long term community noise monitoring has taken place and the results used to determine acoustic design objectives to protect the amenity of nearest residents. The assessment criteria have been formulated from the Baulkham Hills Shire Council Development Control Plan No. 500 and criteria setout in the NSW EPA guidelines.

The assessment that has been undertaken has found that the use of earth berms and the implementation of a noise management plan would provide significant noise control. The mobile equipment in use generates noise levels free of tonal or other annoying characteristics.

The predicted noise emissions with noise controls in place represent a significant improvement in current noise emissions from the site. There have been no known complaints lodged with quarry management regarding excessive noise from the current operations. Furthermore, discussions with residents at the most potentially affected locations have found that they are not annoyed by noise from the site and are generally supportive of the site management. Following the implementation of controls and a comprehensive noise management plan, it is considered unlikely that noise levels at the residents will cause concern.

An assessment of traffic noise impact has determined that the development will have little or no impact on residential traffic noise levels provided the number of traffic movements are limited to approximately 100 movements per day.

Several safeguards have also been recommended to ensure that the site will continue to operate in a manner that will not have an adverse effect on community noise levels.

This concludes the report.

Derek Langgons
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Robert Mason
Technical Assistant

Shane Harris
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R T Benbow
Principal Consultant

8. REFERENCES

Woodward-Clyde Pty Ltd, "Lot 1 and 2 DP228308, Lot 2, DP312327, Maroota, Development Application. Conceptual Mine Plan", 18 June, 1999.

Baulkham Hills Shire Council, "Extractive Industries, Development Control Plan No 500", December, 1997.

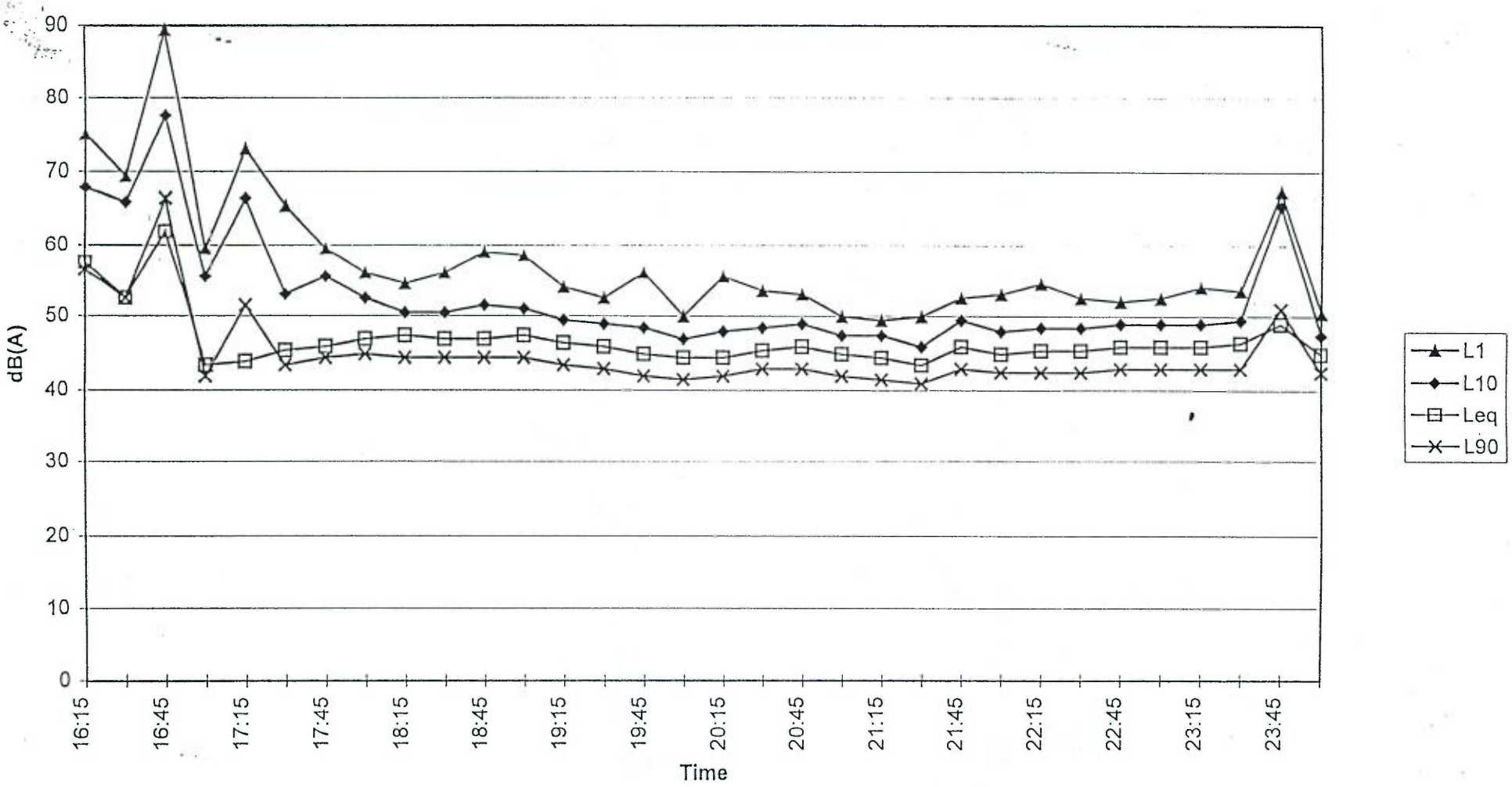
NSW EPA "Environmental Criteria for Road Traffic Noise", May, 1999.

NSW EPA "Environmental Noise Control Manual"

Department of Transport, Welsh Office, "Calculation of Road Traffic Noise", 1988.

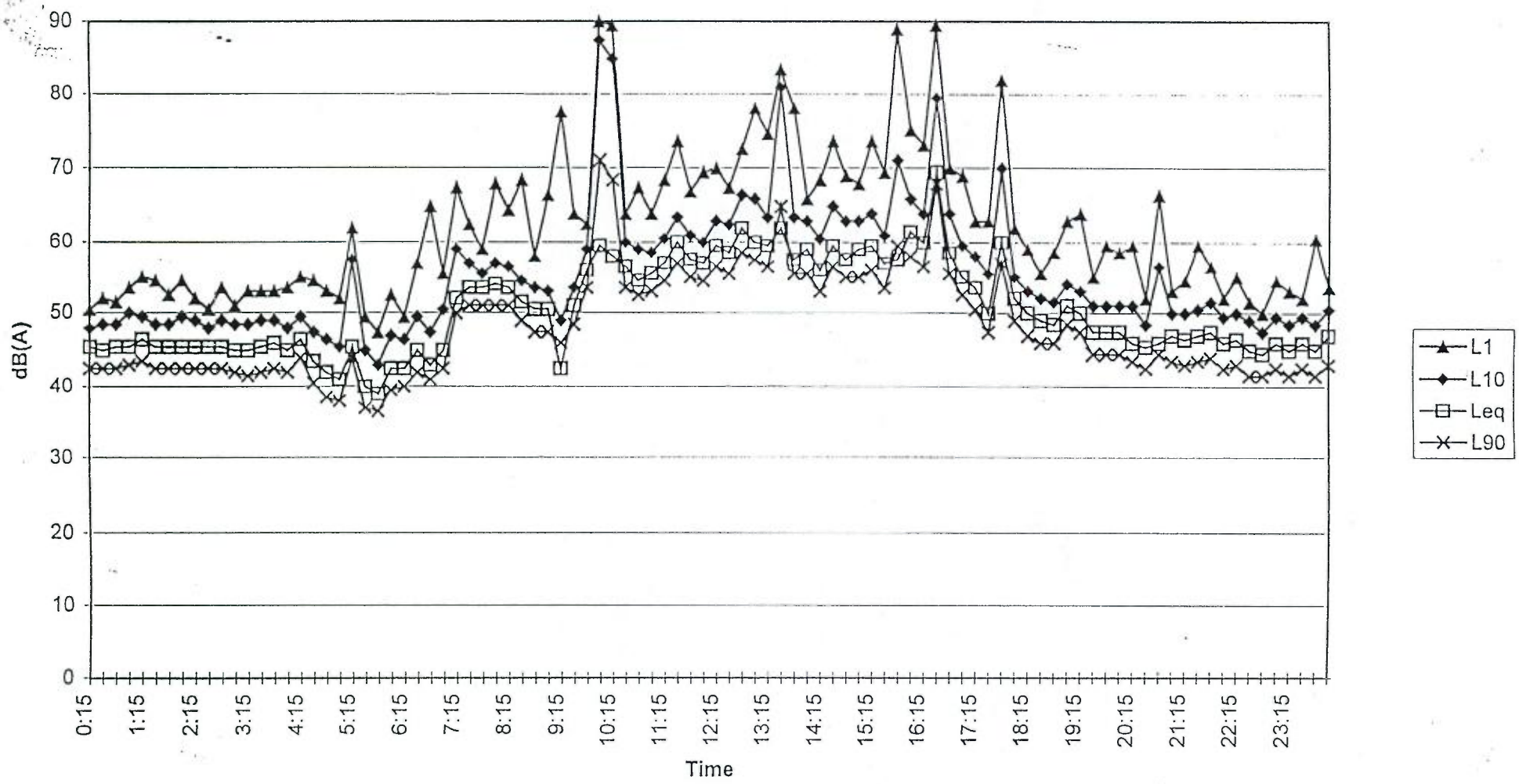
ATTACHMENTS

Location A - Measured Noise Levels (19/7/99)



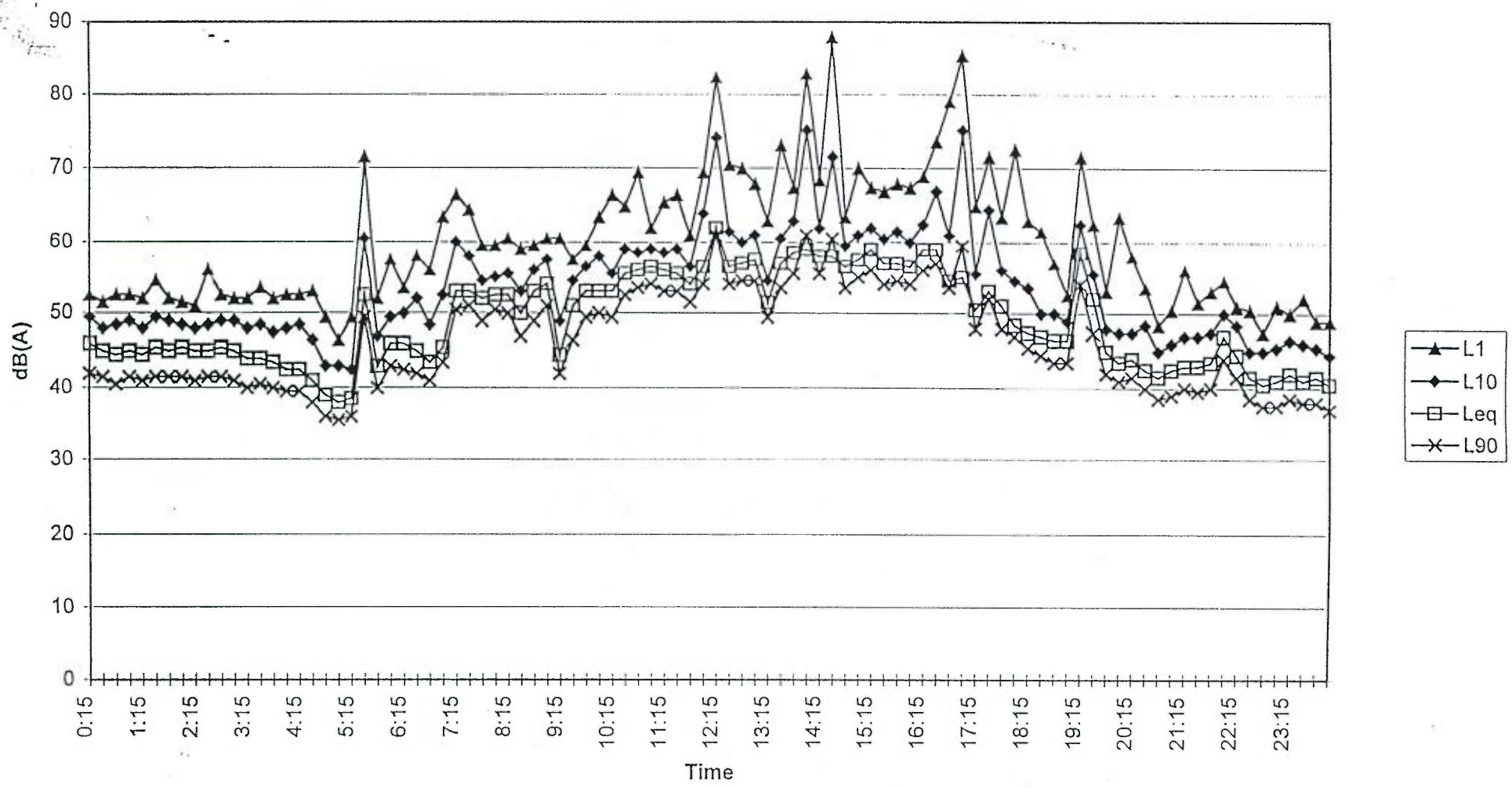
Prepared by Dick Benbow and Associates

Location A - Measured Noise Levels (20/7/99)



Prepared by Dick Benbow and Associates

Location A - Measured Noise Levels (21/7/99)



Prepared by Dick Benbow and Associates

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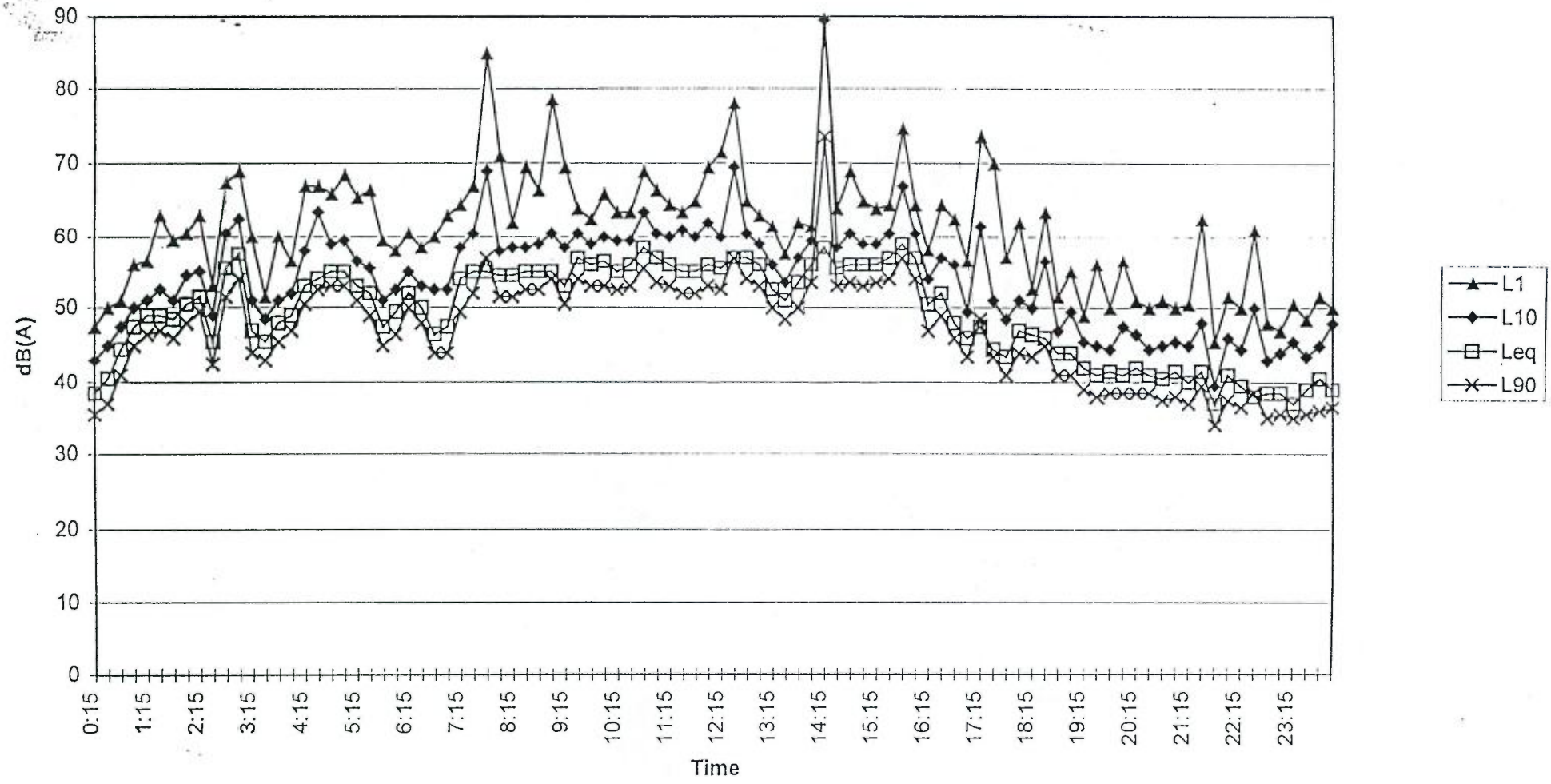
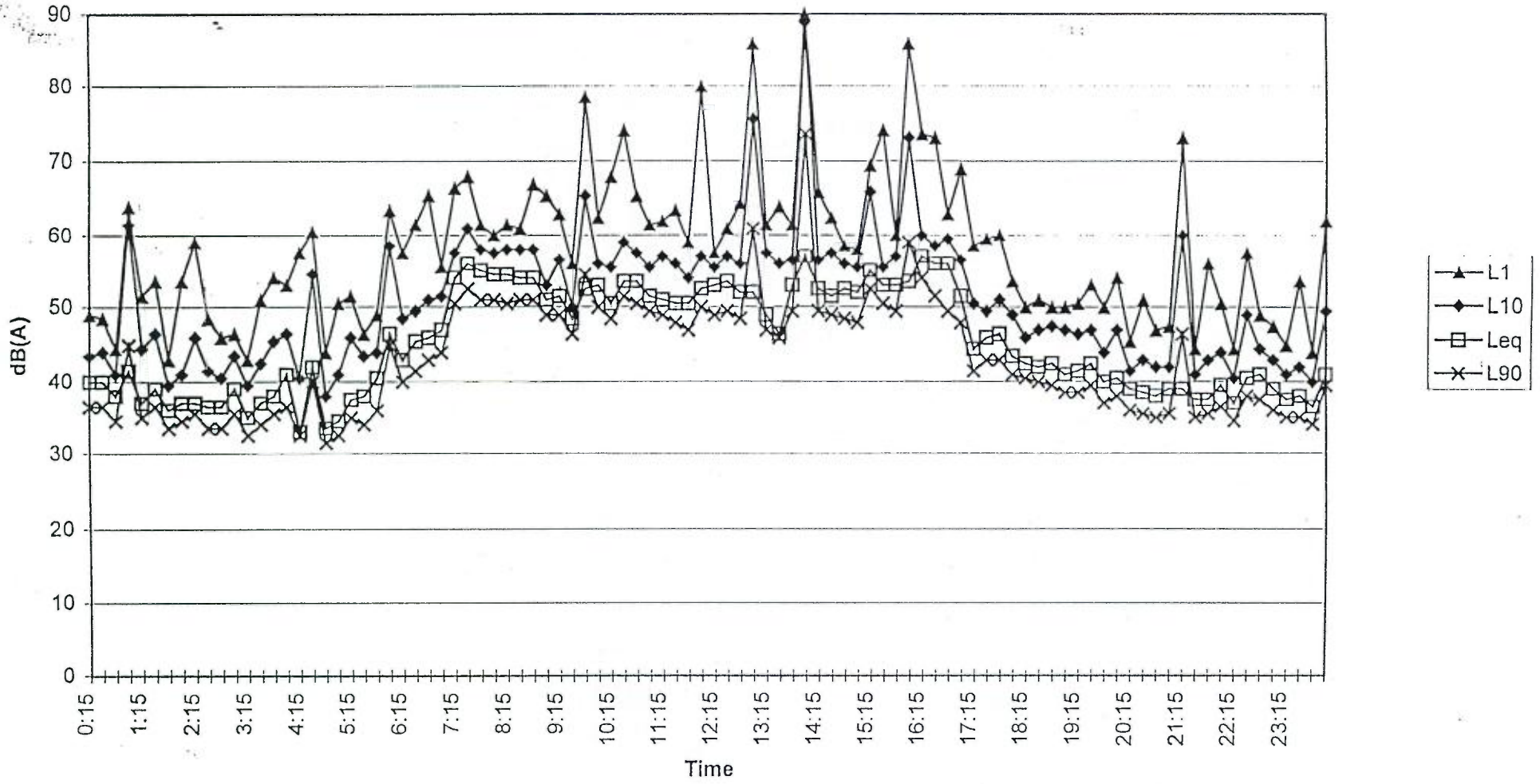


Prepared by Dick Benbow and Associates

Location A - Measured Noise Levels (23/7/99)



Prepared by Dick Benbow and Associates

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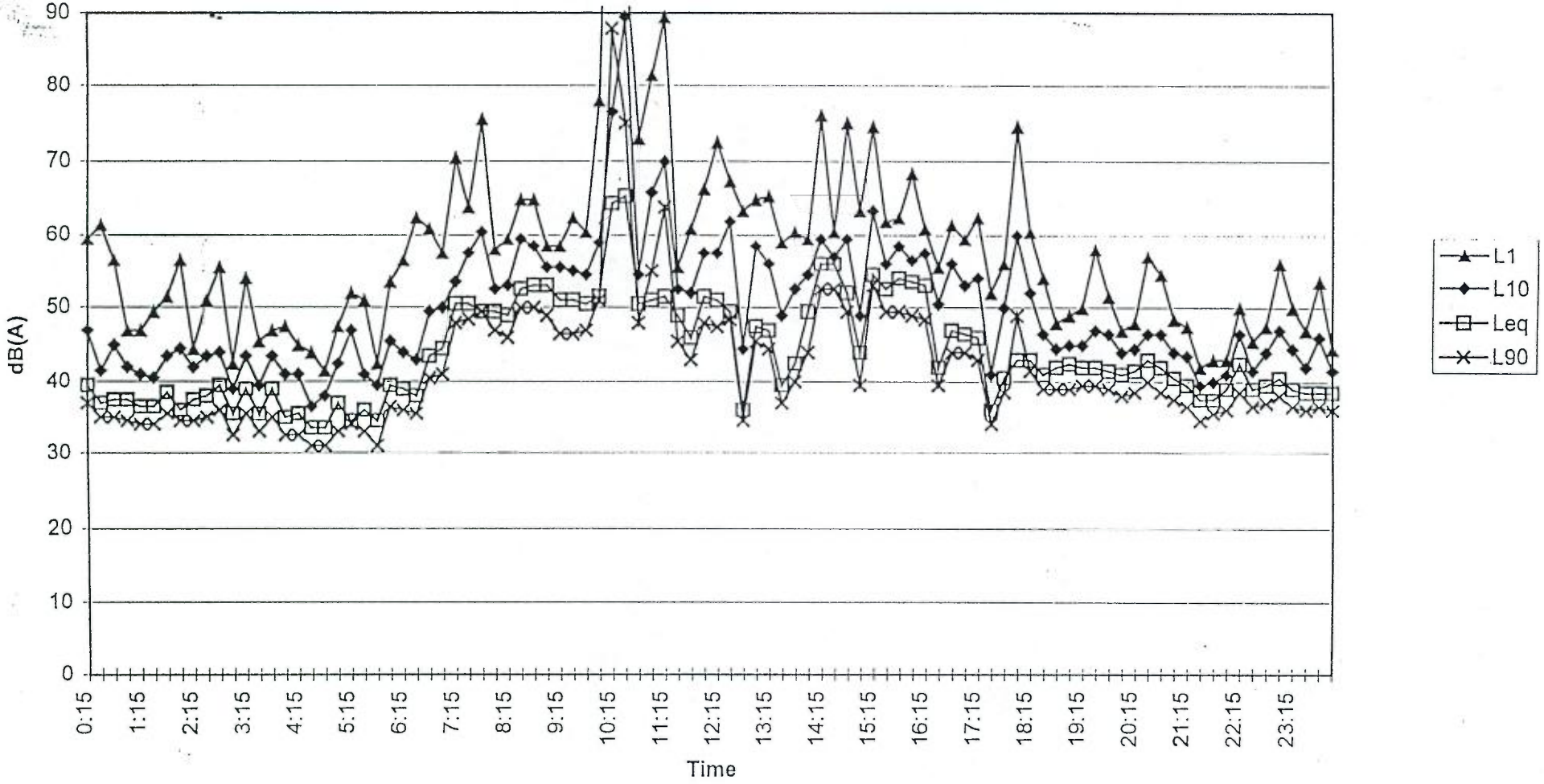

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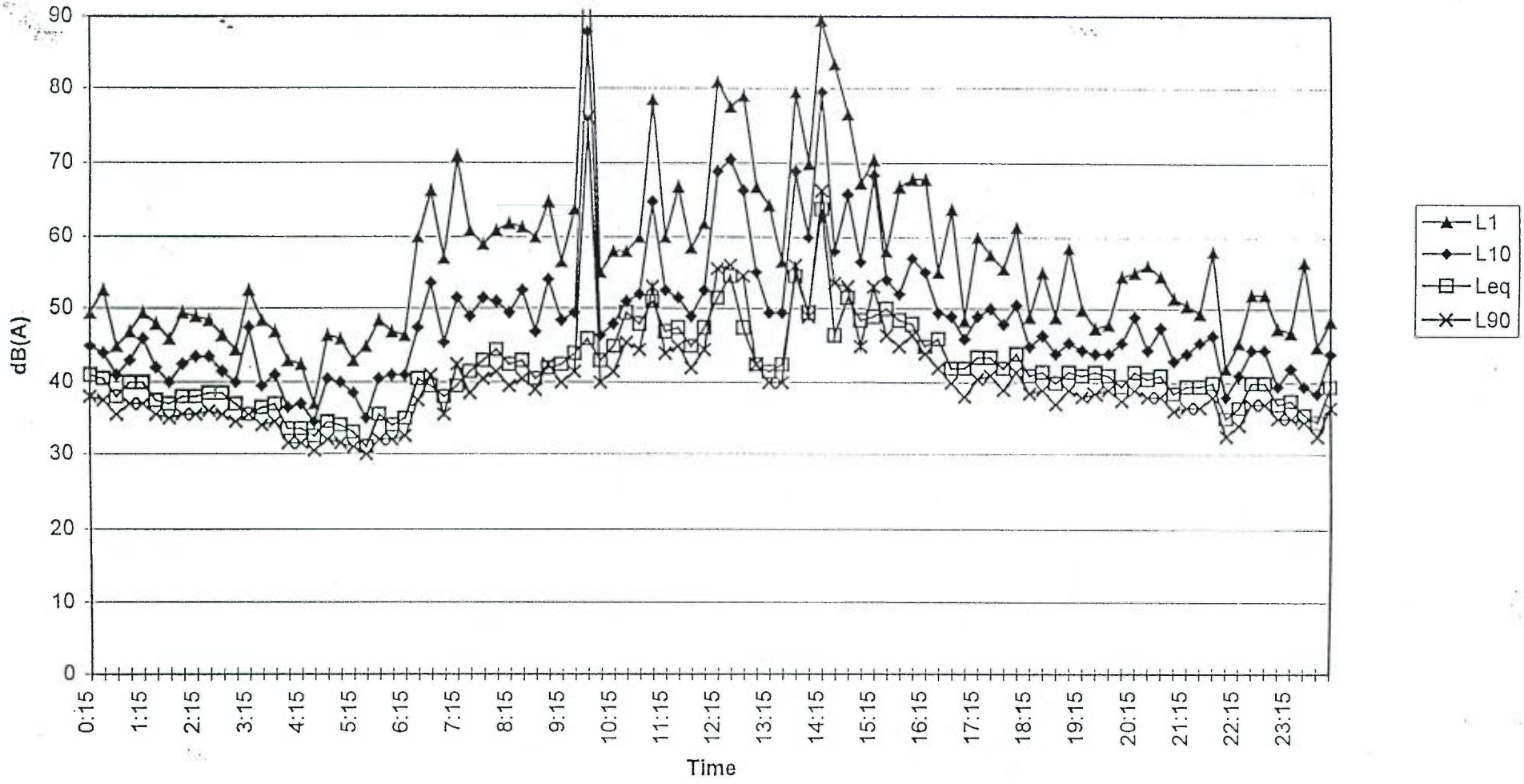

Prepared by Dick Benbow and Associates

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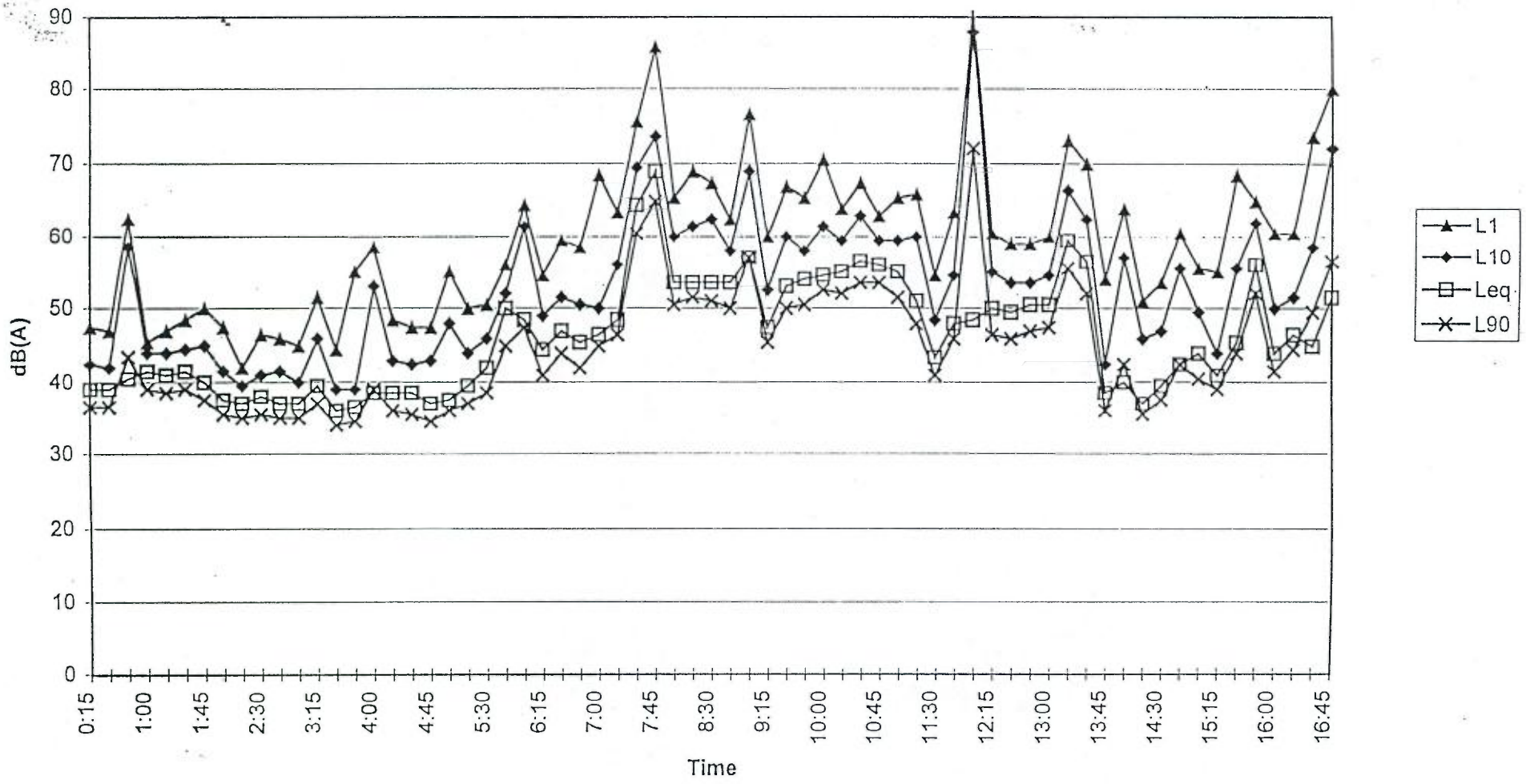

Prepared by Dick Benbow and Associates

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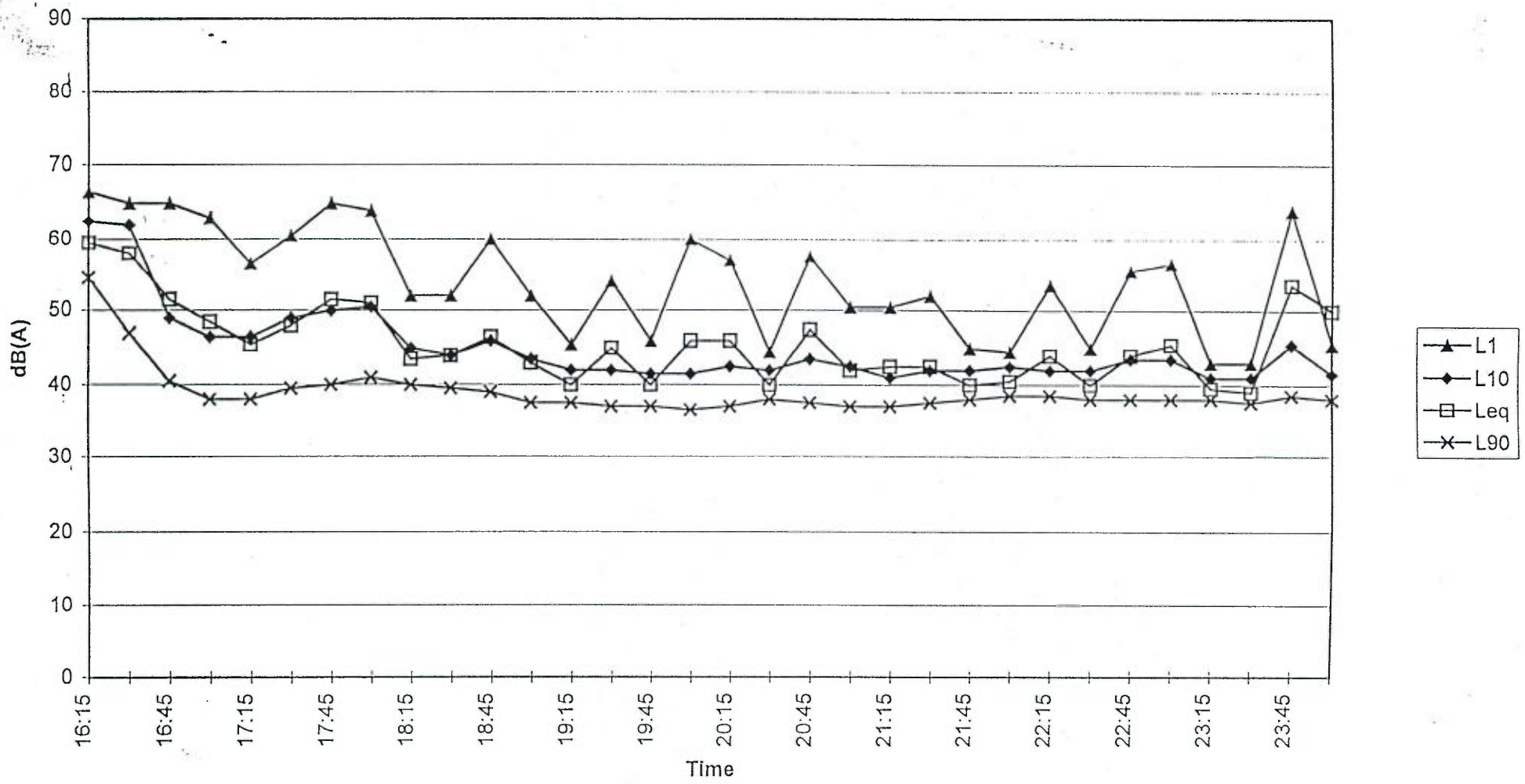

Prepared by Dick Benbow and Associates

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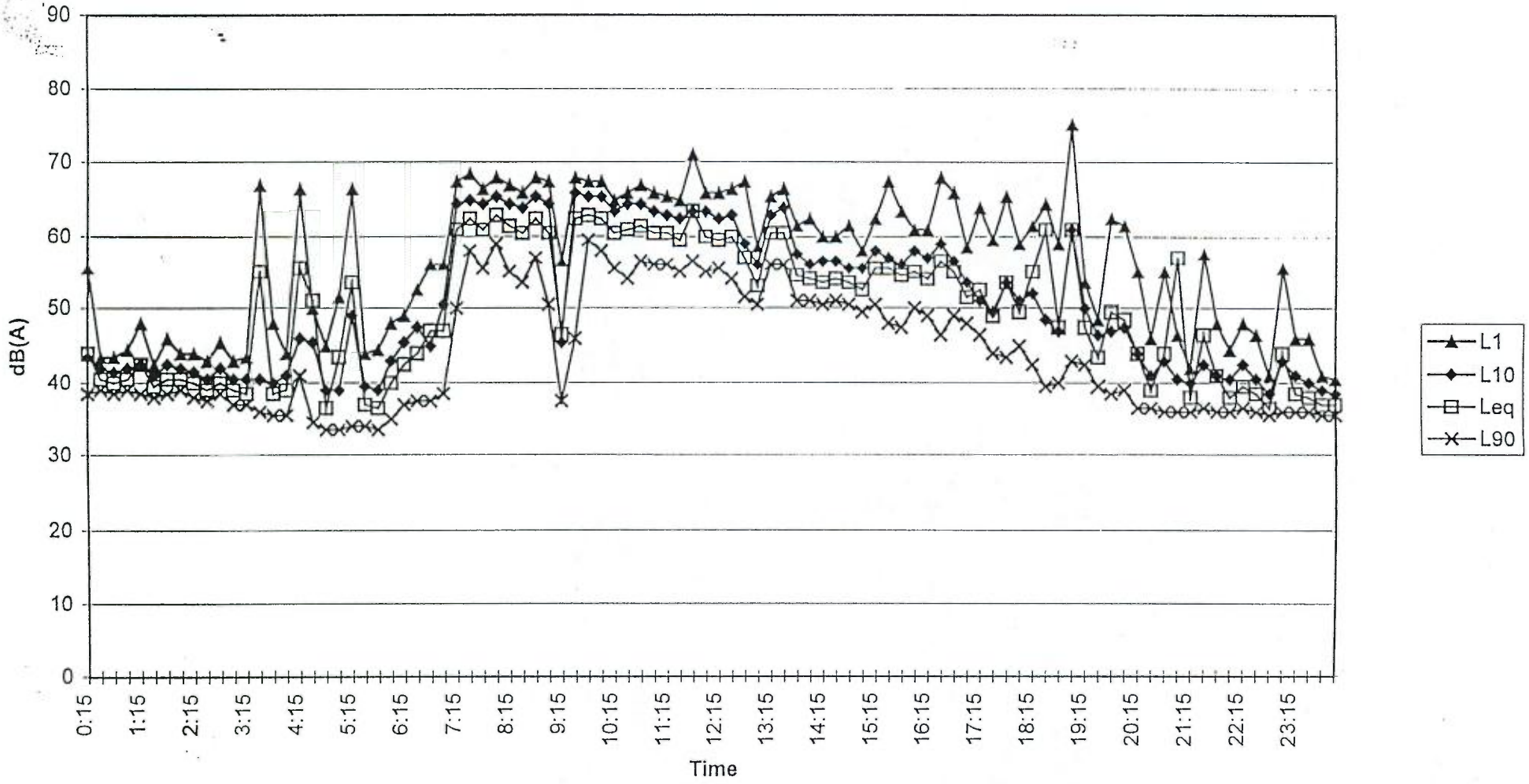

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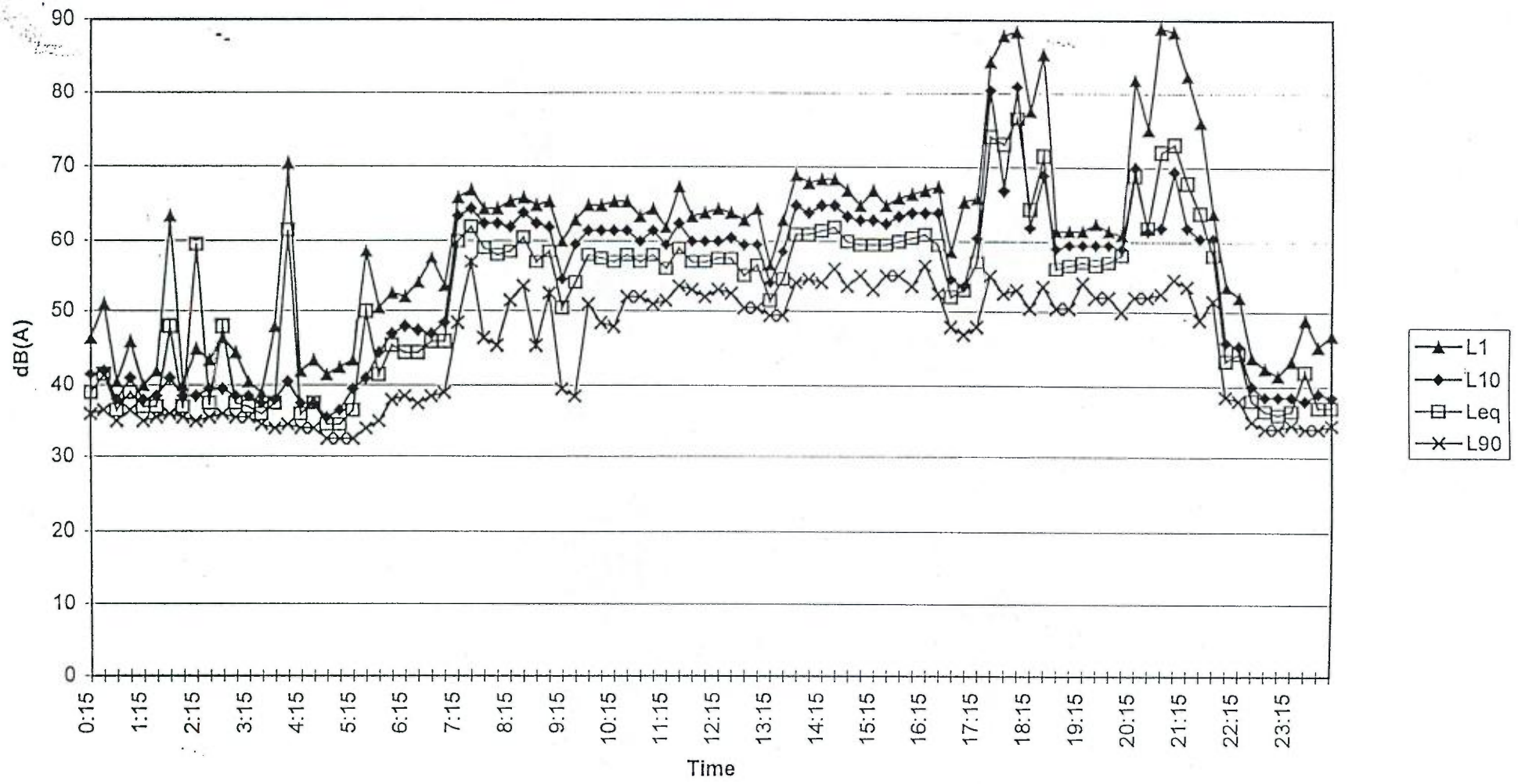
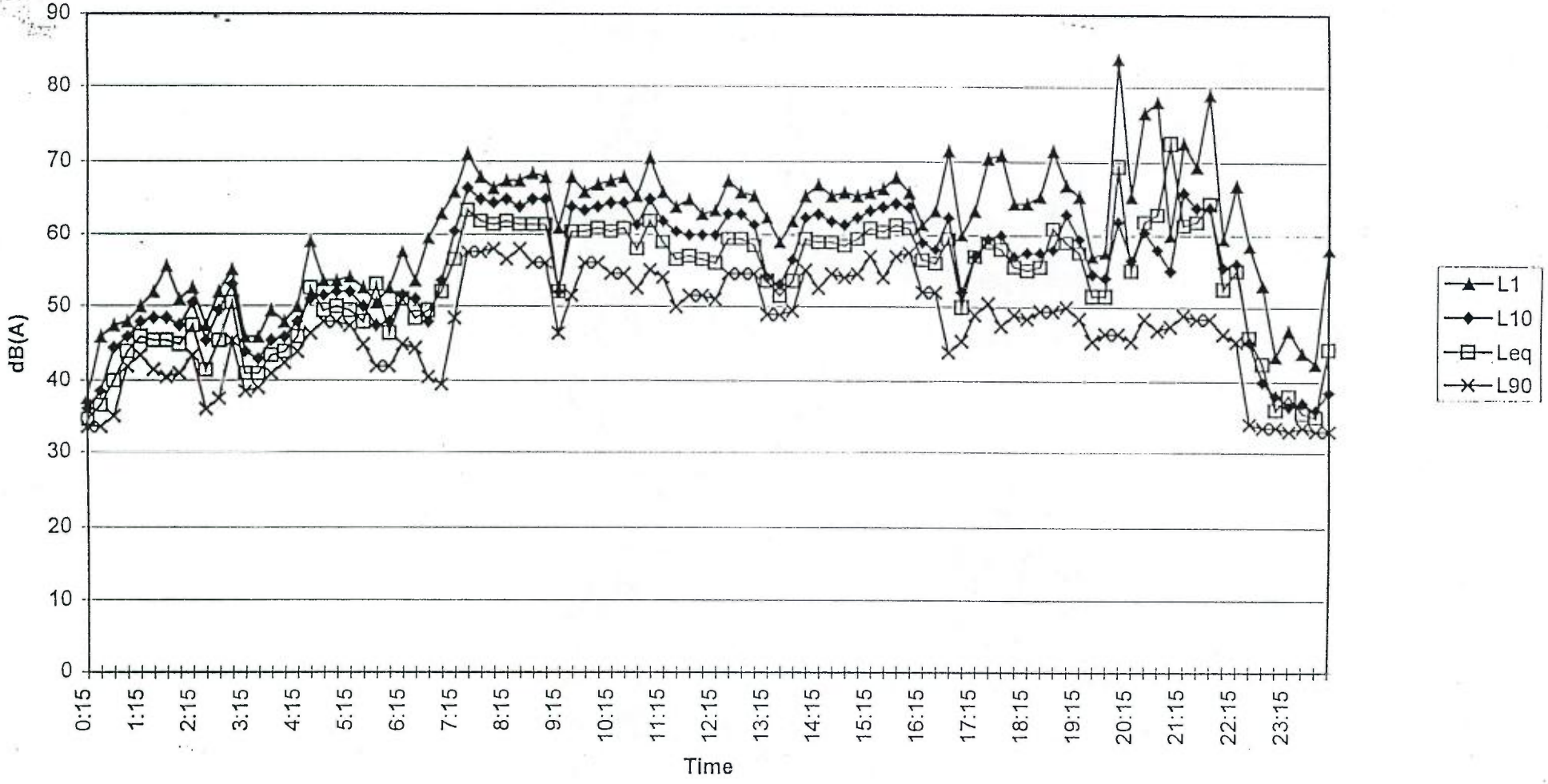


Prepared by Dick Benbow and Associates

Location B - Measured Noise Levels (22/7/99)



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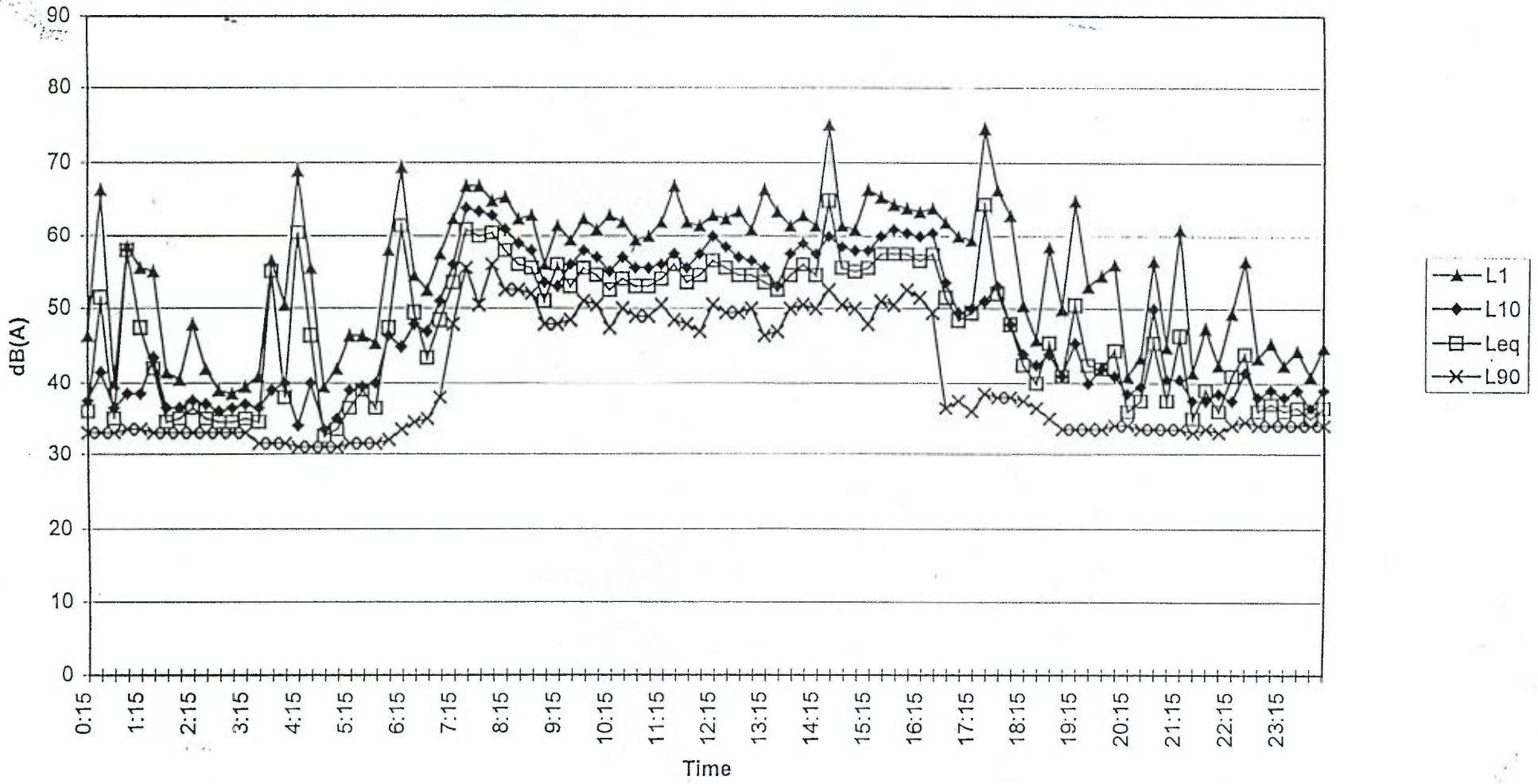

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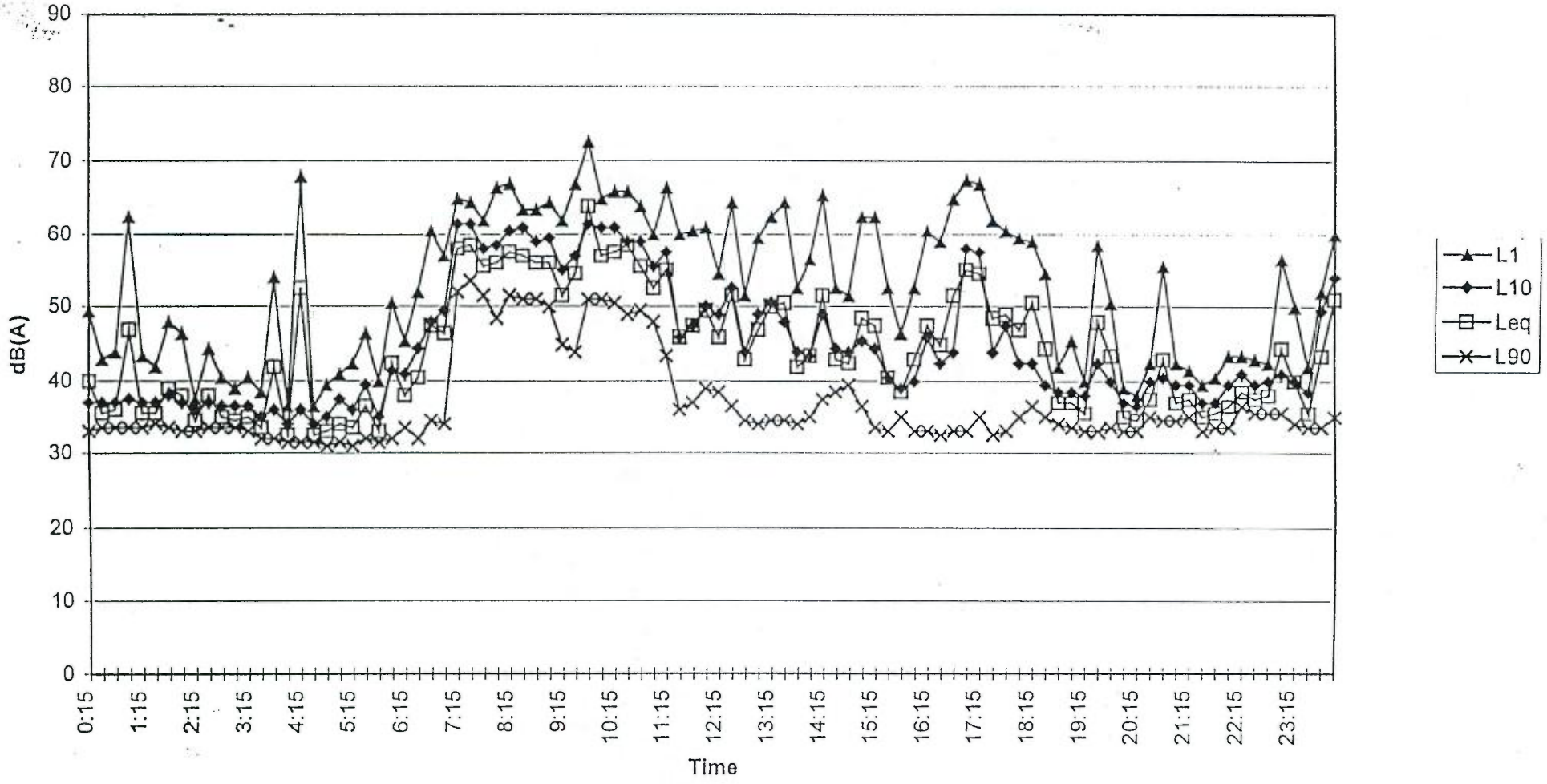

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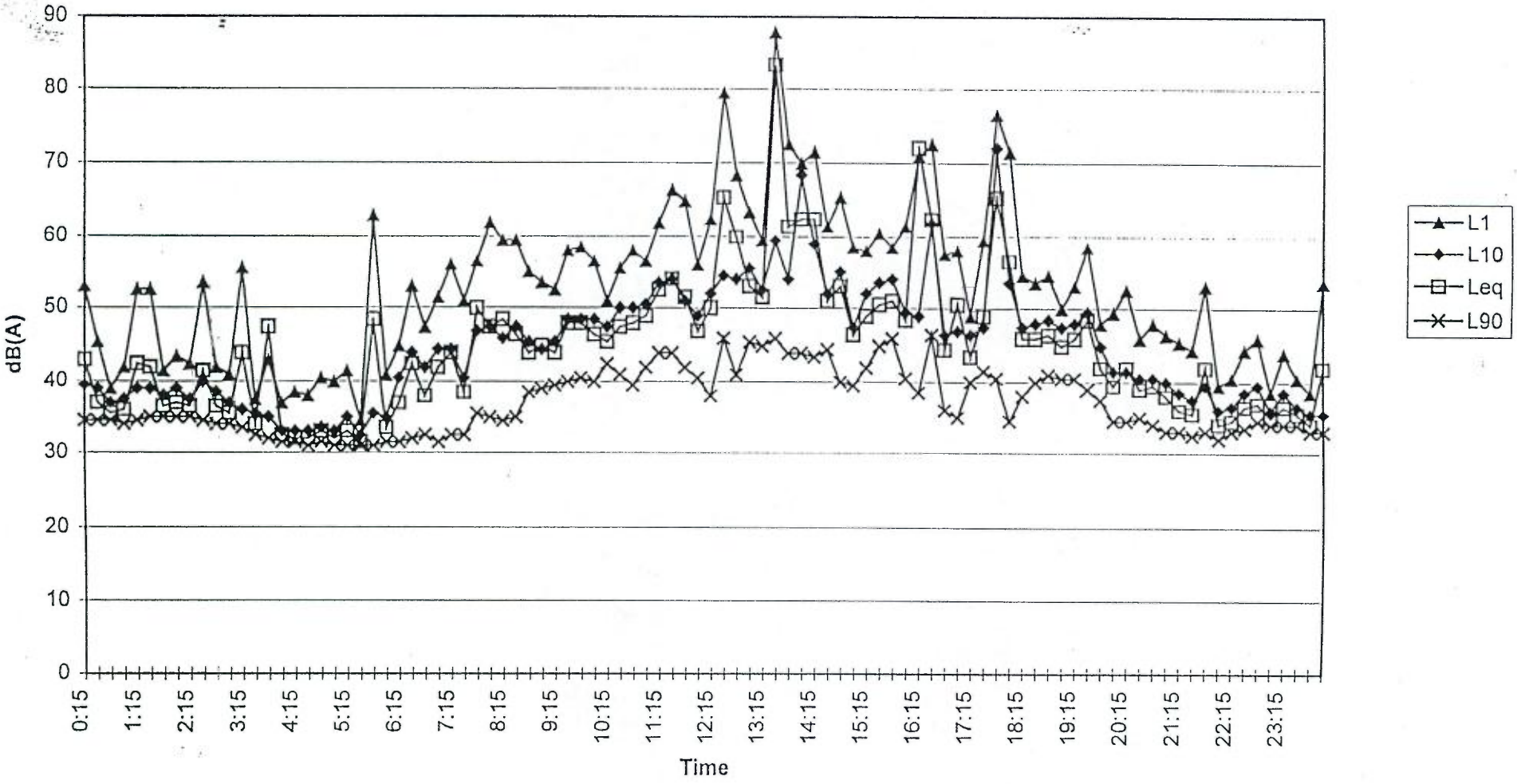

Prepared by Dick Benbow and Associates

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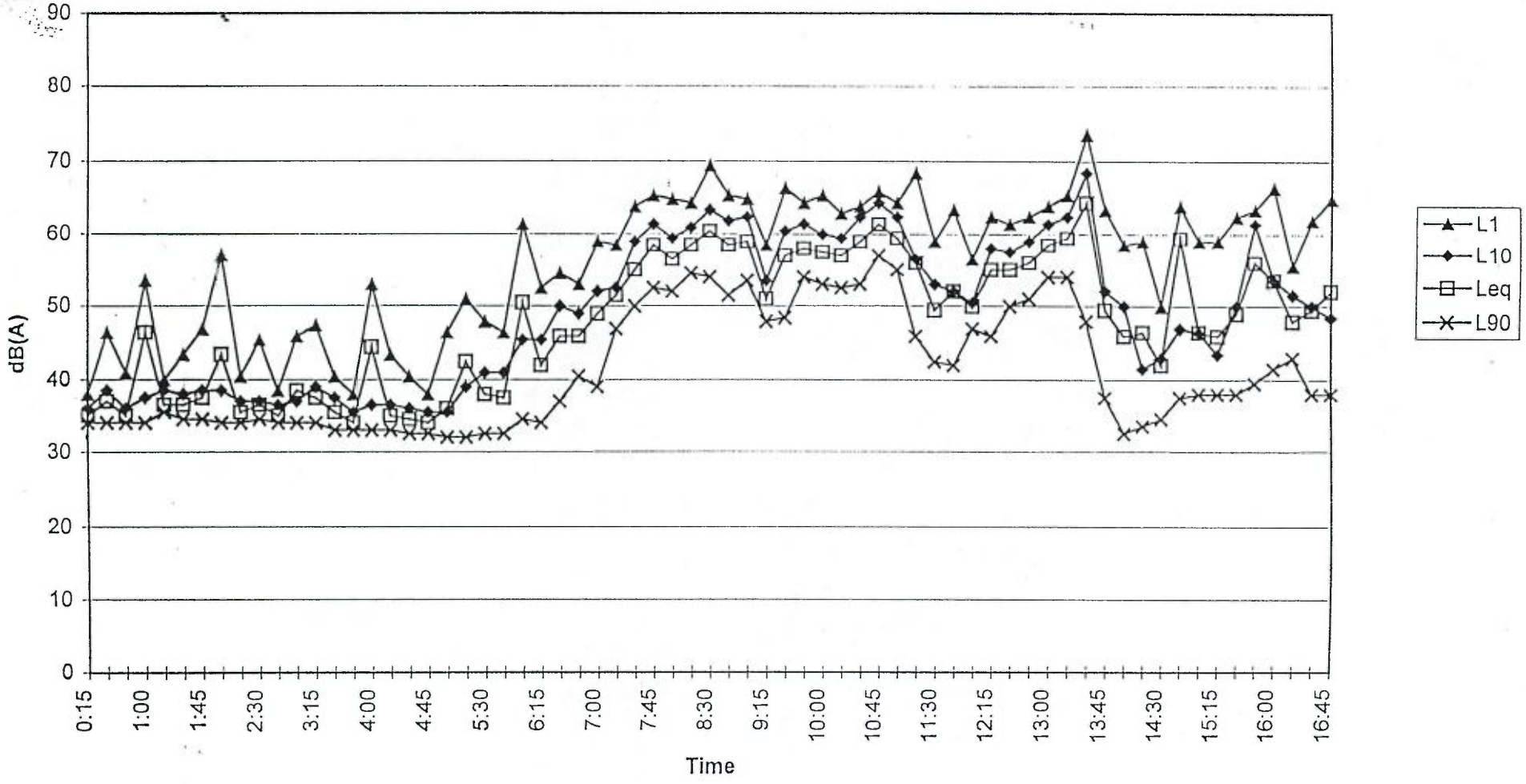

Prepared by Dick Benbow and Associates

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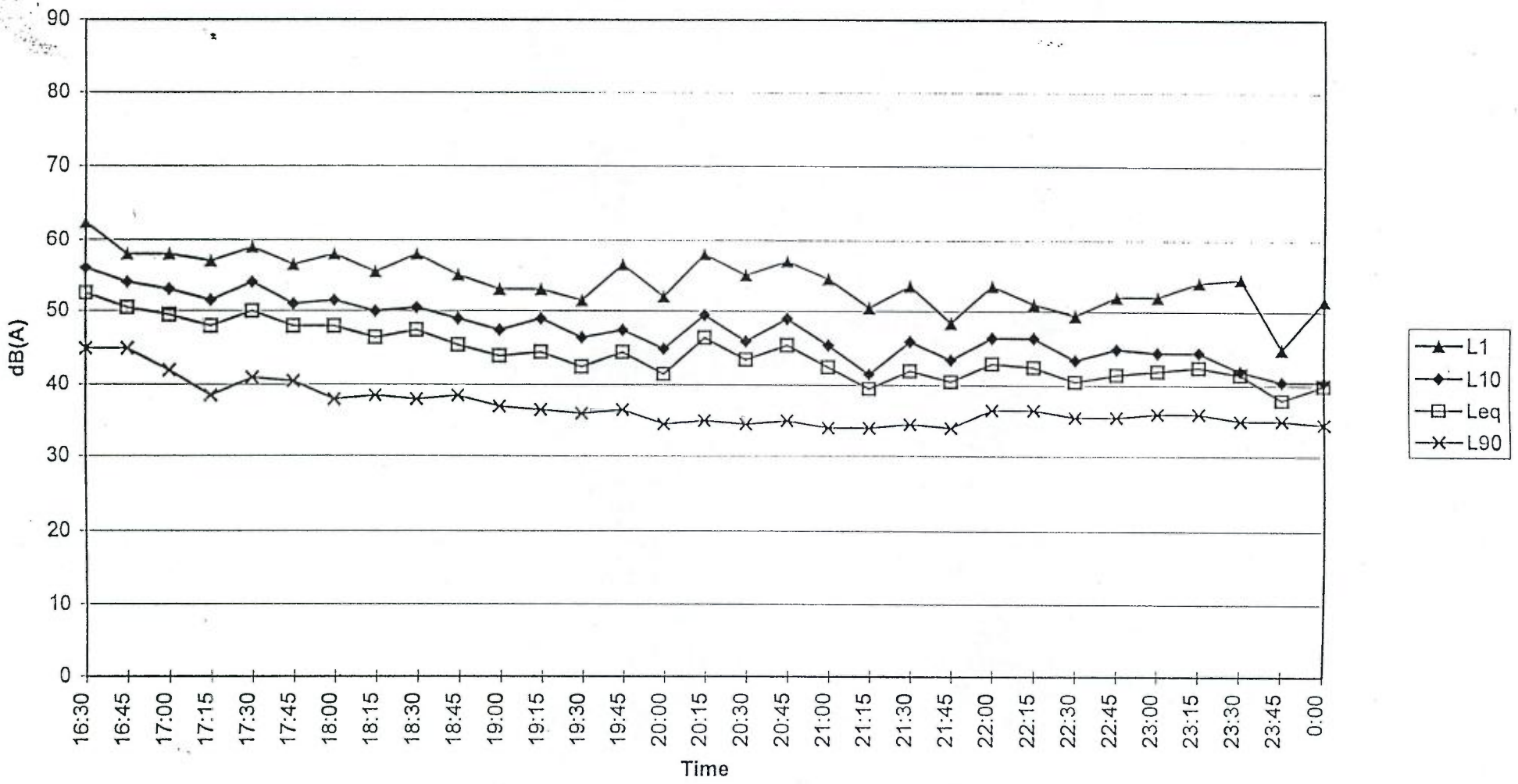

Prepared by Dick Benbow and Associates

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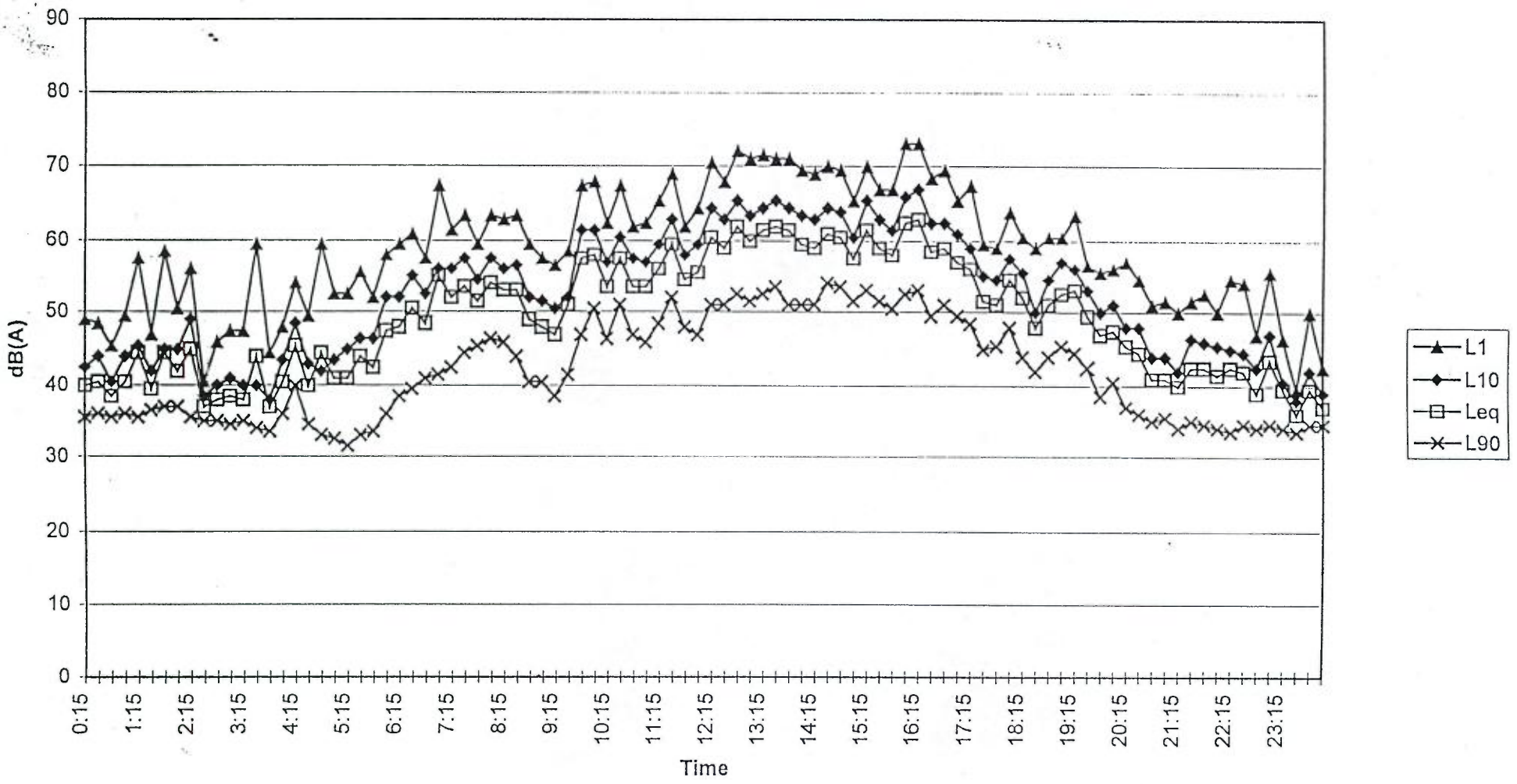

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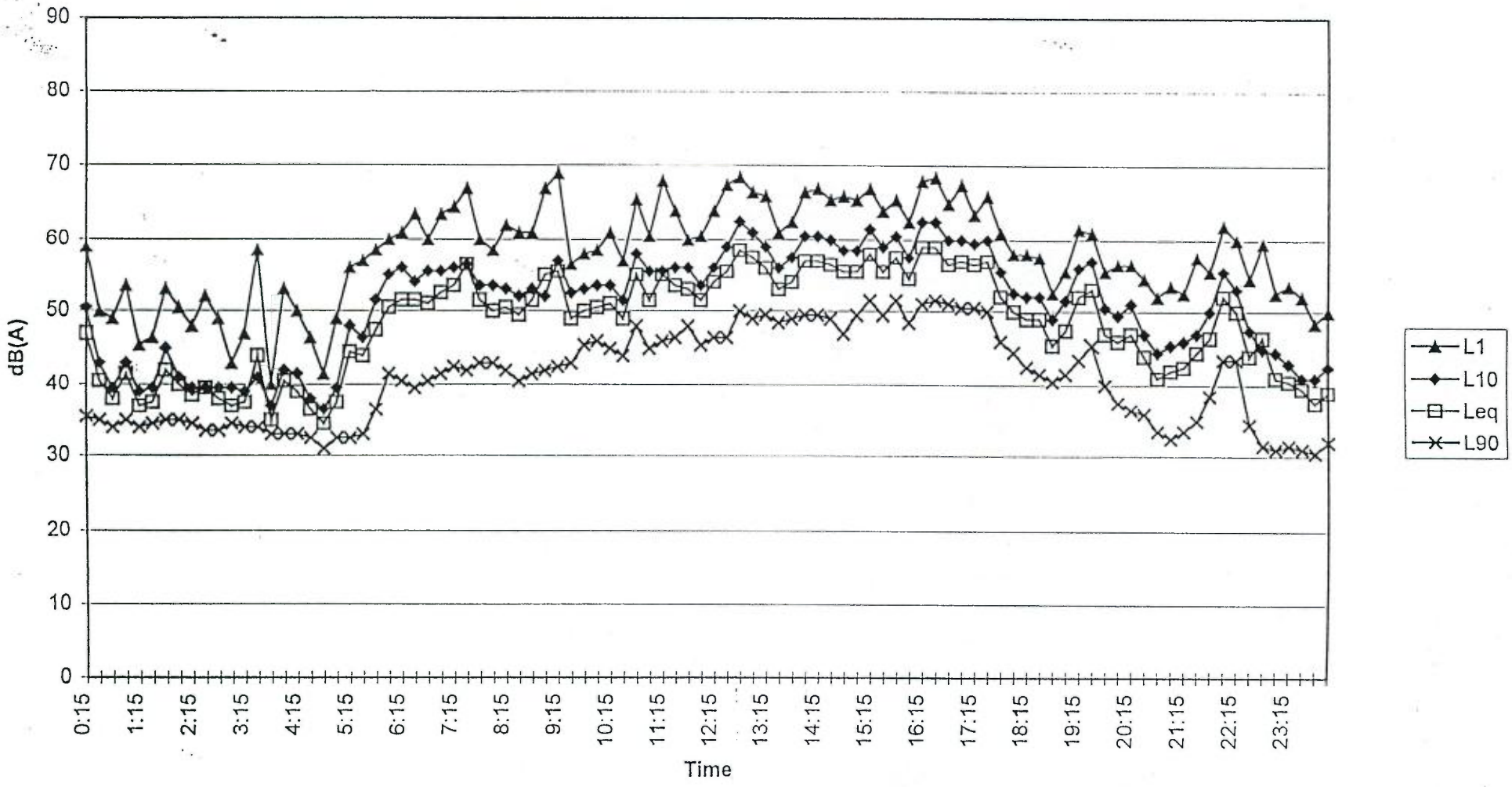

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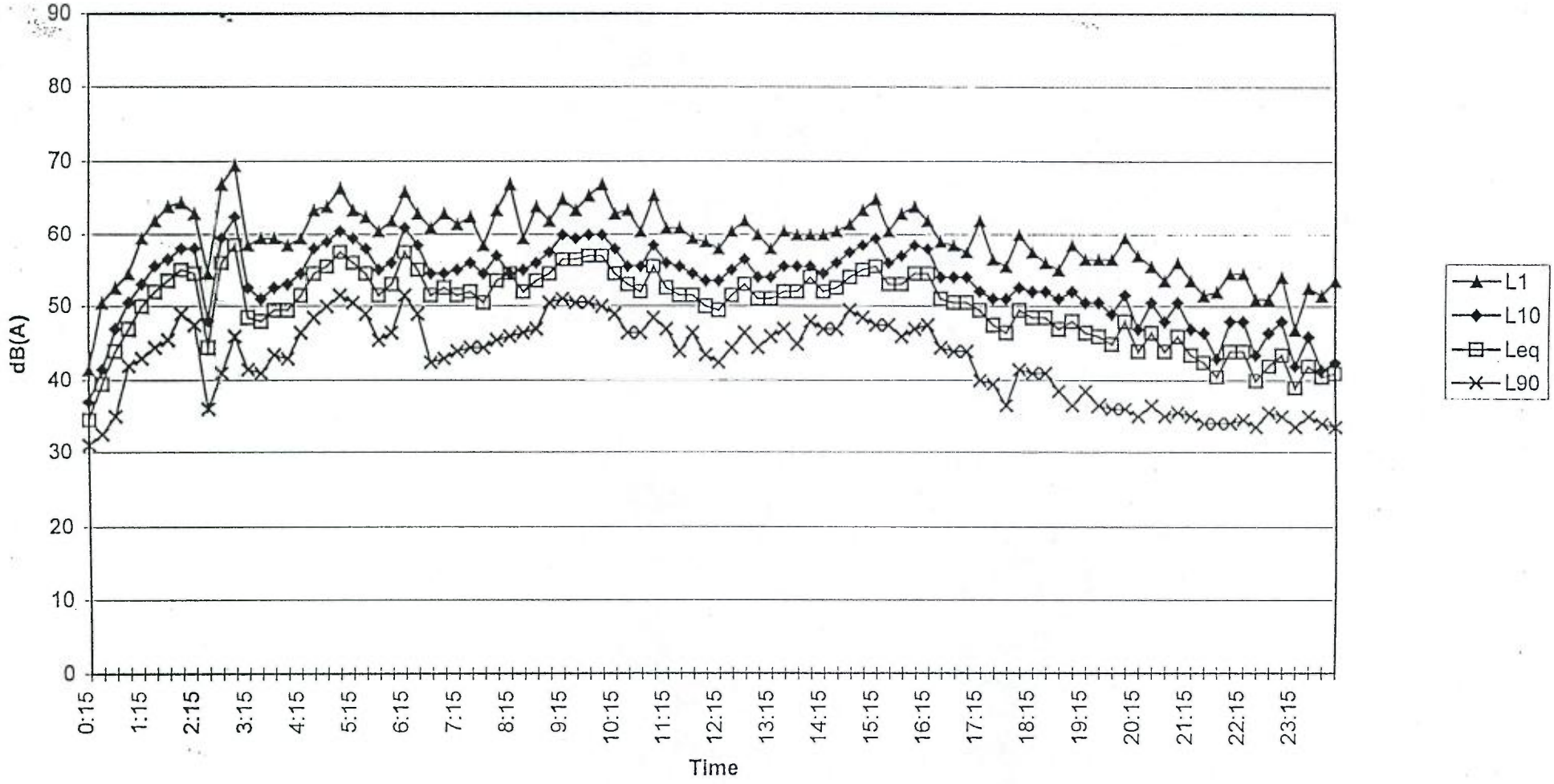

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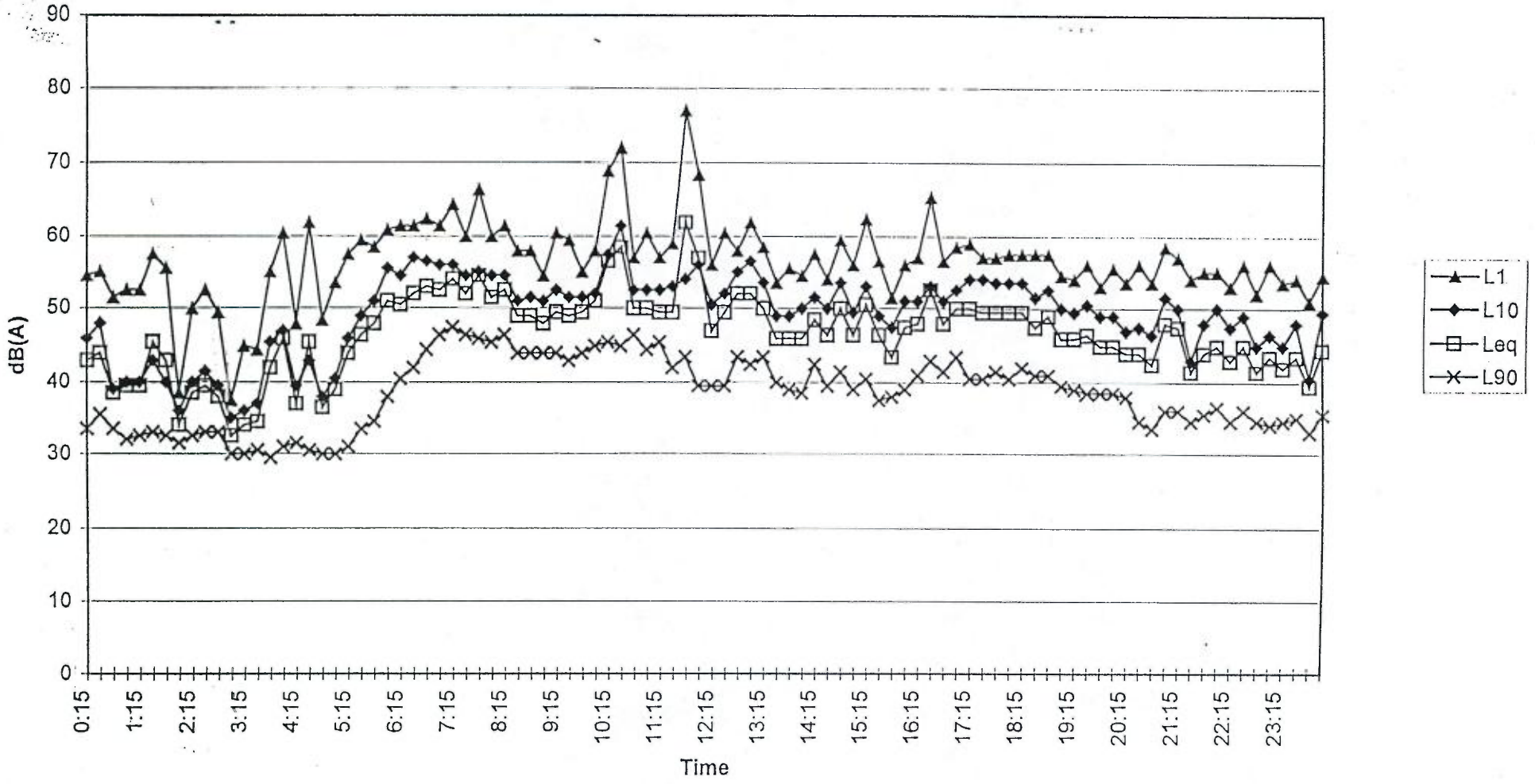

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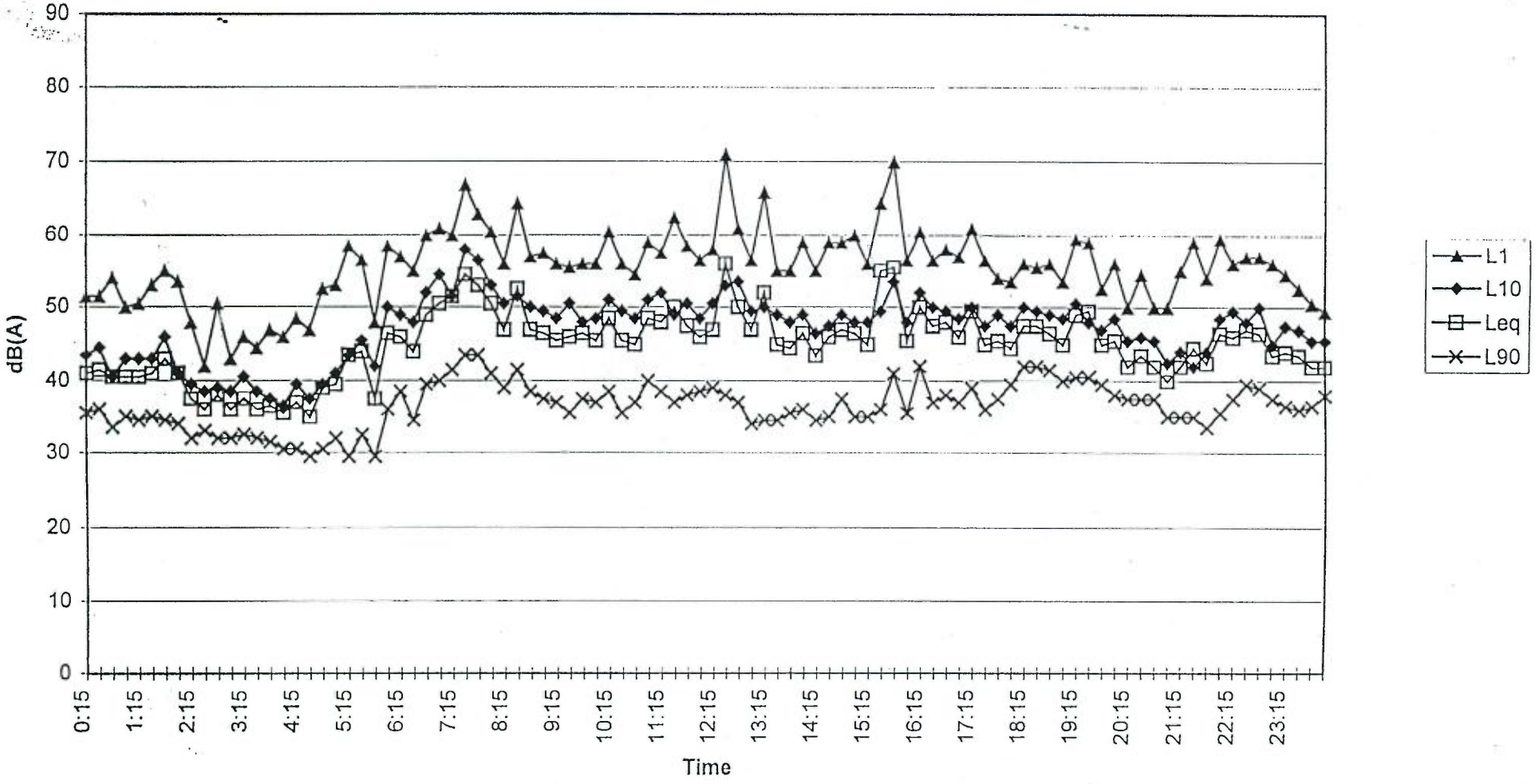

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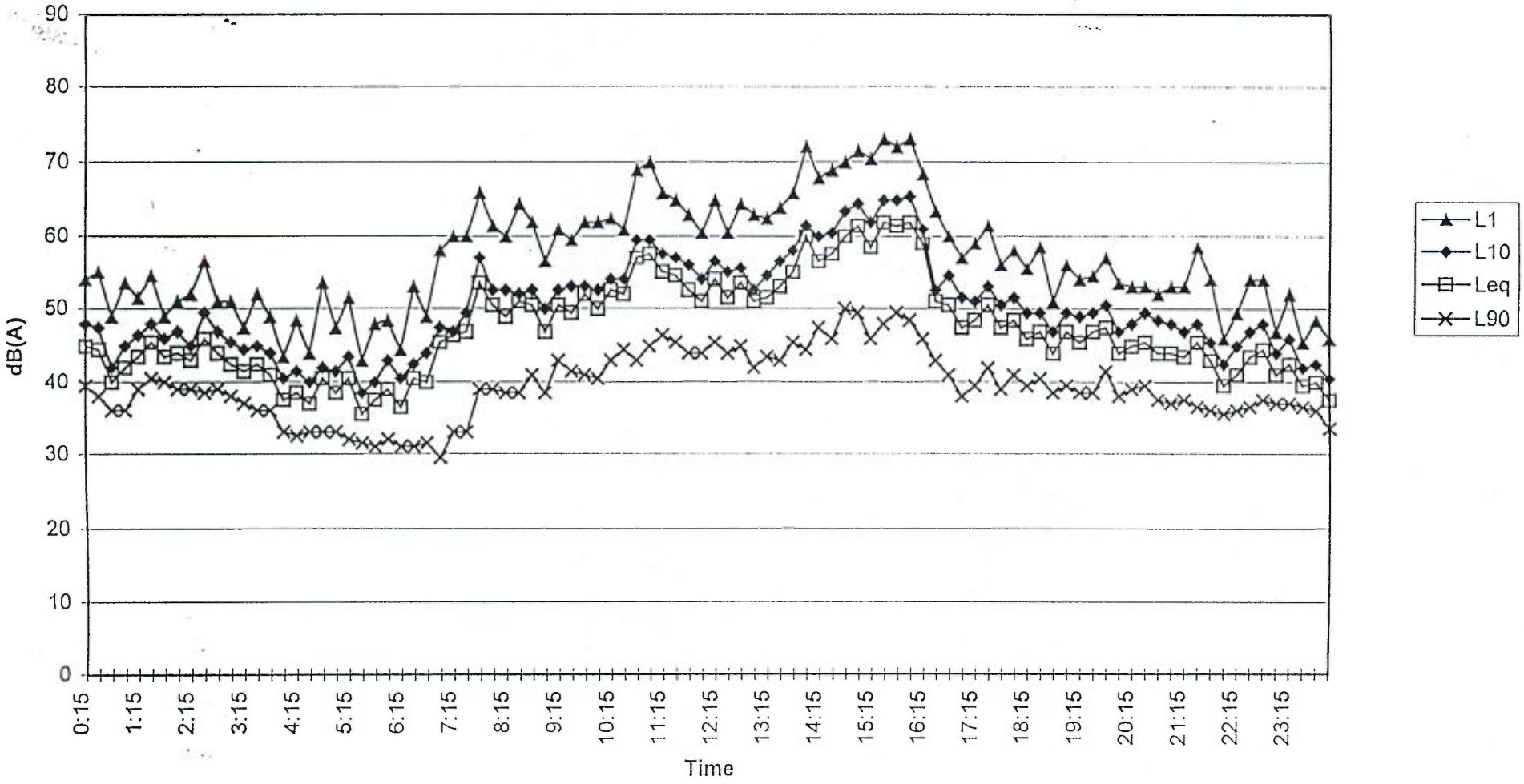

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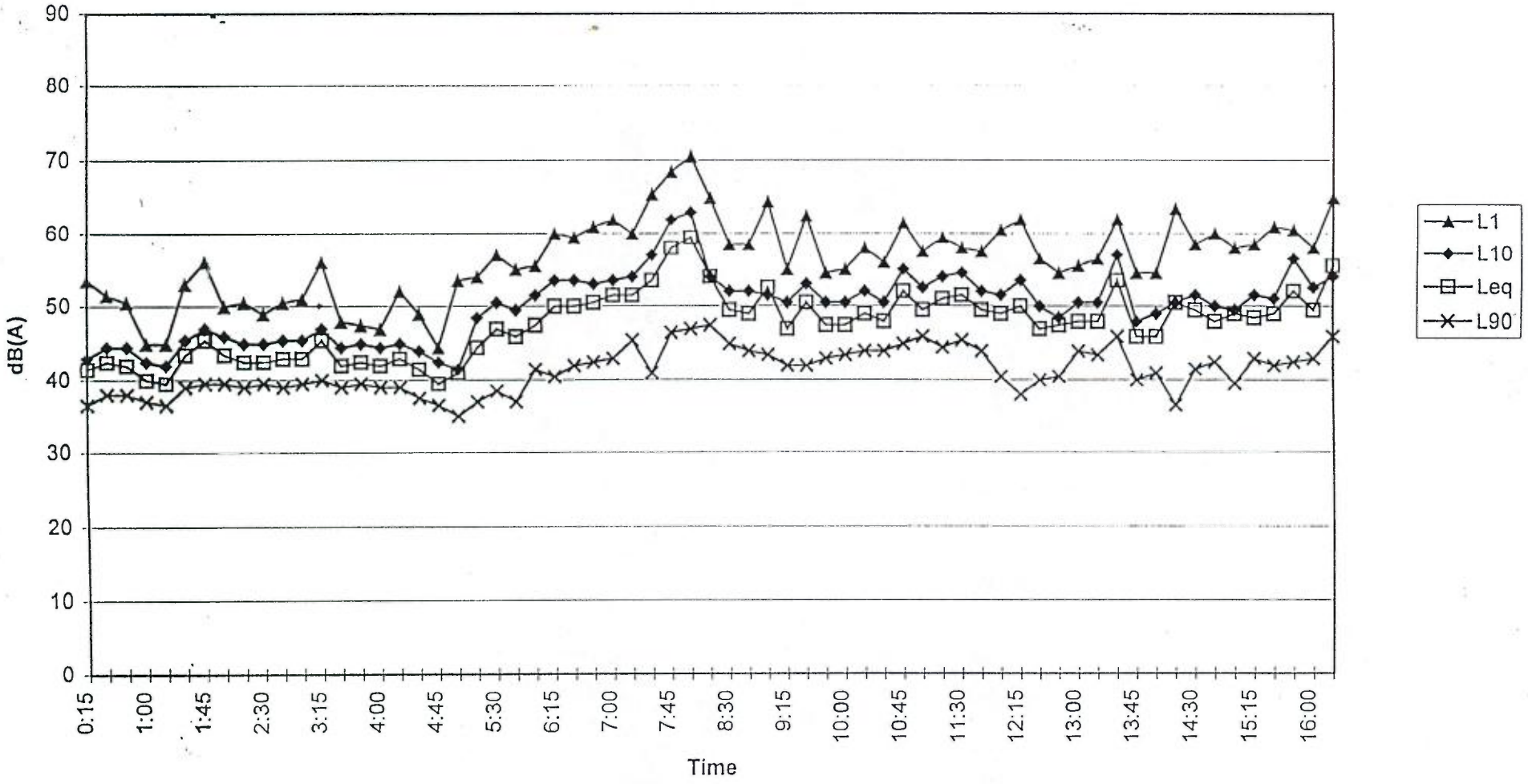

Prepared by Dick Benbow and Associates

Appendix 12

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NEXUS COPY

REPORT

ON

SAND AND CLAY RESOURCE

IN

LOTS 1 and 2 DP 228308, LOT B DP 312327

MAROOTA

FOR

SOUTHERN HIGHLANDS QUARRIES PTY. LIMITED.

September 1991.

Summary

Reserves of sand, sandstone and clay were investigated within the boundaries of Lots 1 and 2 DP 228308 and Lot B DP 312327. This land is triangular in shape, bounded by Old Northern Road and Roberts Road and measures approximately 30 ha. Parts of the land are occupied by a plant nursery, two large dams, several houses and sheds and a sand extraction and treatment operation on its lowest, central part.

The investigation included regional geological appraisal, perusal of available data, detailed geological and topographic surveying, drilling, sampling and screen analysis. It resulted in a report containing pertinent data, test results, plans, sections and interpretations.

Reserves of three specific resource types were calculated, firstly by assuming complete extraction to the boundaries, secondly by invoking reasonable environmental, geotechnical and safety parameters and thirdly by excluding the north-western area containing the nursery and dams. The last consideration was adopted as the most realistic and the reserves calculated thus are:

Maroota Sand	- 2.25 million tonnes
Clay	- 1.25 million tonnes
Friable Sandstone	- 2.70 million tonnes.

Upon applying anticipated waste factors during extraction and processing, the probable product reserves are:

Maroota Sand	- 1.5 million tonnes
Clay	- 0.9 million tonnes
Friable Sandstone	- 1.5 million tonnes.

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Introduction

Following a regional investigation of the potential sand resources of the Maroota region, negotiations with relevant land owners resulted in an agreement to investigate a specific area.

This report deals with the investigation of the sand and clay resources of the land comprising Lots 1 and 2 DP 228308 and Lot B DP 312327. The investigation commenced in June 1991 and was completed in early September 1991.

This report describes the geological parameters leading to a stratigraphic interpretation with resulting volume estimates of the several resource types.

A number of reports on geological interpretations, drilling projects and reserve evaluations were perused prior to commencing field work.

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2. Site Description

The subject land is of an irregular triangular shape with a total surface area of 29.5 ha. The southern boundary is adjacent to the paved, unkerbed Roberts Road, the western curved boundary is adjacent to the paved, unkerbed Old Northern Road, the eastern tip touches Old Telegraph Road and the northern boundary is adjacent to cultivated farm land and orchards.

A plant nursery, incorporating a large galvanised iron building is located on the north-western corner of the land, while a managers house and guest house occupy adjacent sites along the western boundary. Two large galvanised iron sheds have access from Roberts Road, the eastern shed being surrounded by cattle yards and pens and also a caretakers caravan.

Two large farm dams are located just to the east and south of the nursery and a third dam is under construction in the central part of the land. Sand washing equipment and earth moving machinery are stationed on the peripheral area of the dam under construction, together with screened sand stockpiles containing several thousand tonnes. Drains and trenches affect some of the area near this quarry/dam site.

Numerous fences divide the land into uneven paddocks, which hold a flock of angora goats.

A small part of the property lies on the western side of Old Northern Road, but this densely forested area was not considered for the purpose of this report.

Topography

The natural surface of the land has an irregularly undulating aspect, which has been modified by the construction of the several large dams and also by the leveling of a hilltop near the western boundary. In essence the surface forms a central gently sloping depression that drains from south to north and is fed by several shallow gullies that drain from the west to the east and north-east.

In preparation for meaningful reserve calculations a theodolite survey was conducted over the entire property. The resulting plan, with contours at one metre intervals, is attached to this report as Drawing No. 45/91-1.

A relative level of 100 m was adopted for Station A, which is the same level as the leveled rectangular area to its west. The lowest natural point on the land is along the northern boundary at R.L. = 67, while the deepest excavated point is in the central dam under construction at R.L. = 65.

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Field Investigations

Following the topographic survey and drafting of a precise plan at a scale of 1:1000, a triangular grid was devised, adapted to the shape of the land.

The wide spaced, slightly distorted grid resulted in 13 drill sites approximately 140 metres apart. No drill sites are within 50 metres of any external boundary, as the potential of extraction close to boundaries is considered limited.

Drilling contractors Intertech Drilling Services were engaged to drill 13 holes of average anticipated depth of about 20 metres, using the reverse circulation air drilling method. This method of drilling is relatively rapid, virtually free of contamination and allows continuous sampling, through a cyclone, without loss of any intersected materials.

Drilling commenced, in extremely windy but clear weather conditions, on the 5th of August and was completed on the 8th of August 1991. A total of 361.9 metres had been drilled, the holes varying in depth between 13.0 m for RC 3 and 48 m for RC 1, averaging 26.8 m. The holes were sampled at 3 metre intervals, with the exception of the first hole (RC 2), which was sampled at 2 metre intervals.

Samples were collected in a large bucket as underflow from the cyclone and laid out in rows near the drill site. Each sample was inspected, described, logged and sub-sampled for laboratory analysis.

The intersection of ground water in the holes was noted during drilling and upon completion of drilling the static water level in each hole was measured and recorded. Each hole was fitted with about half metre of pipe and then covered with a rock to preserve it for future use, if required.

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During the drilling programme a nearby property was inspected, at the invitation of the landowner and arranged by Dr. Martin; a dam was being sunk in friable Hawkesbury Sandstone and it was considered a potential source of a different grade sand.

Samples were taken from the stockpiles of screened sand and also some bulk samples representing potential glass sand and finally all the drill site samples were leveled to leave the sites in a clean condition.

Logs of the drill holes are attached to this report as Appendix 1.

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LOG OF DRILL HOLE No. R.C. 4 Sheet 1 of 1

Drilling Method: R.V.C. Air	Project: Maroota Sand.
Driller: Intertech	Location: Lot B Roberts Road
Logger: B. Brink	Co-ordinates: Section 1 and 7
Date Commenced: 5-8-91	Angle: Vert. Direction:
Date Finished: 5-8-91	Collar Level: 79.2

Graphic Log	Depth(m)	Sample Numbers. Field	Sample Numbers. Lab.	Description	Comments
				Sandstone, fine grained with pebbles	
		1	1	Sand, fine to coarse, poorly sorted, grey/yellow	
		2	2	Sand, medium to fine, well-sorted, pieces of sandstone at 8 m, arkosic Very hard at base.	
		3			
	10	4	3		
		5			
				E.O.H. =14 m	
	20				
	30				
	40				

nvestigation Results

5.1 Screen Analysis

All the drill hole samples, a total of 131, were grouped into composite samples, based on their field descriptions. This resulted in a total of 51 samples for laboratory screen analysis. Samples of obvious overburden soil and laterite were omitted from the composite samples, as were those representing intervals of predominantly clay.

All the composite samples were sub-sampled, to obtain a 300 grammes sample for screen analysis. Each sub-sample was washed over a 70 micron screen, the oversize dried, weighed and then separated into size fractions on a nest of screens comprising 2.36 mm, 1.18 mm, 600μm, 425μm, 300μm, 212μm, 150μm, 75μm and a tray.

Upon completion of the screen analysis, the results were transferred onto semi-log graph sheets, all the samples of each hole being plotted on one sheet for ready comparison. Both tabulated and graphical results are attached as Appendix 2.

The graphical results were subjected to relevant statistical analysis for the purpose of identifying sand types. It was found that two specific sand types are present within the area, sand types that not only differ in relative coarseness, but also in grain size distribution.

5.1.1 General Differences

It is difficult to pick the difference between Maroota Sand and the sandstone from most of the graphs. There are a number of reasons for this, the more obvious being:

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a. some Maroota Sand contains only a few pebbles and significant amounts of fine sand and silt

b. some of the sandstone samples contain significant quantities of sandstone agglomerates the size of pebbles, thus resulting in a graph similar to that of the Maroota Sand

c. some sandstone contains pieces of hard "ironstone", probably from joint plane coatings, again having the effect of pebbles on the graphs.

However, if the graphs of drill holes 1, 2, 5, 6 and 10 are grouped and compated with the graphs of drill holes 7, 8, 9, 11, 12 and 13, there is an obvious difference. The Maroota Sand graphs are spread over larger areas and look less "tidy", owing to their poorly sorted or well-graded nature.

An exception is the graph of drill hole 7, which contains significant volumes of coarse sandstone. Visual comparison of the screened size fractions readily differentiates between the two sand types. Generally the Maroota Sand is yellowish while the sandstone is almost white and coarse particles of the sandstone samples generally contain sandstone agglomerates that have not disintegrated during the screening process.

5.1.2 Fine Size Fractions

The Maroota Sand varies widely in its fines or tailings content, viz. the -75μm fraction.

The graphs of the drill hole 1 samples show the -75μm fraction to vary between 12% and 47%, with the average

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of all the Maroota Sand at about 27%. Hence, with soil and other reserve losses, the washed products of Maroota Sand would amount to about 65% of the probable reserves.

The friable sandstone contains about 35% of -75μm material, and probably some reject scalpings in the coarse fraction. Hence, 60% or less of the probable reserves would represent products.

If the sand were suitable for glass manufacture the -100μm would need to be screened off, resulting in a probable loss of about 50%.

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Stratigraphic Interpretation

In order to obtain the maximum interpretative presentation of the resources, three sets of sections were constructed, resulting in 13 sections, as shown on Drawing Nos. 45/91-2, 3 and 4.

The drill holes were graphically plotted on each section and boundaries were drawn to separate stratigraphic units based on field descriptions. Upon completion of the screen analysis some of those boundaries were modified.

It is emphasised that, owing to the relatively wide spacing of the drill holes, the interpretations represent approximations and that actual conditions should be expected to differ in some places and some respects. For example, the thick bed of clay in RC 6 is interpreted as lensing out in all directions but Etheridge in his 1980 report has recorded similar thick clay intersections in drill hole M 110, suggesting continuity of an extensive leached shale bed within the Hawkesbury Sandstone.

The results of a drilling programme conducted over the same area by Silica Services Pty. Limited in 1981 were found to be of limited value as the auger drill used had poor penetration capacity. Hence, the holes were generally shallow and further more contamination by the auger action would probably have affected interpretations. Nonetheless, the logs of some holes were adopted as fair interpretations.

A number of holes, shown on Figure 2 of the 1980 Etheridge report, were drilled on or close to the subject property. The logs of such relevant holes are attached to this report as Appendix 3, as are screen analysis results of samples representing those holes. The approximate positions of the holes are marked on Drawing No. 45/91-5. Etheridge too used

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an auger drill and consequently most of his drill holes are also of limited depth. Both drilling programmes lacked acurate collar level control, but this should not detract from the interpretation of individual holes. Table 5.2.1 lists a qualitative comparison of the Etheridge 1980 drill holes with the recent drill holes.

The stratigraphic and structural interpretation of the area investigated is as follows:

A sinuous trough, draining from north to south and eroded into Hawkesbury Sandstone, was filled with the Maroota Sand. The trough enters the subject land about halfway along the northern boundary and exits close to the southern corner. It has generally gently sloping sides flanked by leached, friable sandstones which are yet more resistant to weathering and erosion than the Maroota Sand. Hence, the present topography tends to reflect the paleaotopography where the thickness of the Maroota Sand and drainage pattern allow.

It appears that the Maroota Sand originally covered the Maroota area generally, but erosion has removed it from some paleaotopographic highs, which now form gently sloping hillsides covered with a thin blanket of lag gravels and basal conglomerate.

A thick extensive shale bed in the Hawkesbury Sandstone appears to have been some controlling factor in the erosional base level below the Maroota Sandstone. Weathering and leaching of this shale prior to and during deposition of the Maroota Sand have transformed it into a more or less silty clay.

The composition of the Maroota Sand is variable and may change from very coarse sediments to very fine sediments

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abruptly, both horizontally and vertically. On average it has a coarse composition, indicating a high energy depositional environment.

Isopachs on Drawing No. 45/91-5 indicate the extent and thickness of the Maroota Sand, while basement contours outline the Hawkesbury Sandstone topography below the Maroota Sand on Drawing No. 45/91-6.

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Table 5.2.1 Drill Hole Comparison

Recent		Etheridge 1980	Comparison
RC 13	near	M 25	- fair agreement
RC 11	near	M 13	- no information on M 13
RC 10	near	M 11	- fair agreement, but auger mixed clay, colours
RC 5	near	M 12, M 15	- no information M12 and M15
RC 3	near	M 16, M 25	- good agreement with M 16, poor with M 25
RC 2	near	M 22	- no information on M 22
RC 1	near	M 28	
RC 6	near	M 18, M 19	- no information M18 and M19
RC 8	near	M 26, M 27	- some agreement with M 26, good agreement with M 27.

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Resource Calculations

6.1 Maximum Possible Reserves

Volumes of the several types of resource were calculated to arrive at the maximum possible reserves contained within the boundaries of the subject land as follows:

a. Calculations were performed on each set of sections, (Drawing Nos. 45/91-1, 2 and 3), thus resulting in three comparable values for each type of resource.

b. Each section was measured from boundary to boundary, assuming vertical embankments along the boundary and ignoring any environmental, safety and existing land use constraints.

c. The resource areas of adjacent sections were averaged and the result multiplied by the intervening distance.

d. Boundaries, for the sake of calculations, were adopted as sections with zero area values.

e. Each set of three values for a resource was averaged to arrive at the adopted reserve values.

f. The resources are marked on the sections as M for Maroota Sand, C for clay and SG for white sandstone. No distinction is made between clays within the Maroota Sand and the Hawkesbury Sandstone.

Relevant areas, distances between sections and calculated volumes are tabulated in Tables 6.1.1, 6.1.2 and 6.1.3 for Maroota Sand, Clay and Hawkesbury Sandstone respectively.

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Table 6.1.1 Maroota Sand Reserve Calculations (M)

Section No.	Area(m^2)	Distance(m)	Volume(m^3)
Boundary	-	30	169,800
1 - 1'	11,320	150	1,229,250
2 - 2'	5,070	150	380,250
3 - 3'	-		
4- 4'	-		
		Total(1)	1,779,300 m^3
Boundary	-	140	275,100
5 - 5'	3,930	140	607,600
6 - 6'	4,750	140	548,100
7 - 7'	3,080	30	46,200
Boundary	-		
		Total(2)	1,477,000 m^3
Boundary	-	140	136,500
8 - 8'	1,950	140	704,900
9 - 9'	8,120	140	913,500
10 - 10'	4,930	140	345,100
11 - 11'	-	30	
Boundary	-		
		Total(3)	2,100,000 m^3

The difference between totals 1, 2 and 3 is due to the wide spacing of the holes, and therefore the sections, the difference in distances between section lines and boundaries and probably some unavoidable error in measurements.

The arithmatic mean of the three values is 1,785,000 m^3.

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Table 6.1.2 Clay (C)

Section No.	Area(m^2)	Distance(m)	Volume(m^3)
Boundary	-	30	15,900
1 - 1'	1,060	150	262,500
2 - 2'	2,440	150	301,500
3 - 3'	1,580	150	118,500
4 - 4'	-		
		Total(1)	698,400 m^3
Boundary	-	140	86,800
5 - 5'	1,240	140	272,200
6 - 6'	2,720	140	223,300
7 - 7'	470	30	70,000
Boundary	-		
		Total(2)	652,300
Boundary	-	140	23,800
8 - 8'	340	140	308,000
9 - 9'	4,060	140	380,800
10 - 10'	1,380	140	192,500
11 - 11'	1,370	30	20,500
Boundary	-		
		Total(3)	925,600 m^3

All clay intersections were added together, irrespective of the host formation being the Maroota Sand or the Hawkesbury Sandstone. The only criteria to determine inclusion in the reserve calculations is the potential extractability as a result of sand removal.

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The large volume in Total (3) is due to the thick clay in the Hawkesbury Sandstone being interpreted as being continuous in adjacent drill holes.

The indicated volume of clay is 750,000 m^3.

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Table 6.1.3 White Sandstone (SG)

Section No.	Area(m^2)	Distance(m)	Volume(m^3)
Boundary	-		
		30	-
1 - 1'	-		
		150	442,500
2 - 2'	5,900		
		150	1,106,250
3 - 3'	8,850		
		150	1,371,750
4 - 4'	9,440		
		150	708,000
Boundary	-		
		Total(1)	3,628,500 m^3
Boundary	-		
		140	539,000
5 - 5'	7,700		
		140	1,026,900
6 - 6'	6,970		
		140	1,143,100
7 - 7'	9,360		
		30	140,400
Boundary	-		
		Total(2)	2,849,400 m^3
Boundary	-		
		140	-
8 - 8'	-		
		140	125,300
9 - 9'	1,790		
		140	994,700
10 - 10'	12,420		
		140	1,390,200
11 - 11'	7,440		
		30	111,600
Boundary	-		
		Total(3)	2,621,800 m^3

The large difference between Total 1 and Totals 2 and 3 is attributable to geometry of the area and position of the sections.

The arithmatic mean of three values is 3,033,000 m^3.

6.2 Maximum Probable Reserves

The measurements and calculations described in Section 6.1 were repeated, after applying a 20 metres wide buffer zone around the periphery and allowing for 10 metres wide benches separated by 10 metres high faces inclined at 70°. These limiting features are shown on the sections and the plan on Drawing Nos. 45/91-1, 2, 3 and 4.

The resulting reserve volumes are as shown in Table 6.2.1.

Table 6.2.1 Maximum Probable Reserves
Calculated Volumes (m^3)

Section Nos	Maroota Sand	Clay	Sandstone
1,2,3,4	1,195,000	568,000	2,655,000
5,6,7	1,290,000	594,000	3,119,000
8,9,10,11	1,327,000	644,000	2,496,000
Averages:	1,270,000	602,000	2,757,000

The application of an environmental buffer zone and stable peripheral quarry benches has reduced the available reserves of Maroota Sand by 30%, clay by 20% and sandstone by 10%. The reason for the difference in reductions is mainly due to the location of the materials in relation to the boundaries. For example, the Maroota Sand is thickest near the south-west corner where benches take up a considerable volume, whereas the sandstone is not affected at all in this area.

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6.3 Probable Reserves

In the previous section the maximum probable reserves included those below the two large dams and the plant nursery, which together occupy a considerable area of the north-western part of the subject land. The reserves calculated in this section are based on the exclusion of reserves below that area as well as those below the peripheral buffer zone and quarry benches. The resulting reserve volumes are considered the most relevant at this stage.

Table 6.3.1 Probable Reserves
Calculated Volumes (m^3)

Section Nos	Maroota Sand	Clay	Sandstone
1,2,3,4	1,195,000	470,000	1,412,000
5,6,7	1,251,000	513,000	1,083,000
8,9,10,11	1,327,000	606,000	1,219,000
Averages:	1,258,000	530,000	1,238,000

The sterilisation of the nursery and adjacent dams area, together with the buffer zone and quarry benches, results in reduction of 30% of the Maroota Sand, 30% of the clay and 60% of the sandstone.

The reserve volumes in Table 6.3.1 are considered the more realistic in terms of mine management and environmental considerations.

Adopting conversion factors of 1.8 t/m^3 for Maroota Sand, 2.2 t/m^3 for sandstone and 2.4 t/m^3 for clay, the probable extractable reserves are:

Maroota Sand	- 2.25 million tonnes
Clay	- 1.25 million tonnes
Sandstone	- 2.70 million tonnes.

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6.4 Probable Reserves of Products

The calculated reserves in the previous section do not take into account the effect of processing the reserve materials to produce marketable products. However, Section 5.1.2 outlines considerable reductions in the reserves of both Maroota Sand and friable sandstone in terms of tailings, scalpings and overburden. A reduction factor of 35% applies to the Maroota Sand and 40% to 50% for the sandstone.

As extraction of the clay is considered an uncertain matter at this stage, its recoverable reserve volumes are rough estimates only, say 70% of the calculated reserves.

In summary, the probable marketable products available within the subject land are:

Maroota Sand	- 1.5 million tonnes
Clay	- 1.5 million tonnes
Friable Sandstone	- 0.9 million tonnes

The processing and sale of tailings products is considered conjecture only at this stage. Specific research of the tailings would be required to determine possible products, which then would need to be introduced to industry.

G.B. Brink B.Sc., FAusIMM, MGSA.
20-9-91

Appendix 13

REPORT

LOT 1 AND 2, DP228308, LOT 2, DP312327, MAROOTA, DEVELOPMENT APPLICATION. PROCESS WATER DAM DESIGN

Prepared for
Nexus Environmental Planning
PO BOX 212
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18 June 1999

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A new Development Application (DA) is required for an extractive industry on Lots 1 & 2, DP228308 and Lot 2, DP312327, at the corner of Old Northern Road and Roberts Road, Maroota (Figure 1).

Nexus Environmental Planning Pty Ltd (Nexus) is preparing an Environmental Impact Statement (EIS) to accompany the new DA to Baulkham Hills Shire Council (BHSC) and has engaged AGC Woodward-Clyde Pty Ltd (Woodward-Clyde) to undertake the design of the proposed process water dam required for the extractive operation. The proposed dam surface area reflects that approved under the existing court orders.

The following report has been prepared for inclusion as supporting documentation to the EIS.

The objective of this study is to provide a suitable and practical design of the process water dam which would provide a reliable water supply for future extractive operations.

The scope of work for the design study has comprised:

- a preliminary site inspection to assess the catchment drainage conditions and likely design constraints associated with the water supply dam;
- review of existing site information and historical data, including available borehole logs, to establish the required design criteria for the dam;
- preparation of a water balance model to predict storage capacity requirements for the dam for current and future production of the extractive operation;
- assessment of possible options for construction of the water dam including the various advantages/disadvantages and likely construction costs of each option;
- engineering design of the water dam based on the recommended construction method including a preliminary capital cost estimate to construct the dam and associated works (in the range of ± 20% accuracy); and
- preparation of a report outlining the results of the engineering design process including the critical design assumptions, key constructability issues, preliminary design drawings and a brief assessment of likely impacts on the local environment as a result of the dam construction (such as surface water, groundwater, air and noise).

The following sections describe the work carried out and present the results and conclusions of that work.

3.1 SITE FEATURES AND OPERATIONS

The proposed development is located approximately 50 km north of Sydney, at the junction of Old Northern Road and Roberts Road, Maroota, occupying an area of approximately 29.5 ha. The existing general layout of the site is shown on Figure 2.

The entrance to the proposed sand extraction operation is via Roberts Road along the eastern boundary of the site. The site infrastructure comprises a site office, workshop, weighbridge and a processing plant. Sand materials are currently excavated from a shallow open pit (located near the northern boundary) using sluicing and dredging methods. The soil/water slurry is pumped to the processing plant where the sand is separated (washed and screened) and stockpiled. The sand is sold and transported off-site for use as building material. The residue clay slurry is pumped from the plant into sedimentation ponds and then into drying beds from which the clay soils are dredged and stockpiled separately. Liberated water from the ponds/beds is drained back into the excavation pit for re-use in the process operation.

Current process plant production rates vary, but typical production rates have ranged between 400 and 600 t/day, comprising approximately 70% sand and 30% clay/gravel materials [1].

3.2 TOPOGRAPHY AND DRAINAGE

The area's landscape is formed on a Hawkesbury Sandstone plateau and reflects the characteristic morphology of this formation, with steep valleys flanked by massive cliff faces. The relief ranges from 170 m AHD, south of the project area, to 240.7 m AHD at the Maroota Trig Station. Within the property, elevations range from 226 m AHD at the south western end along Old Northern Road to approximately 178 m AHD at the base of the current excavation pit.

The general drainage pattern of the site is in the northerly direction along a natural creek line which joins a tributary of Coopers Creek, approximately 2 km to the north, which eventually flows into the Hawkesbury River. Drainage within the site is characterised by two separate catchments (Figure 3). The western catchment (some 8.9 ha) contains two dams which provides a water supply to the existing nursery operations. The eastern catchment (some 20.7 ha) drains the remaining site with generally all runoff directed into the existing extraction pit. The pit also collects runoff from the small catchment to the east of Roberts Road (approximately 10.5 ha). Runoff from this catchment enters the site via a road culvert beneath Roberts Road, located some 60 m north of the site entrance. The total catchment area of the current pit is 31.1 ha.

The existing pit is located at the lowest point within the site and it is possible that, during exceptionally high rainfall periods, the pit could overfill. During such events, overflow from the pit would occur via a natural low point in the pit northern wall into the existing natural watercourse.

3.3 CLIMATE

The nearest rainfall station to the site is at the Maroota Bush Fire Brigade Station (No. 067014), located opposite the junction with Roberts Road. Records at this station are available from 1926 to 1997 (missing 9 years between 1954 and 1964), and indicates that the average rainfall for Maroota is approximately 885 mm/year. Records also indicate that rainfall

[1] Based on discussions with Dr Martin.

is highly variable, with a maximum total annual rainfall of 1637 mm in 1990 and a minimum of 354 mm in 1953.

Evaporation data is available at Richmond AMO/MO (Station No. 067033), located some 30 km south west of Maroota. Although this station is located in a different topographic setting, in the absence of other data, the records are considered applicable to Maroota for the purpose of this study. Mean daily pan evaporation ranges from 1.8 mm in June to 7.0 mm in December, with the annual average of 4.2 mm per day.

Table 2 below presents a summary of climatic statistics for the area.

Table 1

CLIMATE STATISTICS

Monthly Rainfall (mm)

	Feb	Jan	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Mean	104.8	101.5	103.9	90.5	61.2	89.9	46.6	55.2	53.9	64.7	76.9	76.4	884.8
Median	75.9	73.6	84.0	58.8	41.9	50.8	26.0	22.8	40.3	53.7	66.6	69.1	869.2
Highest	464.9	395.5	437.7	467.2	370.1	445.4	250.6	497.4	174.0	220.3	208.3	375.0	1636.6
Lowest	0.0	0.0	2.1	0.0	1.5	0.0	0.0	0.0	0.4	0.6	0.5	0.0	353.9

Mean Daily Pan Evaporation (mm)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
6.3	5.4	4.4	3.3	2.1	1.8	2.0	3.1	4.3	5.4	5.9	7.0	4.2

3.4 GEOLOGY

The Maroota area is known for the production of sand, which represents a valuable resource to the building industry. The sand is obtained from two main sources, the Maroota Sand and the weathered profiles of the Hawkesbury Sandstone. The occurrence of the Maroota Sand has, in the past, been systematically mapped by the Department of Minerals and Energy of New South Wales (Etheridge, 1980) and its distribution over the area is well documented. Figure 1, adapted from Etheridge, shows the occurrence of the Maroota Sand in relation to the area under study.

The general stratigraphy of the area is as shown in the table below:

Table 2

STRATIGRAPHIC SEQUENCE

AGE	UNIT	LITHOLOGY
Quaternary	Soils	Variable
Tertiary	Unnamed	Basalt
	Maroota Sand	Sand, gravel, clayey sand and clay
Triassic	Ashfield Shale	Shale and laminite
	Hawkesbury Sandstone	Quartzose sandstone with shale lenses

The Maroota Sand comprises a sequence of interbedded and poorly sorted sands, gravels, clayey gravels, gravelly sands, pebbly sands, clayey/silty sands and clay which range from well compacted to partly consolidated materials. However, the bulk of these sediments consists of sand sized material. Ferricrete bands are common and occur at a number of levels within the formation.

The detailed geological description of the Maroota Sand and Hawkesbury Sandstone is provided in Section 4.

3.5 HYDROGEOLOGY

The formations present in the Maroota area have dissimilar hydrogeological characteristics. The high degree of lithological variability (i.e. sands, clays, shale, sandstone, etc.) often results in the establishment of perched water tables in both the Maroota Sand and in the Hawkesbury Sandstone. Within the latter, perched water table could occur between the weathered profile and the fresher sandstone. The hydrogeology of the Maroota Sand is the subject of the current studies by the DLWC and reported in the Stage 1 and Stage 2 reports.

Under these conditions, three separate aquifers can be identified, although the extent of their hydrogeological separation or, conversely, interconnection, is sometimes uncertain. These aquifer units are:

- the Maroota Sand;
- the eluvial/weathered profile of the underlying Hawkesbury Sandstone; and,
- the fresh Hawkesbury Sandstone.

The more significant aquifers are the Maroota Sand and the deeper Hawkesbury Sandstone. The detailed description of the hydrogeological characteristics of these two aquifers are presented in Woodward-Clyde (1998) "Lot 1 and 2, DP228308, Lot 2, DP312337, Maroota, Development Application. Groundwater Impact Assessment".

Table 3 shows a summary of water levels obtained from a number of bores and excavations completed in the Maroota Sand. Bores PT84MW1 to PT84MW3 are located within the site and are shown on Figure 2. Bore 75002/2 is located some 400 m north of the site, adjacent to Old Telegraph Road. Bore PF167MW1 contains the longest available records of the deeper Maroota Sand water table in the area.

With the exclusion of the perched water table levels, it appears that the water table within the Maroota Sand aquifer in the area ranges between 177.7 m AHD to 183.59 m AHD, with an

average of around 180 m AHD. The higher water level of 183.59 m AHD was recorded in bore PT84MW3 at the center of the DA site in October 1998. Data collected by the automatic data loggers installed in January 1999 indicate a fall in water level to 182.27 m AHD in May 1999.

In addition to bore water levels, surveyed Maroota Sand water table data are also available from the licensed dam in Portion 167, excavated to the base of the Maroota Sand. Due to the geological conditions of the dam, the groundwater level at this site is considered representative of the deeper aquifer in this formation. Surveyed water levels are also being collected from the dam in the DA site, excavated to the top of the Hawkesbury Sandstone within the Maroota Sand palaeochannel.

Data indicate that the average level during the recorded period for the dam in Portion 167 is 179.5m AHD. The water level in the dam in the DA site has been measured at 180.3 m AHD on 22.2.99.

Table 3

SHALLOW AQUIFER (MAROOTA SAND) WATER TABLE RECORDS

Bore No	Location	Surface RL m AHD	Static Water Level m b.ground	Static Water Level m AHD	Hydrogeological Assessment
PT84MW1	Lot 2, DP228308, DA site	213.43	5.34	208.09	perched water table
PT84MW2	Lot 1, DP228308, DA site	226.8	24.52	202.28	perched water table, possibly dry[1]
PT84MW3	Lot 1, DP228308, DA site	202.43	18.84	max.=183.59m (Oct 99) min.=182.27m (May99)	deep Maroota Sand
PF167MW1	Portion 167, SSW of site	187.64	9	178.8* min.=177.7m(April98) max.= 180.7 m (Jan 99)	deep Maroota Sand
PF166MW1	Portion 166, SW of site	209.94	10.57	199.37	perched water table
75000/1(DLWC)	Portion 81, Haerses Rd, SW of site	194.59	14.4	180.19	deep Maroota Sand
75002/1(DLWC)	Lot 1, DP531835, N of site	187.59	7.0	180.59	deep Maroota Sand
75002/2(DLWC)	Lot 1, DP531835	187.78	9.2	178.58	deep Maroota Sand
Dam					
Portion 167	Portion 167, SSW of site			179.5** min.=177.0 (April 98) max.=181.3m(April 99)	deep Maroota Sand
Portion 84	Lot 2, DP228308			180.29 (April 99)	deep Maroota Sand

1 the water level is at the top of the bore sump

* average between March 1996 and February 1999 (data courtesy of PF Formation)

** average between September 1996 and April 1999 (data courtesy of PF Formation)

4.1 GENERAL

A review of previous investigations undertaken at the site has been carried out to assess the geological conditions. The previous reports include:

- Potential Resource Value of the Maroota Sand Deposit, by Golder Associates, October 1980;
- Assessment of Clayey Sand and Gravel and Clay Occurring on Lots 1 and 2 DP22308 and Lot B 237615, Old Northern Road, by Silica Services Pty Limited, April 1981;
- Report on Sand and Clay Resource in Lots 1 and 2 DP228308, Lot B DP312327, Maroota, by Brink and Co Pty Limited, September 1991;
- Maroota Groundwater Study Stage 2, by the Land and Water Conservation, September 1998; and
- Lots 1 and 2, DP228308, Lot 2, DP312327, Maroota, Groundwater Impact Assessment by Woodward-Clyde, December 1998.

4.2 SUBSURFACE CONDITIONS

Based on our review of the above documents, and from our experience in the area, two main geological units are present at the site:

- Unit 1, Maroota Sand Formation; and
- Unit 2, Hawkesbury Sandstone Formation

The inferred boundary between these units is presented on Section A-A' (Figure 4). Additional details of the identified geological units are provided below.

Unit 1 - Maroota Sand Formation

The Maroota Sand comprises a sequence of interbedded and poorly sorted sands, gravels, clayey gravels, gravelly sands, pebbly sands, clayey/silty sands and clay, which reportedly range from compacted to partly consolidated materials. However, the bulk of these sediments consist of sand sized material derived from the eroded and re-worked material of the Triassic Hawkesbury Sandstone and of the Permian Conglomerates. Ferricrete bands and clay beds, comprising kaolinite with some silica content, are common throughout the Maroota Sand and occur at a number of levels within the formation. This clay has been extracted in the past for use as a ceramic clay in the manufacture of cream-burning bricks. Based on previous investigations, the thickness of the Maroota Sand is expected to vary from 9.5 to 30 metres below the existing ground surface..

Unit 2 - Hawkesbury Sandstone

The Hawkesbury Sandstone is a widespread formation occupying a large portion of the Sydney Basin. It comprises a thick sequence of sub-horizontal, massive, cemented quartz sandstone, with well developed cross-bedding and intercalations of shale and siltstone beds. Grain size is generally in the range of fine to medium sand, but sorting is generally poor with some silt and pebble grains. Shale layers and bands and occasional carbonaceous beds are also common within the Hawkesbury Sandstone. Shale beds have been identified at various locations at the contact between the Maroota Sand and the underlying Hawkesbury Sandstone.

The weathered profile of the Hawkesbury Sandstone, which is the primary target of other quarrying operations in the area, is of variable thickness and can be as much as 15 m deep. It is represented by a soft and friable rock ranging in colour from white to red-brown, the latter resulting upon the presence of variable iron oxides content. Where this weathered zone is consistently above water table, it has been leached by infiltrating rainwater and is present as weakly cemented, white sandy soil, referred to as eluvial sand (Etheridge, 1980).

4.3 CONSTRUCTION MATERIALS

Based on previous investigations carried out on the site, it appears that most dam construction materials can be sourced from within the site. The following provides a summary of the construction materials available at the site and their expected properties.

4.3.1 Clay Liner

It is anticipated that the on site clay reserves (in situ and previously extracted and stockpiled materials) produced from the washing processes and excavation, would be suitable for use as a clay liner for the pond. Based on discussions with site personnel and from visual assessment, the material appears to be a silty clay of medium plasticity. Experience with similar materials indicates that a permeability in the order of 10^{-8} to 10^{-9} m/s should be achievable. However, as a result of the washing and extraction process, the clay would have to be conditioned (moisture content adjusted by drying or wetting) to enable the material to be placed and compacted. Further testing during the detailed design phase is recommended to confirm the engineering properties of the material.

4.3.2 General Fill

The excavated/processed on-site materials would be suitable for bulk filling purposes. Conditioning of these materials may be necessary (moisture content adjustment by drying or wetting) to enable the required compaction levels to be achieved. It is recommended that a well graded granular material be used with fines content less than 5%. This is to ensure free draining if excavation dewatering is required during filling operations (refer to Section 6.4)

4.3.3 Rehabilitation Soils

Based on available information, limited quantities of good quality topsoil exist at the site and would be stripped and stockpiled separately for use during site rehabilitation. Experience with the site materials also indicates that the processed clay and the sediment that settles from the process water has been successfully used as a growth medium for rehabilitation purposes.

4.4 STABILITY OF EXISTING PIT

Visual assessment of the stability of the existing excavation in the Maroota Sand formation has been carried out to assess suitable batter slopes for future work.

The existing excavation is approximately 12 to 17 metres deep, with sidewalls cut near vertical in some areas. Tension cracks near the excavation boundary were noted, along with differential weathering of weak/harder layers resulting in localised overhangs within the side walls. Thus, the pit will require battering to minimise the risk of pit wall instability which could adversely impact on people working below, and to allow construction of the dam.

Based on Woodward-Clyde's experience, it is recommended that permanent batter slopes of 2(H):1(V) be constructed. In the short-term, cuts could be battered at 1.5(H):1(V) subject to inspection and confirmation by a suitably qualified geotechnical engineer during construction. The adoption of the latter batter slopes assumes that properly constructed surface drainage measures are implemented to divert stormwater away from the slopes.

4.5 ADDITIONAL LABORATORY TESTING

The above assessment of the on site materials has been based on limited test results and from visual inspection of the materials only. It is recommended that prior to construction of the water storage dam, laboratory testing be undertaken on the soils to confirm the assumed properties and material suitability. The recommended testing program would include:

- Atterberg Limits / linear shrinkage to assess plasticity;
- particle size distribution/hydrometer (to determine the clay content of the material);
- Emerson Crumb (to assess the dispersive nature of the material); and
- compaction and permeability to measure the compacted permeability of the material.

The results of these tests should be reviewed by a suitably qualified geotechnical engineer to confirm the suitability of the materials for their proposed use.

5.1 GENERAL

The proposed process water dam is to be constructed to include the existing excavation pit located along the central northern boundary of the site. It is intended that the existing stockpiles of clay residue within the site will be used to construct the storage lining and perimeter embankments.

The general design criteria for the process water dam are as follows:

- to provide a reliable source of process water for current and future extraction operations; and
- to be suitably located to maximise the quantity of sand available for extraction and to maximise surface runoff inflows from the surrounding catchment.

5.2 STORAGE DESIGN REQUIREMENTS

The water supply dam has been sized for future extractive operations at the site which is to involve conventional dry excavation methods (ie. using scrapers and/or loaders/trucks). Process water for washing and screening of the sand would be sourced from the water dam.

The following storage requirements and assumptions regarding the future operation process/layout have been adopted:

- a sand production rate up to 1000 t/day[2] is assumed, but will vary depending on supply and demand during the life of the operation;
- operations will be carried out on 5.5 days per week for the life of the operation;
- the proportion of reject material (clay and gravels) is approximately 30% on average;
- the washing/screening process will be a closed system with free water returning to the dam storage for re-use;
- no discharge of water off the site is intended;
- sand is stockpiled nearby the plant with any free water able to be drained into the water dam;
- clay residue materials are discharged to nearby drying areas with free water able to be drained into the water dam;
- water from the dam will not be used to supplement the existing water ponds for use in the existing nursery operations.

Based on the above, water inputs to the storage would be direct rainfall and surface runoff from the surrounding catchment, with outputs comprising evaporation and seepage losses from the storage and general process (ie. stockpile) losses. The components to the overall water balance of the storage are discussed further below.

---

[2] Assuming 50 laden truck loads per day @ 20 t/load (provided by Neil Kennan from Nexus Environmental Planning Pty Ltd).

5.3 WATER BALANCE MODELLING

A monthly water balance was undertaken for the proposed process water dam to simulate storage level fluctuations during operation and to predict the likelihood and frequency of overflow from the storage. As outlined in Section 5.2, the objective of the storage is to provide a reliable water source based on adopted future operation process requirements.

The model simulated the response in the storage of the water dam based on catchment yield (surface runoff) and storage losses (eg. evaporation, seepage and process outputs). The following criteria, assumptions and data were used in the model:

- 63 years of monthly rainfall (based on a consecutive record using Maroota Bush Fire Brigade Station rainfall from 1926 to 1954 and 1964 to 1997 inclusive[3]);
- monthly average evaporation (average from Richmond AMO/MO);
- all surface runoff from the dam catchment area (refer Figure 3) is directed and drained into the dam storage;
- a weighted average monthly runoff coefficient of approximately 0.2 was estimated for the total catchment (used to convert monthly rainfall over the catchment to direct monthly storage input) based on the following runoff coefficients (C) for different soil/vegetation areas within the catchment (from recent aerial photography of the site):
  - dam surface: C = 0.95
  - disturbed/bare ground (no vegetation): C = 0.25
  - sand/clay stockpiles (no vegetation): C = 0.20
  - grassed/shrub areas (no trees): C = 0.15
  - forest/timbered areas: C = 0.10
- a nominal dam surface area of 20 000 m^2 (ie., approximately 140 m x 140 m) was assumed to match the dam approved under the existing court orders;
- vertical perimeter embankment walls were assumed for simplicity (ie., a constant surface area versus depth relationship - a conservative approach);
- a maximum water storage depth of 3 metres was adopted for practicality of construction and to maximise the quantity of sand available for extraction (thus providing a maximum storage capacity of 60 ML);
- an initial dam storage volume of 50% of the total storage capacity at the start of each model run;
- a pan evaporation factor of 0.9 for the water storage (to convert recorded pan evaporation data to pond surface evaporation);
- dam foundation seepage losses were estimated based on a compacted clay liner thickness of 0.6 m and an average permeability[4] of 5 x 10^{-9} m/s (see Section 4.3.1);

---

[3] Rainfall records between 1955 to 1963 (some 9 years) are missing . Average monthly totals were also substituted where isolated monthly totals were missing in the record.

[4] Based on visual inspection of existing clay materials stockpiled on site.

- pond dead storage in the dam (below which further extraction of process water can not occur) assumed to be 10% of total storage capacity; and
- stockpiled sand and clay materials have approximately 5% and 35% moisture content (by mass) on average respectively.

Based on the above criteria, process water (ie. stockpile) losses for a range of average sand production rates used in the model are summarised in the table below:

Table 4

STOCKPILE WATER LOSSES

Average Sand Production Rate (t/day)	Average Clay Production Rate [1] (t/day)	Sand Stockpile Water Loss [2] (m^3/day)	Clay Stockpile Water Loss [3] (m^3/day)	Total Stockpile Water Loss (m^3/day)	Total Stockpile Water Loss (ML/month)[4]
600	257	30	90	120	2.6
800	343	40	120	160	3.5
1000	429	50	150	200	4.4

[1] Assuming the proportion of clay reject material is 30% of the total excavated material (by mass) on average.
[2] Based on a stockpiled sand moisture content of 5% by mass on average.
[3] Based on a stockpiled clay moisture content of 35% by mass on average.
[4] Based on 5.5 days operation per week.

5.4 RESULTS

The water balance was run with average sand production rates of 600, 800 and 1000 t/day for the extraction operation. For each production rate, the number of "shortfall" months were recorded (ie. the number of months when storage losses exceeded the dam storage volume for the month[5]) and subsequently the storage "reliability" was calculated over the 63 year rainfall sequence.

The predicted storage volume versus time over the 63 year rainfall sequence for each of the production rates is provided in Appendix A.

The water balance modelling results are summarised in Table 5.

[5] A supplementary water supply source (ie. from groundwater bores) would therefore be required during these "shortfall" months. This would be available from groundwater bores constructed into the Hawkesbury Sandstone, as discussed further in Section 8.1.1.

Table 5

WATER BALANCE MODELLING RESULTS

Average Sand Production Rate	Number of Shortfall Months	Storage Reliability	Frequency of Additional Water Requirement	Average Monthly Shortfall Volume	Average Storage Depth
(t/day)		(%)	(%)	(ML)	(m)
600	214	75	25	2.0	0.8
800	356	60	40	2.7	0.6
1000	460	40	60	3.4	0.5

(1) Frequency of months when pumping from the storage is required to prevent overflow.

The above modelling results (based on 63 years of rainfall record) indicate the following:

- for an average sand production rate of 1000 t/day, a storage reliability of 40% is predicted to supply water for the washing / screening process;
- for an average sand production rates of 600 t/day, the storage reliability predicted increases to 75%;
- when "shortfall" is predicted within the storage, the average monthly shortfall volume is predicted to be 2.0 ML (or 0.8 L/sec) and 3.4 ML (or 1.3 L/sec) for 600 and 1000 t/day average production rates respectively; and
- average storage depths should range between 0.5 to 0.8 m for the range of sand production rates modelled.

The sensitivity of the model on storage area and capacity with respect to the storage reliability was also examined by increasing the storage area and depth by 50% and re-running the model to predict the storage reliabilities. The results indicated that for an increase in storage area of 50% (ie. resulting in a modelled storage area of 30 000 m^2), the storage reliability is decreased by an average of 25% for the range of sand production rates modelled. This is due to a substantial increase in evaporation loss from the storage as a result of the increase in the storage surface area, thus reducing the overall storage reliability.

Also, for an increase in storage depth by 50% (i.e. resulting in a storage depth of 4.5 m), the storage reliability only increases by an average of 4% for the range of sand production rates modelled. This is due to the relatively low predicted frequency of overflow occurring from the storage in the "base" case and, therefore, the effects of additional storage capacity on storage reliability would only be minimal.

The above model sensitivity analysis indicates that substantially increasing the storage area and capacity has only minimal (or negative) impact on the predicted storage reliability.

The storage reliability could be increased by dividing the storage area into separate cells and transferring water from one cell to the other during periods of low inflow. In this manner, the surface area would be reduced and the evaporation minimised, thus increasing the reliability factor. Such water management scheme will be investigated more thoroughly during detail design. During that stage, possible methods of reducing surface evaporation by the installation of partial covers of the surface area, such as floating plastic spheres, will also be investigated, as any means of reducing evaporation will increase the storage reliability.

5.5 CONCLUSIONS

Based on the water balance modelling results, the following conclusions are provided:

- a nominal 60 ML water storage (approximate dimensions of 140 x 140 x 3 m deep) should provide a storage reliability of at least 40% assuming an average (maximum) sand production rate of 1000 t/day is achieved during the extraction operation;
- the storage reliability increases to around 60 to 75% if average sand production rates between 600 and 800 t/day are achieved during the extraction operation;
- substantially increasing the storage area and capacity has only minimal (if not negative) impact on the predicted storage reliability;
- an alternative water supply source would, therefore, be required to supplement the process water dam between 25 to 60% of the months (for the range of sand production rates modelled) during extended periods of low or no rainfall. For example, 2 deep groundwater bores constructed into the Hawkesbury Sandstone with a combined capacity of 2.5 L/sec could supply up to 6.5 ML/month, which is above the calculated total stockpile water loss of 4.4 ML/month outlined in Table 4; and
- storage reliability could be increased by the adoption of appropriate water management strategies at the dam, including the introduction of possible evaporation control measures.

6.1 GENERAL

The proposed preliminary dam design has been carried out based on the results of the water balance modelling (refer Section 5), and from discussions with the client. The main objectives of the design were to provide details on:

- liner properties and thickness;
- required batter slopes for pond perimeter embankments and pit batter slopes;
- constructability; and
- surface water control measures.

The design assumptions and criteria are provided in the following section. The proposed dam design is presented on Figures 5, 6 and 7 and outlined in Section 6.3. The geometry of the dam should be chosen to achieve the required design batter slopes, storage volume and to maximise the use of the existing excavation to reduce construction costs. The geometry shown assumes that the existing pit boundary provided on the supplied survey is accurate.

6.2 DESIGN CRITERIA

The following criteria have been adopted for preliminary design of the water storage dam:

- a storage capacity of approximately 60 ML (approximate dimensions 140 × 140 × 3 m deep);
- the base level of the dam (top of liner) to be at 180 m AHD (this ensures that there is always a net outward water pressure gradient from the pond and that the potential leakage from the pond acts as a local source of recharge to the Maroota Sand, i.e. no groundwater loss from the Maroota Sand);
- full supply level in the dam to be at 183 m AHD;
- a 2.0 m exclusion zone above the water table for mining operations;
- maximum use of on site materials; and
- design and construction of the dam in accordance with good engineering practice.

However, to enable sand production to continue during construction of the process water dam, it is proposed to adopt a two stage construction method.

Stage 1 (approximate dimensions = 110 × 110 × 2.5 m) will comprise the construction of the first portion of the storage dam to a clay liner top level of 181 m AHD (Figures 5 and 6), whilst the existing dam continues to supply water to the processing plant. The Stage 1 dam will have a temporary northern wall with batters of 3(H):1(V). Once completed, the Stage 1 Dam will be filled by pumping from the existing dam and used for continued supply to the processing plant during construction of the Stage 2 portion of the dam.

Stage 2 (approximate dimensions = 100 × 100 × 3 m) will comprise the construction of the remainder of the dam and will start with emptying the existing dam into Stage 1. The clay liner will be constructed to a top level of 180 m AHD.

Upon completion of overall construction, the temporary wall separating the two portions of the dam could be breached to form one large storage. However, as discussed in Section 5.4, it

may be preferable to retain two separate dams during the quarry life to improve the storage efficiency and for water management purposes.

6.3 PRELIMINARY STORAGE DAM DESIGN

6.3.1 Liner

To minimise the loss of water due to seepage, it is recommended that a 600 mm thick clay liner with a minimum hydraulic permeability of 10^{-8} m/sec be adopted. No testing has been carried out on available clay reserves on the site, however it is anticipated that these materials would be suitable (refer Section 4.3.1).

6.3.2 Batter Slopes

Table 6 below presents the recommended batter slopes for the site. These batter slopes assume that properly constructed surface drainage measures are implemented to divert stormwater away from slopes.

Table 6
RECOMMENDED BATTER SLOPES

Location	Condition	Recommended Maximum Batter Slope
Pit Batters	long-term	2(H):1(V) (may require some maintenance)
Processing and Stockpiled Areas	short-term	1.5(H):1(V)
Pond Perimeter Embankment	long-term	3(H):1(V)

6.3.3 Sedimentation Pond

A sedimentation pond will be necessary to minimise sediment build up in the process water storage dam with approximate dimensions 30 × 50 × 1 to 1.5 m deep. A 500 mm diameter HPDE pipe is recommended to transport water from the sediment pond to the process water dam. The location and details of the sedimentation pond are provided on Figures 5 and 6. It is also recommended that a baffle be placed in the sedimentation pond (such as concrete blocks, steel sheeting or equivalent) to assist the sedimentation process.

6.3.4 Sedimentation Pond Spillway

During storm events, where the capacity of the pipe from the sedimentation pond to the process water dam could be reached, it will be necessary to provide a 2 metre wide by 0.3 metre concrete lined spillway. The spillway should be placed at an elevation of approximately 183.7 m (0.3 m below the dam crest level), to minimise scouring of the dam if overtopping occurs. The location of the concrete lined spillway is shown on Figure 5.

6.3.5 Spoon Drains

Spoon drains, 1.0 m wide by 0.5 m deep, are recommended around the perimeter of the process water storage dam. The drains are to divert sediment laden stormwater run-off from the pit batters around the dam into the sedimentation pond.

6.3.6 Process Water Dam Overflow Spillway

In the event of exceptionally high rainfall, a concrete lined spillway channel, 10 to 20 m wide and 1 m deep, will be provided on the northern wall of the dam to allow flow into the existing natural watercourse at approximately 192 m AHD. The spillway channel location is shown on Figure 5.

6.4 CONSTRUCTION ISSUES

6.4.1 Dewatering of Excavation

It will be necessary, prior to placement and compaction of materials in the Stage 2 dam, to dewater and clean out the existing pit to provide a firm and stable foundation for backfilling. Based on information supplied by the client, inflows into the excavation are expected to be low, enabling a low water level to be maintained in the pit during backfilling. However, due to ongoing seepage inflows, it will be necessary to create a low point and sump within the base of the excavation. During backfilling, the sump will be maintained and pumped to enable placement of backfill materials.

6.4.2 Placement and Compaction of Materials

General Fill

General fill, obtained from the site, will be used for backfilling the dam foundation prior to placement of the clay liner. The general fill should comprise a granular material (<5% fines). The material should be backfilled in 250 mm loose layers to a minimum of 95% of the standard maximum dry density ratio or 65% density index at ± 3% of the optimum moisture content. Due to the potential for "pumping" of groundwater through the material during compaction, it will be necessary to ensure that vibration equipment is not used on the initial fill placed, and that only the minimum number of passes of the compaction plant are used to achieve the required density. A 10 tonne smooth drummed roller is recommended for this material, in conjunction with careful monitoring during construction.

Clay Liner

To achieve the desired minimum hydraulic conductivity, the compaction standard for the clay liner material given in Table 7 below is recommended.

Table 7
RECOMMENDED CLAY LINER COMPACTION CRITERIA

Test	Requirement	Test Method
Dry Density	Minimum 98% Standard Compaction	AS1289.5.1.1 (1992)
Moisture Content	0 to +4% of the Optimum Moisture Content	AS1289.5.1.1 (1992)

The material should be placed and compacted in no more than 250 mm loose layers. A 10 tonne vibrating sheeps foot roller is recommended for this material.

In addition, it will be necessary to provide a filter layer between the clay liner and the underlying compacted fill to prevent the migration of fines from the clay into the fill. A geotextile (such as BIDUM A24) is recommended; however, it may be possible to use on site materials as natural filter such as a fine grained silty sand. If a natural filter is to be provided, then grading tests on the material would be required to design the grading envelope of the filter for compatibility purposes.

6.5 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

QA/QC requirements for construction of the pond would involve ongoing engineering supervision, particularly during the initial stages of construction, to correlate the construction method with design assumptions and desired material performance.

Specific QA/QC testing will be required for the clay liner. The basis for this QA/QC programme is field density testing carried out at specified frequencies (to be determined as part of the detailed design stage).

6.6 ALTERNATIVES

An alternative to the proposed compacted clay liner would be a synthetic liner, such as a 2.0 mm HDPE geomembrane. The method of constructing the dam would be to place general fill (as specified) to a minimum height of 180 m AHD. The liner would then be installed at that level. It will be necessary to provide anchor trenches around the perimeter of the dam. Specific detailing of liner construction would be necessary at the detailed design stage.

7.1 GENERAL

The proposed water storage dam has been designed and will be constructed in such a manner as to minimise the impacts on the local environment. The environment which could potentially be impacted upon during construction of the dam and during the life of its operation would be:

- the groundwater in the Maroota Sand and Hawkesbury Sandstone aquifers;
- the surface water;
- air and noise levels in the surrounding area.

Each of the above aspects will be discussed in the following sections.

7.1.1 Groundwater

Previous sections of the report have presented and discussed the hydrogeology of the area and of the site.

The dam has been designed with an impermeable clay liner to exclude direct contact with the groundwater in the Maroota Sand and in the Hawkesbury Sandstone aquifers.

Hawkesbury Sandstone

The Hawkesbury Sandstone aquifer is located beneath the clay lined water dam and is not expected to receive any inflows from the sand extraction operations. However, an additional water supply will be required to supplement the surface water in the dam. Discussions held with the DLWC concluded that such supply could be obtained from the Hawkesbury Sandstone without adverse effects on the capacity of this aquifer, which remains substantially untapped in the Maroota area.

The process of developing a water supply from the Hawkesbury Sandstone will be subject to the approval process required by the Water Act and administered by the DLWC. After suitable scrutiny, the DLWC has indicated that it will issue the appropriate licences which will entail the principle of sustainability of supply. Thus, no negative impacts will be generated upon the Hawkesbury Sandstone aquifer.

Maroota Sand

The core principle of the proposed dam design is the exclusion of the Maroota Sand groundwater, to allow this groundwater to be available to other users. As with the proposed mining plan (Woodward-Clyde, 1999), which follows the guidelines set in the Baulkham Hills Shire Council Development Control Plan No 500 with regards to depth of mining, no groundwater will be extracted from the Maroota Sand for the purpose of activities associated with mining.

Current groundwater records from excavations and from purpose built monitoring bores in the deeper Maroota Sand aquifer presented in Table 3 and discussed in Section 3.5, show that a base level of 180 m AHD could be adopted for this aquifer.

The proposed dam design places a clay liner at 180 m AHD in order to exclude inflows into the dam from the aquifer by the construction of an impermeable barrier and by the maintenance of a positive outward hydraulic head.

The proposed mining operations have the potential of beneficial impacts upon the surrounding environment. The impacts will be by :

- relinquished use of the Maroota Sand aquifer groundwater, thus allowing use by others; and
- increased aquifer recharge from the exposed areas during sand extraction.

7.1.2 Surface Water

Surface water from the site catchment is currently fully collected in the existing excavation. The water model study has indicated that the potential exist for occasional high flow to occur and adequate engineering provisions have been made in the design. Excess run-off from the catchment east of Roberts Road will be diverted to the natural drainage towards the north, thus providing a contribution to the storage dams north of the site.

Because such contribution is generally not available under the present conditions, it is considered that the current dam design will provide a potential beneficial effect upon the surrounding users.

7.1.3 Air Quality

A full air quality study of the impacts of the proposed mining operations is being carried out by others. During the construction of the dam and of the associated earth works, additional machinery will be required, which will potentially create dust problems and increased fugitive (exhaust) emissions. However, the nearest residences (receptors) are located at approximately 250 m from the dam site and it is expected that no impact, additional to the existing levels, will be generated during the construction of the dam at those locations.

7.1.4 Noise

A full noise study of the impacts of the proposed mining operations is being carried out by others. During the construction of the dam and of the associated earth works, additional machinery will be required, which will potentially create increased levels of noise.

All activities will be subject to the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979, which ensure that operations are carried out in such a manner as to keep noise at acceptable levels, by limiting the hours of operations and ensuring that adequate exhaust systems are fitted the machinery.

A great deal of the earth works will be carried out at the lowest elevation of the site which is expected to provided a buffering effect. In addition, dam construction activities are expected to be of short duration, thus limiting the length of possible exposure to higher noise levels.

Department of Land and Water Conservation. Water Resources Consulting Services Resources *"Maroota Groundwater Study, Stage 1"* September 1996

Department of Land and Water Conservation. Centre for Natural Resources *"Maroota Groundwater Study, Stage 2"* September 1998, CNR 98.027

Etheridge, L.T. *"Geological Investigation and Resource Assessment of the Maroota Tertiary Alluvial Deposit"* Geol. Survey NSW Report GS1980/201

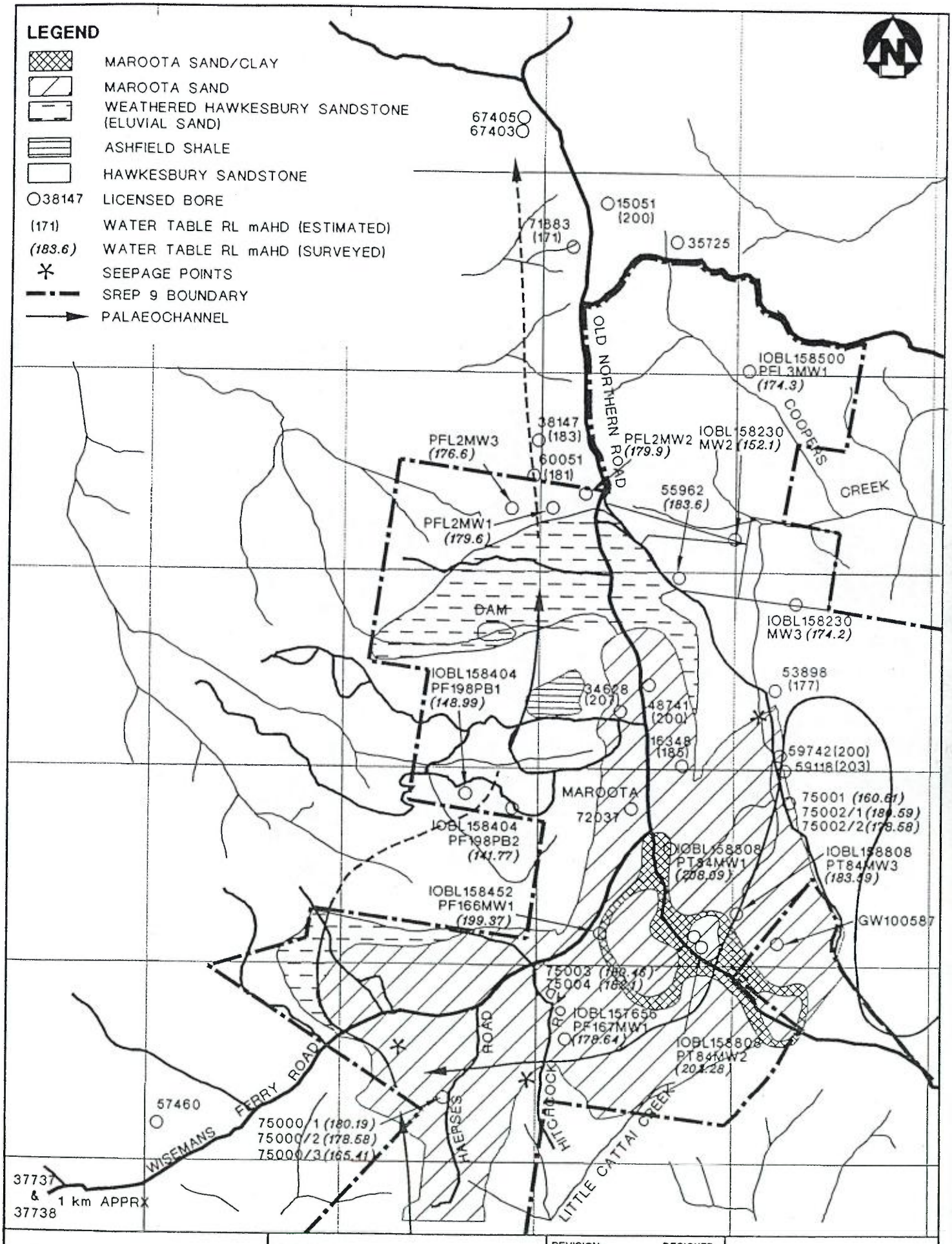
Institute of Engineers *"Australian Rainfall and Runoff, A guide to Flood Estimation"* Vol 1 and 2, Revised Edition, 1987.

Southern Aerial Surveys Pty Ltd. *"Maroota, Run 1, 6967-6974, 3.4.98"*

Woodward-Clyde *"Lots 1 and 2, DP228308, Lot 2, DP312327, Maroota Development Application. Groundwater Impact Assessment"* December 1998.

Woodward-Clyde *"Lots 1 and 2, DP228308, Lot 2, DP312327, Maroota Development Application. Conceptual Mining Plan"* May 1999.

FIGURES



Woodward-Clyde

CLIENT
NEXUS ENVIRONMENTAL PLANNING

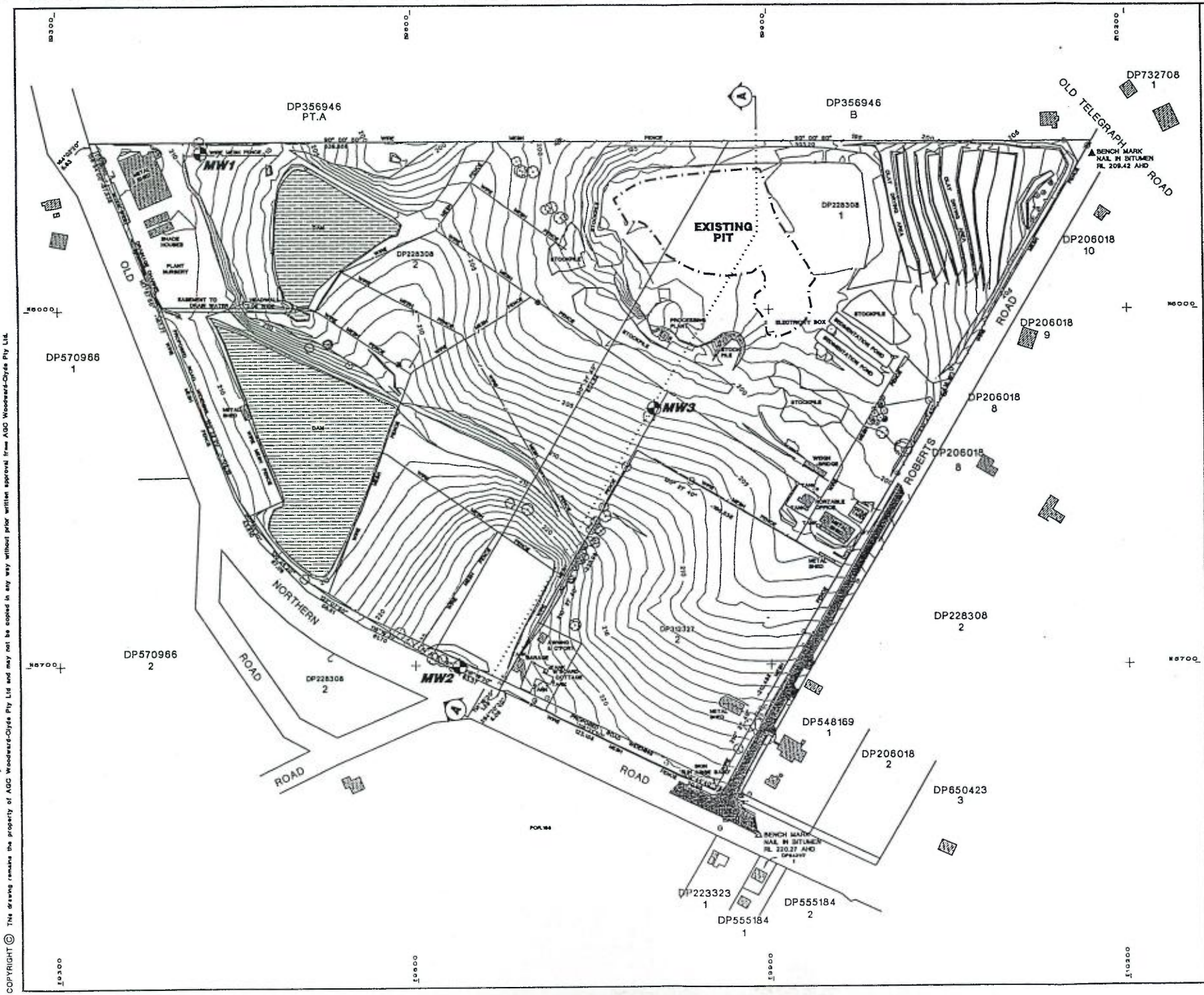
PROJECT
LOT 1 & 2, DP228308, LOT 2, DP312327 MAROOTA DEVELOPMENT APPLICATION- PROCESS WATER DAM DESIGN

REVISION: B	DESIGNED: SRR
SCALE: AS SHOWN	DRAWN: LJE
DRAWING No: A86 2019\0001	CHECKED:
CAD FILE NO: G.009	APPROVED:
DATE:	STATUS: FINAL

TITLE
LOCALITY AND GEOLOGY

FIGURE
1

A4



REVISION:	B	DESIGNED:	SRR
SCALE:	AS SHOWN	DRAWN:	LJE
DRAWING No:	A8602019\0001	CHECKED:	SRR
CAD FILE NO:	G016	APPROVED:	PC
DATE:	22/6/99	STATUS:	FINAL

LEGEND

MW1 GROUNDWATER MONITORING WELL

A GEOTECHNICAL CROSS SECTION

CLIENT

NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT

LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION- PROCESS WATER DAM DESIGN

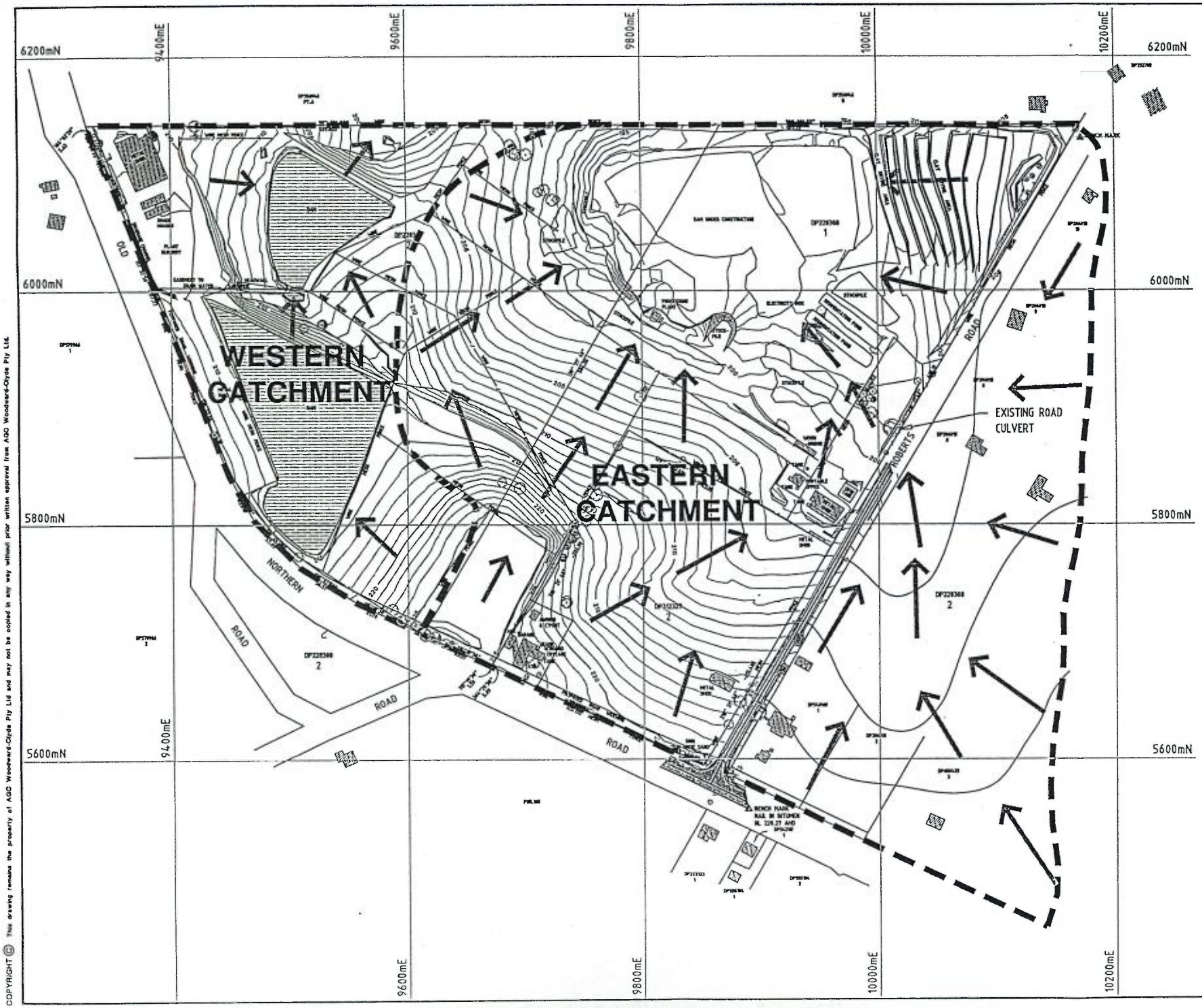
TITLE

EXISTING SITE LAYOUT

FIGURE

2 A3

Woodward-Clyde



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SCALE: AS SHOWN DRAWN: LJE

DRAWING No: A8602019\0001 CHECKED: SRC

CAD FILE NO: 0012 APPROVED: FC

DATE: 22/6/99 STATUS: FIN

LEGEND

CATCHMENT BOUNDARIES

DIRECTION OF SURFACE DRAINAGE

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED REGISTERED SURVEYORS & PLANNERS DETAIL SURVEY LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327 OLD NORTHERN ROAD MARODTA

0 50 100 150
metres

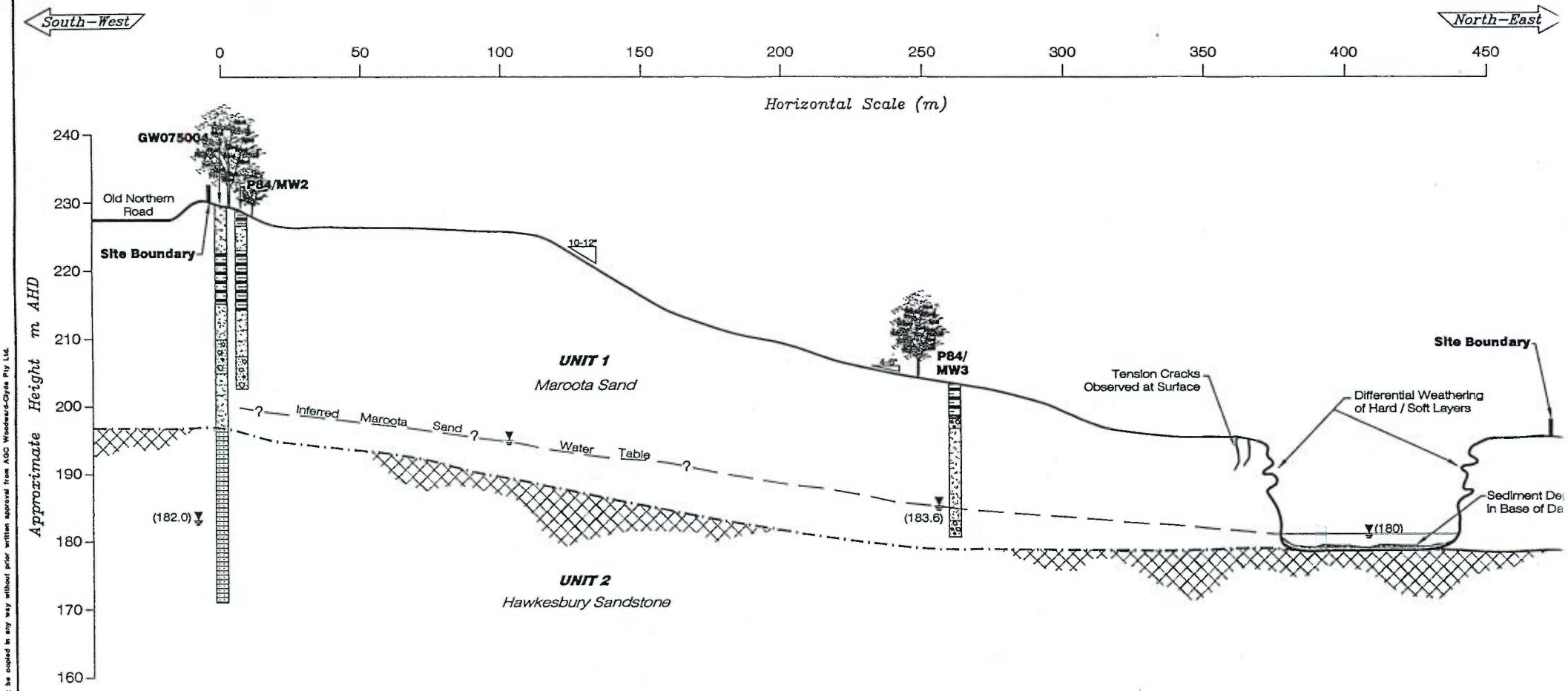
CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT
LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION- PROCESS WATER DAM DESIGN

TITLE
DRAINAGE AND CATCHMENT AREA

FIGURE
3 A

Woodward-Clyde



LEGEND

- SAND
- CLAY
- GRAVEL / SANDY GRAVEL
- SANDSTONE
- (182.0) GROUNDWATER LEVEL m AHD
- **P84/MW2** DR MARTIN MONITORING BORE
- **GW075004** DLWC MONITORING BORE
- INFERRED BOUNDARY BETWEEN UNITS

GEOLOGICAL UNITS

UNIT 1 MAROOTA SAND:- Interbedded and poorly sorted, sands, gravels, clayey gravels, gravelly sands, pobbly sands, clayey / silty sands and clay, which range from compacted to partly consolidated materials

UNIT 2 HAWKESBURY SANDSTONE:- Medium to coarse grained quartz sandstone, very minor shale and laminite lenses

Woodward-Clyde

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT
LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION- PROCESS WATER DAM DESIGN

REVISION: B
SCALE: AS SHOWN
DRAWING No: A8602019\0001
CAD FILE NO: G006
DATE: 22/6/99
DESIGNED: SRR
DRAWN: LJE
CHECKED: SRR
APPROVED: FC
STATUS: FINAL

TITLE
GEOTECHNICAL CROSS SECTION A-A'

FIGURE
4

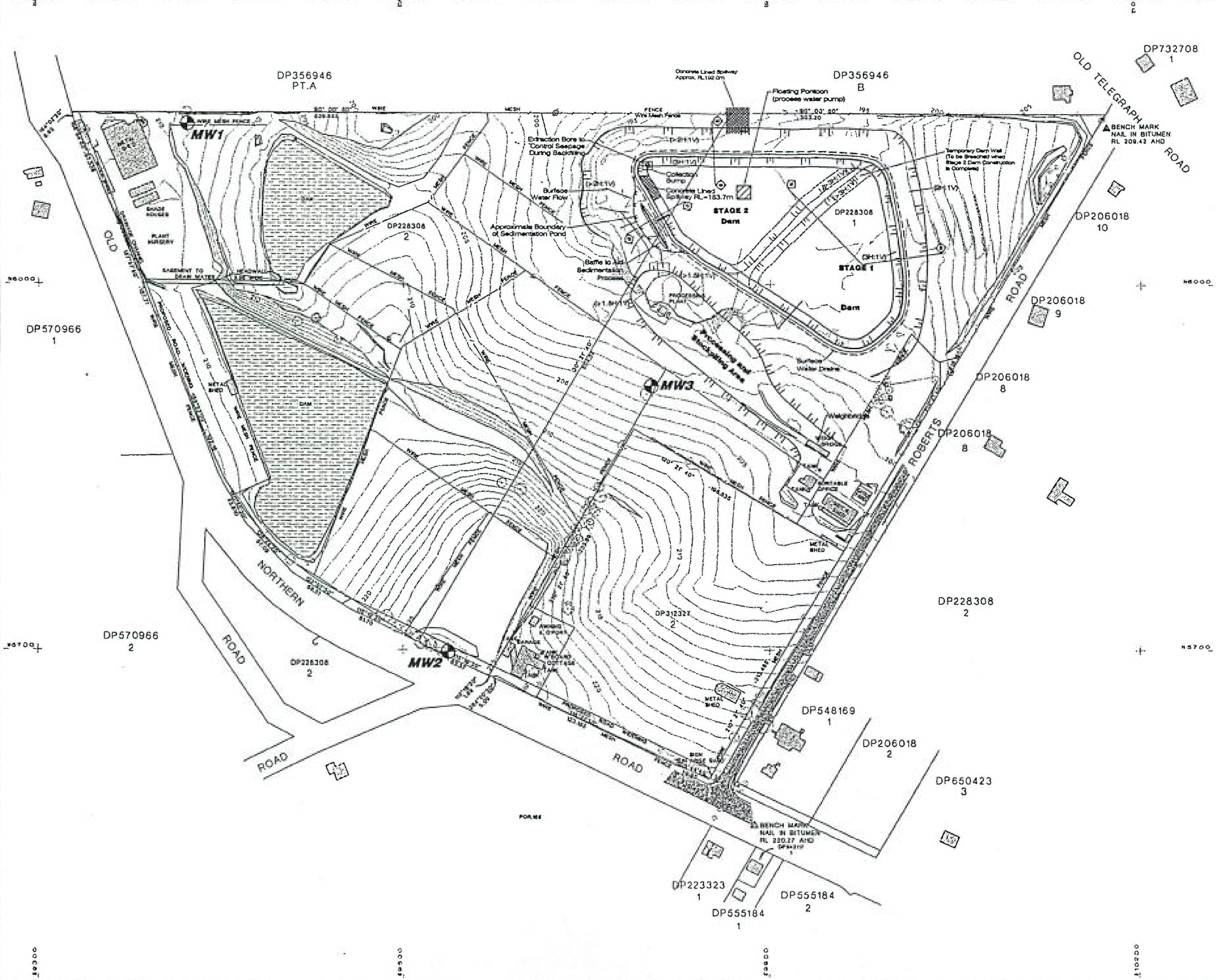
EVISION SIGNE

SCALE: AS SHOWN DRAWN: LJ

DRAWING No: A8602019\0001 CHECKED:

CAD FILE NO: G018 APPROVED:

DATE: STATUS: FIN



LEGEND

CROSS SECTION LOCATION

PROPOSED PROCESS WATER DAM

(1.5H : 1V) RECOMMENDED BATTER SLOPES

RECOMMENDED BATTER SLOPES

0 50 100 150
metres

CLIENT

NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT

LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION- PROCESS WATER DAM DESIGN

TITLE

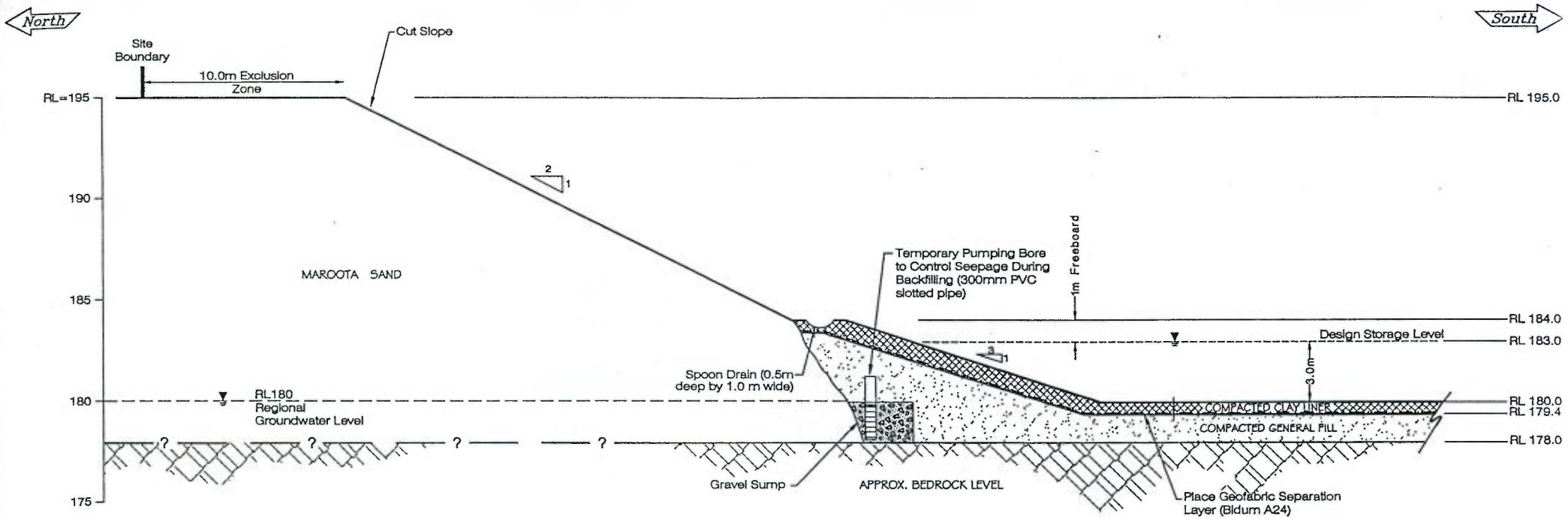
PROPOSED WATER DAM LAYOUT

FIGURE

5

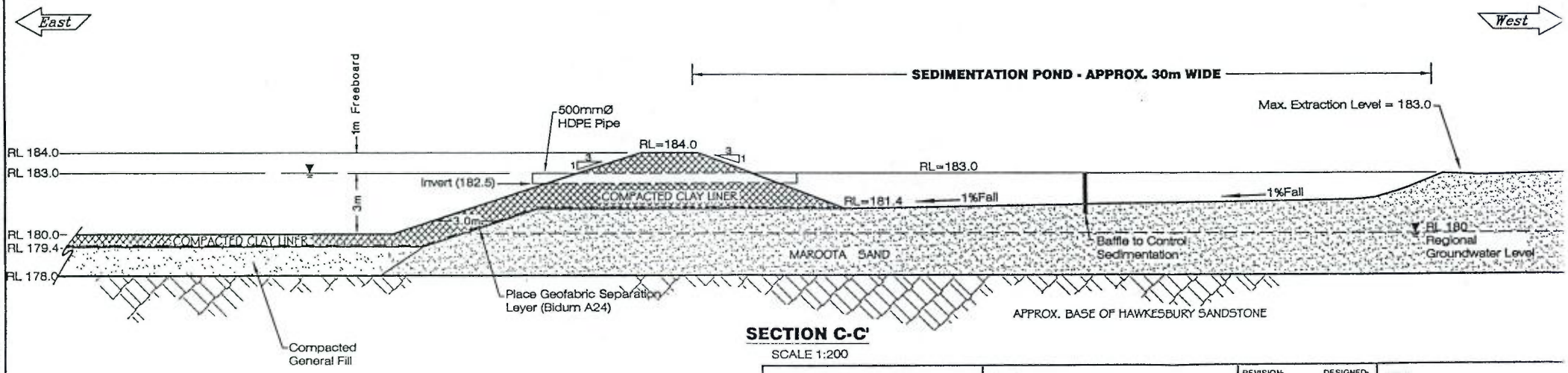
A1

Woodward-Clyde



SECTION B-B'

SCALE 1:200



SECTION C-C'

SCALE 1:200

0 2 4 6 8 10
metres

Woodward-Clyde

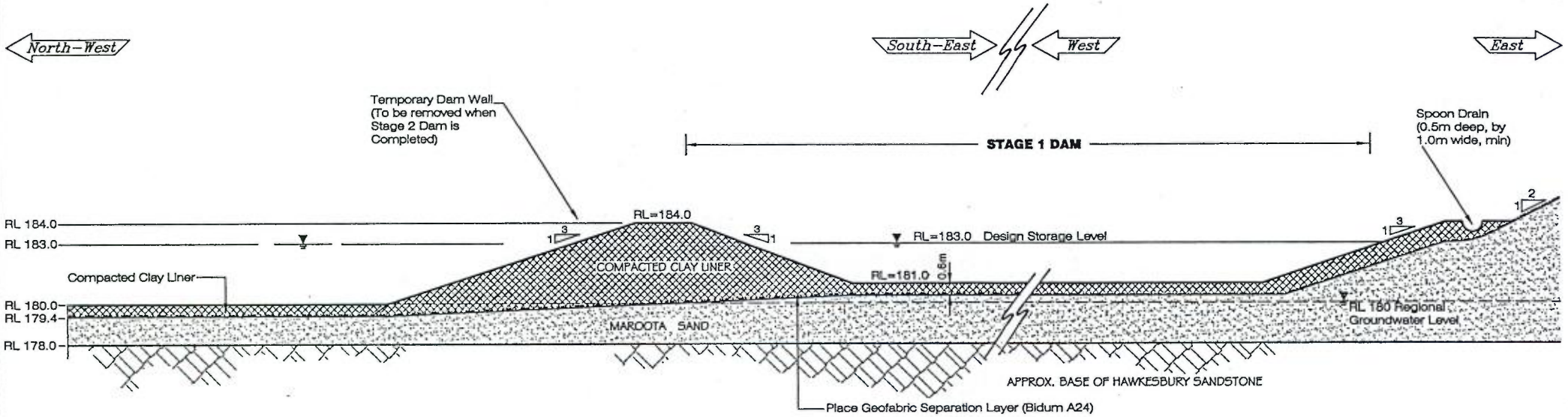
CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT
LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION PROCESS WATER DAM DESIGN

REVISION: B
DESIGNED: SRR
SCALE: AS SHOWN
DRAWN: LJE
DRAWING No: A8602019\0001
CHECKED: SRR
CAD FILE No: G006
APPROVED: FC
DATE: 22/6/99
STATUS: FINAL

TITLE
PROPOSED PROCESS WATER DAM CROSS SECTION

FIGURE
6



SECTION D-D'

SCALE 1:200

0 2 4 6 8 10
metres

Woodward-Clyde

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT
LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION PROCESS WATER DAM DESIGN

REVISION: B
DESIGNED: SRR
SCALE: AS SHOWN
DRAWN: LJE
DRAWING No: A8602019\0001
CHECKED: SRR
CAD FILE NO: G017
APPROVED: TC
DATE: 22/6/99
STATUS: FINAL

TITLE
PROPOSED TEMPORARY PROCESS WATER DAM CROSS SECTION

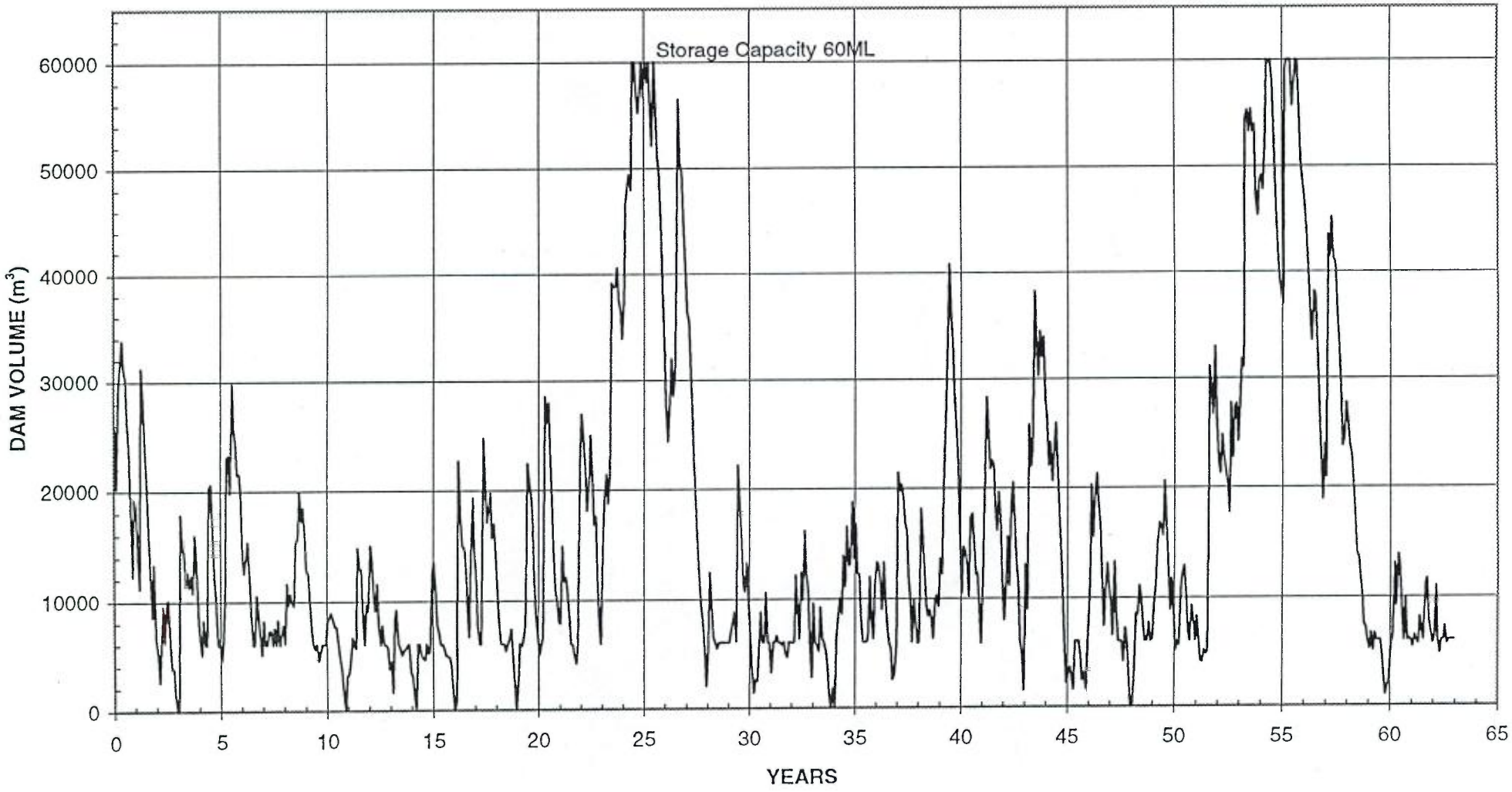
FIGURE
7

A3

Appendix A

Water Balance Model Results

MODELLED WATER DAM VOLUME VERSUS TIME
600 t/day SAND PRODUCTION



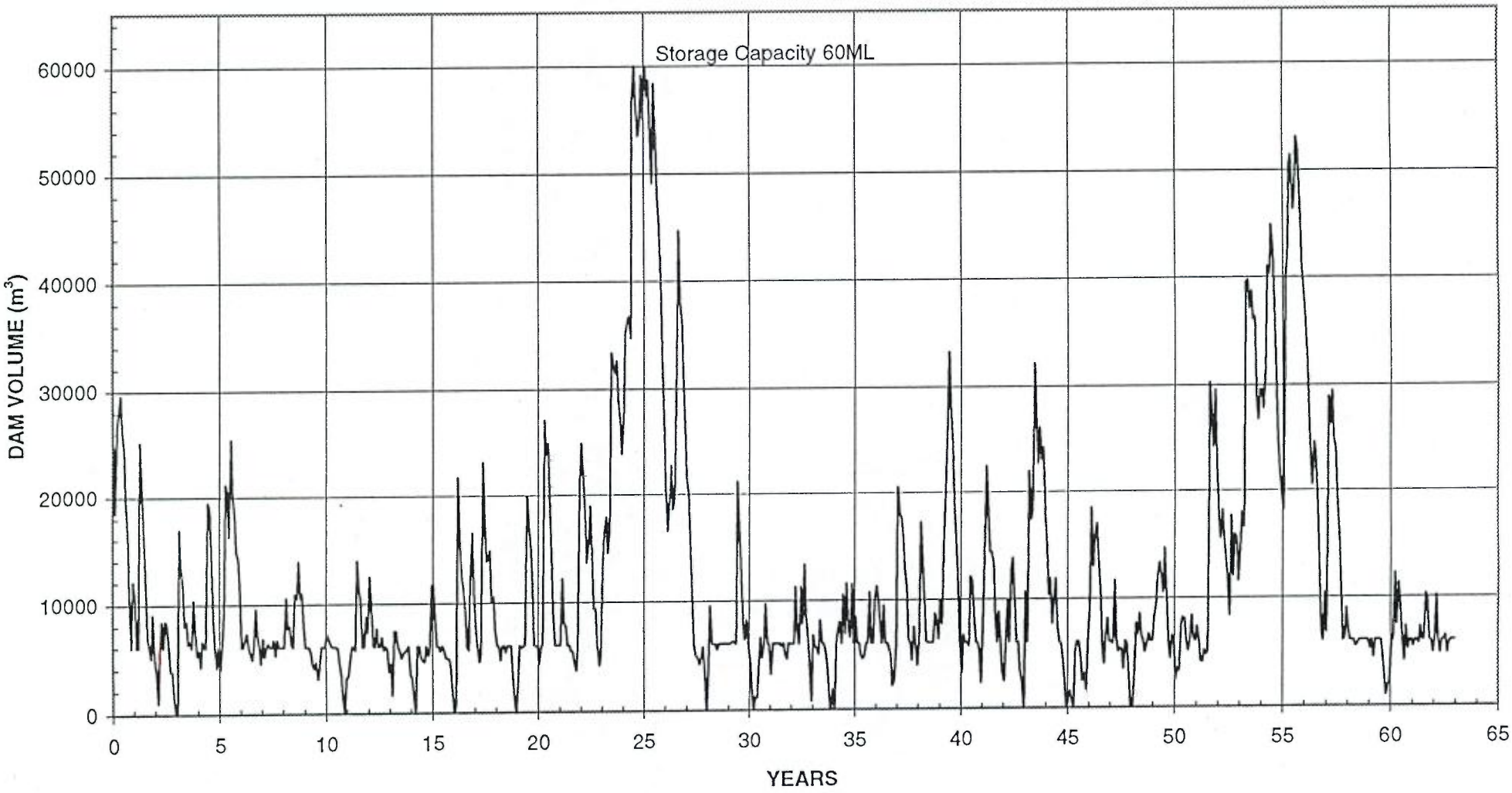
21 JUNE 1999

A8602019/0002

WOODWARD-CLYDE

FIGURE A1

MODELLED WATER DAM VOLUME VERSUS TIME
800 t/day SAND PRODUCTION



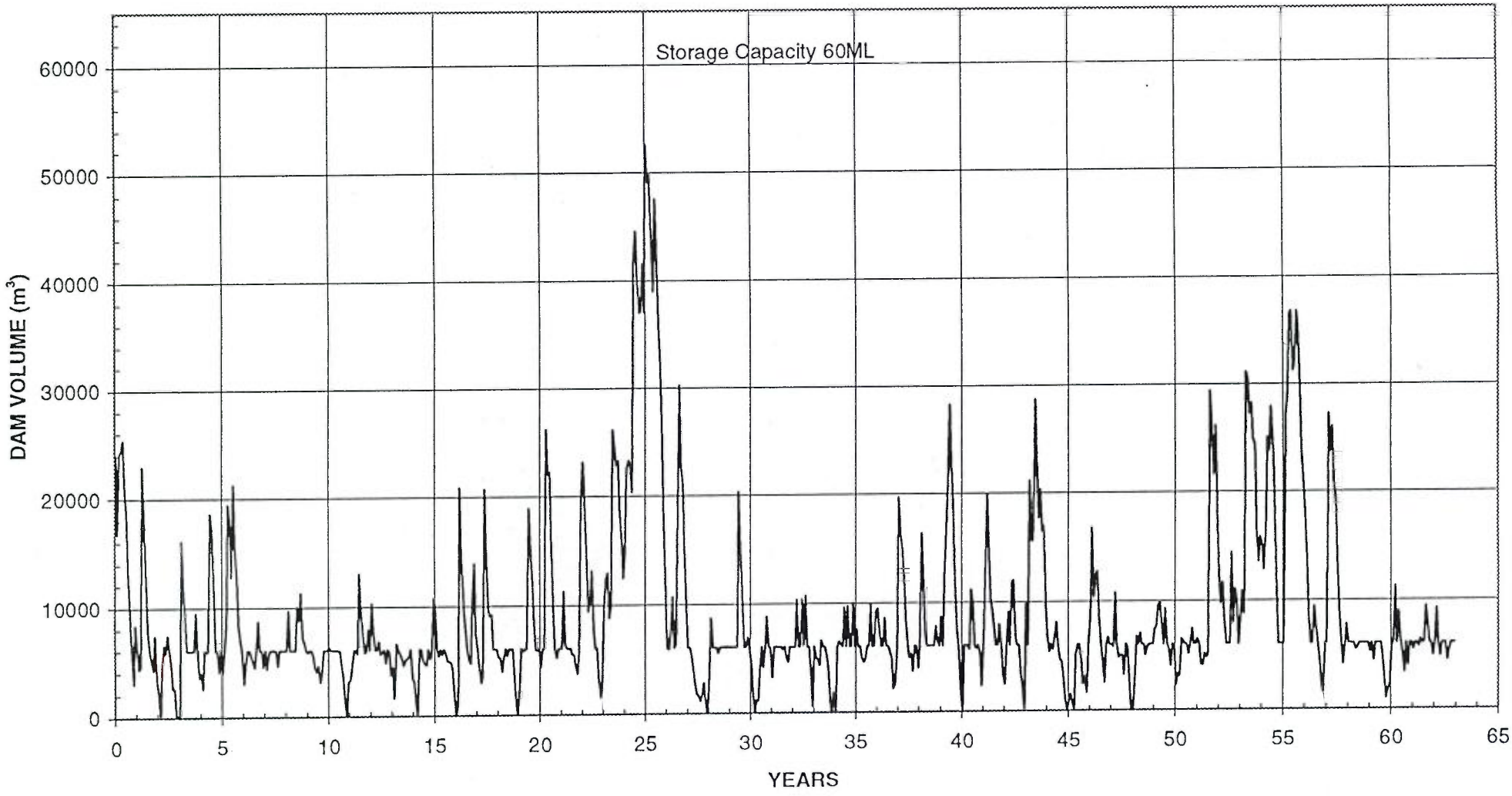
21 JUNE 1999

A8602019/0002

WOODWARD-CLYDE

FIGURE A2

MODELLED WATER DAM VOLUME VERSUS TIME
1000 t/day SAND PRODUCTION



21 JUNE 1999

A8602019/0002

WOODWARD-CLYDE

FIGURE A3

Appendix B
Capital Costs Estimates

GENERAL

For comparative purposes, cost estimates were undertaken for the construction of both a synthetic lined dam and a clay lined dam. The unit rates for the proposed works are given in Appendix B, along with estimates on construction times and material quantities. The construction costs were calculated based on our experience and with reference to Rawlinson's Australian Construction Handbook 1998, and quotes obtained from material suppliers. A contingency of 20 % has been included in the costing to allow for the uncertainties in our estimates.

Preliminary costs were estimated based on the following assumptions:

Dam Size (approximate area)	20 000 m^2
Volume Clay Liner (600 mm thick)	15 000 m^3
Area Synthetic Liner and Geotextile Layer	20 000 m^2
Volume of Bulk Filling to achieve design levels	
- clay liner option	12 000 m^3
- synthetic liner option	20 000 m^3
Length of spoon drains	600 m

All construction materials to be sourced on site.

Option 1 - Clay Liner

		Estimated Cost
1.	Excavation of sediment in existing pond to provide a firm base for placing and compacting foundation for liners and dewatering.	$12 000
2.	Compaction and placement of materials	
	- sand filling	$60 000
	- clay liner	$65 000
3.	Supply and installation of geotextile.	$5 000
4.	Installation of concrete spillway.	$15 500
5.	Temporary erosion control matting for embankments.	$10 000
6.	Drainage control works (ie diversion channels and spoon drains).	$9 000
Total Estimated Cost		**$176 500**
Contingency (+20%)		**$212 0000**

Option 2 - Synthetic Liner

	Estimated Cost
1. Excavation of sediment in existing pond to provide a firm base for placing and compacting foundation for liners and dewatering	$12 000
2. Compaction and placement of fill to design levels. - sand filling	$61 000
3. Supply and installation of geotextile	$10 000
4. Installation and placement of 2.0 mm HDPE liner	$195 000
5. Installation of concrete spillway.	$15 500
6. Temporary erosion control matting for embankments.	$5 000
7. Drainage control works (ie diversion channels and spoon drains)	$ 9 000
Total Estimated Cost	$307 500
Contingency (+20%)	$369 000

Please note that the above costings do not include landscaping and assume that all general fill and clay liner materials can be sourced on site. No costs associated with excavation from surface level to dam level have been allowed for as it is assumed that this will be carried out as part of the quarrying operation.

Appendix 14

REHABILITATION REPORT

For a

PROPOSED QUARRY

LOT 1 AND LOT 2, DP 228308
LOT 2, DP 312327
ROBERTS ROAD, MAROOTA

Prepared For:

NEXUS ENVIRONMENTAL PLANNING PTY LTD

Prepared By:

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Date:

October 1999

CONTENTS

1.0 INTRODUCTION

This Report has been prepared by Scott Murray and Associates to describe the landscape rehabilitation strategy for the proposed sand extraction activity at the Dr Martin property - Lots 1 and 2 DP 228308 and Lot 2 DP 312327 – situated on the corner of Old Northern and Roberts Roads, Maroota. This site is currently the subject of construction works for a Court approved dam structure.

This Report should be read in conjunction with the Environmental Impact Statement prepared by Nexus Environmental Planning Pty Ltd and the following plans prepared by Scott Murray & Associates: -

- **MP – 01A** **- Initial Earth Bunding & Boundary Planting Plan**
- **MP – 02A** **- Earth Bund & Planting Details**
- **MP – 03A** **- Year 3 Progressive Rehabilitation Plan & Section**
- **MP – 04A** **- Year 8 Progressive Rehabilitation Plan & Section**
- **MP – 05A** **- Final Landform / Rehabilitation Plan**

The supplemental documents accompanying the EIS should also be considered - in particular: -

- Flora and Fauna Report, prepared by AES,
- Soil and Water Management Plan, prepared by Morse McVey & Assoc.
- Strategy for Surface Water Management, prepared by Morse McVey & Assoc.
- Strategy for Rehabilitation (Erosion Control) prepared by Morse McVey & Assoc.
- Noise Impact Assessment Report, prepared by Dick Benbow & Associates Pty Ltd
- Conceptual Mine Plan Report, prepared by AGC Woodward-Clyde Pty Ltd

The Report and Plans have been prepared on the basis of a review of the following: -

- BHSC's 'Extractive Industries Development Control Plan No. 500'
- Dept of Housing "Managing Urban Stormwater: Soils and Construction"
- Dept. of Conservation and Land Management handbook 'Urban Erosion and Sediment Control'
- Site inspections

This report does not include a detailed Environmental Management & Rehabilitation Plan, as this will be prepared as a condition of consent - which is consistent with the Department of Urban Affairs and Planning requirements for the preparation of an EIS for Extraction Industries. Notwithstanding this, the Report does address, in principle, all items to be covered by the future EMRP, and therefore should not inhibit the granting of development consent, should the proposal be deemed appropriate.

2.0 AIM

The aims of the rehabilitation guidelines presented here are to: -

- Initially establish, within the boundary setback areas, extensive screen planting – supplemented with earth bunding where required – to provide for visual screening and noise control of the proposed extraction works

- Ensure the extraction site is fully rehabilitated in an "orderly, progressive and controlled manner"
- Ensure that the proposed rehabilitation processes facilitate the successful establishment and on-going performance of the nominated end land-use for each disturbed area, namely:-
  - Indigenous native vegetation to the majority (70 %) of the site
  - Unimproved pasture / existing facilities to remain (23 %)
  - Retention of the existing dam (7 %)
- Ensure that the progressively rehabilitated areas of the site are protected and monitored for the life of the development.

Plan **MP – 01A** shows the intent of the initial boundary screening and earth bunding works. A similar plan has previously been submitted to Council for approval. This plan varies from the earlier plan through the inclusion of additional earth bunding works – as recommended by Dick Benbow & Associates following the completion of their Noise Impact Assessment Report.

Plan **MP – 02A** shows typical details of earth bunding and planting works, as well as recommended vegetation species, grass seed mixes and proposed treatment of final excavated surfaces.

Plans **MP – 03A** & **MP – 04A** show the intent and extent of the progressive rehabilitation strategy at specific program intervals through Stages 1 & 2.

Plan **MP – 05A** shows the intended final land form of the site following completion of the extraction and rehabilitation works.

3.0 VISUAL ANALYSIS

The subject site is approximately 29.5 Ha in size, and is located in Maroota at the intersection of Old Northern Road and Roberts Road.

The topography of the site is such that it falls away from Old Northern Road, and hence affords extensive vistas of large portions of the site when viewed from various vantage points along both Old Northern and Roberts Roads.

As a result, the current dam construction and sections of the future proposed extraction works would be visible to public and private view. The visual impact generated by these works is currently – and will in the future - be caused by the colour contrast of exposed soils.

While these visual impacts are temporary - and will be totally eliminated once rehabilitation works have been undertaken - strategic bund wall construction and planting works along the boundaries of the subject property, will provide a visual screen for the current, and, in particular, the future extraction works within the site.

4.0 REHABILITATION STRATEGY

There are a number of equally important facets that, together, form the rehabilitation strategy for the site. Each of these is discussed in turn.

4.1 Protection of Existing Vegetation

The current site has long been cleared of its native vegetation, except for some remnant native trees along the boundaries of the property, and the odd tree within the site. Generally, existing trees within the designated boundary setbacks will be retained and protected throughout the life of the development. However, the positioning of the proposed earth bunding for noise control may, in one area, conflict with the odd tree. Where this occurs, an on-site decision will be made to either: -

- Vary the bunding to retain the tree, where the tree is deemed to be significant
- Remove the tree to install the bunding, where the tree is not deemed to be significant

In a small section of scrub north of the entry gates along Roberts Road, six individual specimens of the "Vulnerable" species of small shrub known as Acacia bynoeana have been located. This shrub area where they exist will be retained and protected.

On going monitoring of retained vegetation will be undertaken to ensure that these areas remain intact; with particular attention being given to weed invasion and its eradication.

Methods of weed eradication will be identified in the EMRP

4.2 Native Seed Collection

To ensure the re-establishment of plant communities that are indigenous to the area, native seed and plant cuttings will be collected from the area by a qualified horticulturist. The majority of the seed collected shall be used as part of a hydromulch mix to be sprayed on site. The remainder of the seed, together with site cuttings, shall be propagated under appropriate nursery conditions, and maintained until the resultant seedlings are ready to be planted on site.

Seed and cuttings shall be collected, treated, stored and propagated by an approved specialist to ensure the quality and viability of the seed and plant stock returning to site.

Seed and cutting collection will be undertaken at times to suit the proposed staged rehabilitation program. As such, a detailed program will be provided in the EMRP.

4.3 Removal of Vegetation

Any vegetation nominated and approved for removal shall be chipped and stockpiled for re-use as mulch. Mulch shall be re-spread in all mass planted areas. This mulch will provide three main benefits to these mass planted areas: -

- As an additional native seed source.
- As a ground stabiliser.
- As a moisture and warmth retainer, providing improved growing conditions for these mass planted areas.

Stockpile sites for the mulch will be provided in the EMRP.

4.4 Topsoil Stripping and Storage

Areas approved for extraction (or related) works shall, following vegetation removal, have the topsoil level stripped and stockpiled for later re-use.

Following topsoil stripping, approximately 300 - 500mm of the next layer of soil shall also be stripped and stockpiled, in a similar manner to the topsoil. The purpose of stripping this additional layer of soil is for its use in re-establishing, as close as possible, the soil profile and growing conditions of the vegetation community to be re-established.

Soil stockpiles, if to remain longer than 14 days, shall be seeded with a temporary vegetation cover. Refer to Morse McVey Report.

Once detailed works staging plans are prepared for the EMRP, details of stockpile area locations and timing schedules for reuse of stockpiled soils will be provided.

4.5 Initial Bunding and Screen Planting

At the beginning of the project, and within the boundary setback zones, earth bunds shall be established. These bund walls and the remaining boundary setback areas will then be permanently mass planted with appropriate native plants for visual screening and noise attenuation purposes. Plan MP-01A shows the location and intent of these works.

Proposed bund walls - within the 30 metre setback zone to Old Northern Road and Roberts Road - are typically 23m wide, up to 3m high, and have a profile that portrays a 1 in 4 grade to the road frontage and a 1 in 3 interior grade. Service and maintenance access routes are proposed at the base of both the front and rear of these bund walls.

Nominated bund walls with the 10 metre setback zone along the northern property boundary, shall achieve a 2 metre height – as required for noise attenuation – and will therefore have 1 in 2 finished batter grades.

The bund walls will be constructed using overburden from the existing dam works, and capped with a 150mm layer of site topsoil.

Within the extraction works areas, additional earth bunding will be provided around nominated works areas to provide additional visual screening and noise attenuation (refer to the Noise Impact Assessment Report prepared by Dick Benbow & Associates). These internal bunds will be temporary and, as such, shall be stabilised with a grass cover crop.

4.6 Treatment of Final Excavated Surfaces

Surfaces that are ready for rehabilitation shall be treated as follows: -

- deep ripping of surface, along the contour, to a depth of 500mm
- sub-surface soil, from the soil stockpile, is then placed over the ripped surface to a minimum depth of 300mm

- topsoil - from the topsoil stockpile - is then placed over the subsoil to a depth of about 100mm.

The north and west facing slopes will be rehabilitated at a 1:4 grade. South and east facing slopes shall be rehabilitated at the 1:3 grade.

4.7 Vegetation Cover

Following the establishment of soil profiles, the predetermined vegetative cover is to be established through the following process: -

(a) Areas nominated for native vegetation cover: -

- Surface hydromulched with a seed mix of predetermined native vegetation and an annual cereal crop (which provides initial surface stabilisation until the native seed establishes). The hydromulch mix will also contain a polymer binder that will stabilise the surface until the cereal crop establishes. The native seed used in the mix will be the locally collected indigenous native seed.
- The boundary setback zones along Old Northern Road, Roberts Road and along the northern property boundary, shall be mass planted, as previously stated, with seedlings grown-on from the locally collected native seed and cuttings.

(b) Areas nominated for unimproved pasture: -

- These areas will be limed, fertilised and hydromulched with a seed mix that provides initial stabilisation and longer term improved grass cover.

The grass seed component of the hydromulch mix shall, depending on the season. be made up of the following grasses: -

- **Autumn / Winter Mix**

Oats	15Kg/ha
Rye Grass	10Kg/ha
White Clover	5Kg/ha
Red Clover	5Kg/ha

- **Summer / Spring Mix**

Japanese Millet	20Kg/ha
Dobson Ryegrass	8Kg/ha
White Clover	3Kg/ha
Red Clover	3Kg/ha

Grass seed mixes for areas where a permanent grass cover is required shall also contain: -

- Rhodes Grass 5Kg/ha
- Hulled Couch 5 Kg/ha

Following seeding, grassed areas will be regularly watered as necessary to establish and maintain a solid grass cover.

Surfaces that fail to germinate will be reseeded.

Areas proposed to be rehabilitated to a native vegetation cover (ie 70 % of the site) shall have the seed of some or all of the following indigenous plants as part of the hydromulch mix. These species are typical of the "Sandstone – Shale Transition Forest" identified as pertaining to this location: -

Trees

- Allocasuarina littoralis
- Angophora costata
- Angophora floribunda
- Eucalyptus acmenoides
- Eucalyptus agglomerata
- Eucalyptus eugenoides
- Eucalyptus gummifera
- Eucalyptus notabilis
- Eucalyptus punctata
- Eucalyptus paniculata
- Syncapia glomulifera

Shrubs

- Acacia longilfolia
- Acacia parramattensis
- Banksia spinulosa
- Kunzea ambigua
- Leptospermum polygalifolium
- Leptospermum trinervium
- Hakea sericea

All species planted will be at tube stock size. They will be fertilised, mulched and have rabbit proof guards, if required.

The **Final Landform / Rehabilitation Plan, MP-05A,** shows the intent of this rehabilitation strategy. **MP – 02A** nominates the major plant species to be used in the rehabilitation process.

The EMRP will provide a more detailed vegetation selection, as well as appropriate rates of application for seed mixes and the proportions and densities of planting for individual seedlings.

4.8 Maintenance

The rehabilitated areas shall be regularly maintained to ensure the quick and healthy establishment of the proposed vegetation as well as its long term viability and performance. As part of the maintenance process, the following will be undertaken: -

- regular watering, until establishment
- re-planting and re-seeding of any areas that fail to germinate
- replacement of dead plants
- repairing of any erosion problems
- pest and weed control
- fertiliser applications to grass cover areas

Note that the water used for irrigation will be sourced from either the sediment control ponds or tanker water. Sediment control ponds shall be regularly checked for nutrient levels.

The EMRP will provide expanded details of suitable methods to undertake the maintenance works. Whether these works will be undertaken in-house or by outside consultants / contractors is not known at this stage, however, specific requirements, standards and reporting / monitoring schedules will be established to ensure compliance with the approved standards.

4.9 Progressive Rehabilitation

The extraction areas will be progressively rehabilitated so that vegetative cover is established at the earliest possible opportunity, thus minimising the extent of disturbed land within each extraction cell, and ensuring that any potential visual impact has a limited life.

The EMRP will provide detailed staging plans for the excavation and progressive rehabilitation of the works.

The extraction process will entail operating in cells approximately 200 x 50 metres (1hectare). It is intended that 3 cells may be open at any one time: -

- the newest cell will be extracted
- the previous cell will now be used for clay drying and topsoil stockpiling
- the oldest cell will now be rehabilitated, as described previously

It is proposed that, as part of the progress rehabilitation process and the on-going maintenance of these works, management plans will be prepared and updated on a yearly basis. These management plans will outline what has been achieved in the previous year and what is proposed in the upcoming year.

5.0 Conclusion

It is proposed that if the methods outlined in the report are followed, then: -

- The nominated extraction areas can be successfully rehabilitated, re-establishing an extensive native vegetation cover
- The rehabilitation process can be staged in a progressive manner to limit possible visual impacts resulting from the excavation works.
- Appropriate standards will be set for the on-going monitoring of the rehabilitation process and maintenance works to ensure the successful establishment and on-going performance of these rehabilitation areas.

On the basis of the above, we recommend the granting of approval for this application.

PLAN DRAWINGS

10M WIDE SETBACK –
TO BE PLANTED WITH SELECTED
INDIGENOUS NATIVE PLANTS
(REFER DETAIL 3, MP-02 A)

10M WIDE SETBACK –
WITH 2M HT EARTH BUND WALL
MASS PLANTED WITH SELECTED
INDIGENOUS NATIVE PLANTS
(REFER DETAIL 4, MP-02 A)

EXISTING NURSERY AND SHADE HOUSES
TO BE RETAINED
• FACILITIES TO BE USED FOR PLANT
PROPAGATION FOR USE IN SCREENING

EXTENT 10M WIDE EARTH BUND WALL –30M

OLD TELEGRAPH ROAD

BENCH MARK
NAIL IN BITUMEN
RL 209.42 AHD

EXISTING VEGETATION TO BE
RETAINED AND PROTECTED

EXISTING BUNDING TO BE RETAINED

30M WIDE SETBACK –
TO BE PLANTED WITH SELECTED
INDIGENOUS NATIVE PLANTS
(REFER DETAIL 1, MP-02 A)

PROTECTIVE ZONE:
6 EXISTING ACACIA BYNOEANA TO
BE PROTECTED AND RETAINED

EARTH BUND TO BE MODIFIED
AND INTEGRATED WITH EXISTING
VEGETATION TO BE RETAINED
WITHIN THE PROPOSED 30M
BUFFER

EXISTING VEGETATION TO BE
RETAINED AND PROTECTED

ACCESS ROAD

SAND EXTRACTION SITE

30M WIDE SETBACK –
WITH 3M HT EARTH BUND WALL
MASS PLANTED WITH SELECTED
INDIGENOUS NATIVE PLANTS
(REFER DETAIL 2, MP-02 A)

EXISTING VEGETATION TO BE
RETAINED

30M WIDE SETBACK –
TO BE PLANTED WITH SELECTED
INDIGENOUS NATIVE PLANTS
(REFER DETAIL 1, MP-02 A)

CONSTRUCT EARTH BUNDS TO FACILITATE
SCREENING OF NEGATIVE VISUAL IMPACTS

EXISTING SIGN TO REMAIN

BENCH MARK
NAIL IN BITUMEN
RL 220.27 AHD

LEGEND

- BENCH MARK
- COMMUNICATIONS PIT
- DUST GAUGE
- GAS MARKER
- MANHOLE
- MONITORING WELL
- PIPE INVERT
- POWER POLE
- SIGN
- TREE
- WATER SERVICE
- EXISTING VEGETATION TO REMAIN
- PROTECTION ZONE
- PROPOSED EARTH BUND
- PROPOSED EXTENT OF EXCAVATION
- PROPOSED SCREEN PLANTING

0 20 40 60 80 100 120
SCALE

North point

Issue	Rev.	Revision Description	Date
A		D.A. ISSUE	OCT 99

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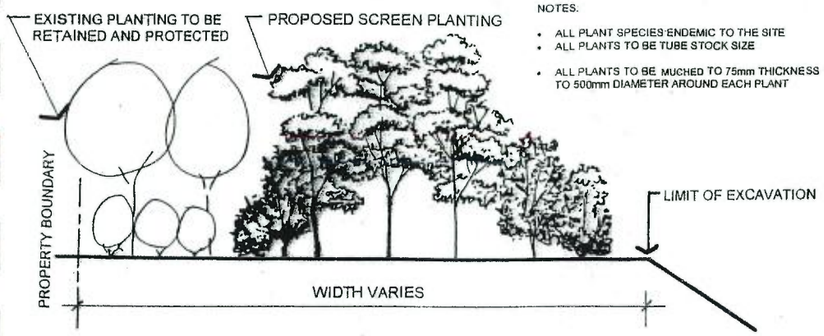
Title
INITIAL EARTH BUNDING & BOUNDARY PLANTING PLAN

Scale:		SMA Proj. No:		
Drawn / Date	Checked	Coordinated	PM Approval	Director Verification

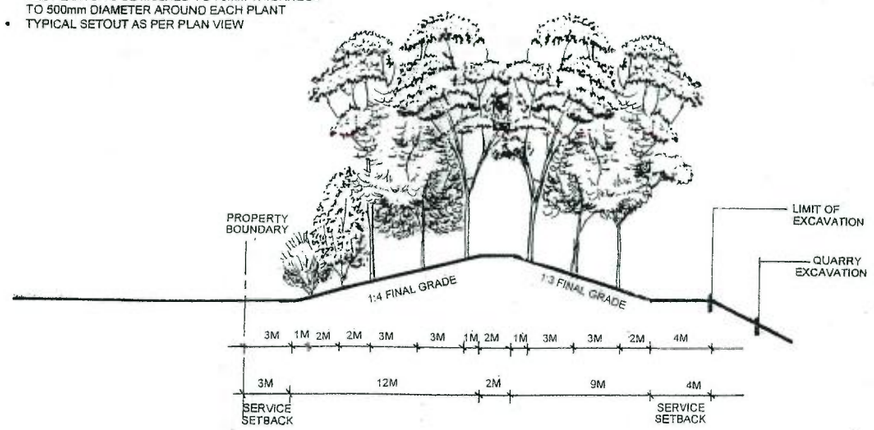
Job Number - Drawing Number: MP-01
Issue: A



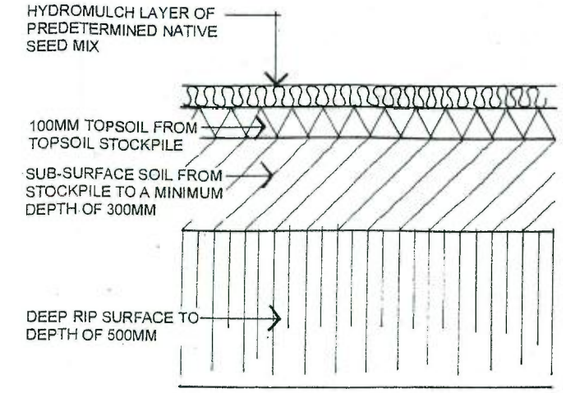
1 TYPICAL SCREEN PLANTING DETAIL WITHIN 30M SETBACK TO BOUNDARY NTS

NOTES:

- ALL PLANT SPECIES ENDEMIC TO THE SITE
- ALL PLANTS TO BE TUBE STOCK SIZE
- ALL PLANTS TO BE MULHED TO 75mm THICKNESS TO 500mm DIAMETER AROUND EACH PLANT
- TYPICAL SETOUT AS PER PLAN VIEW



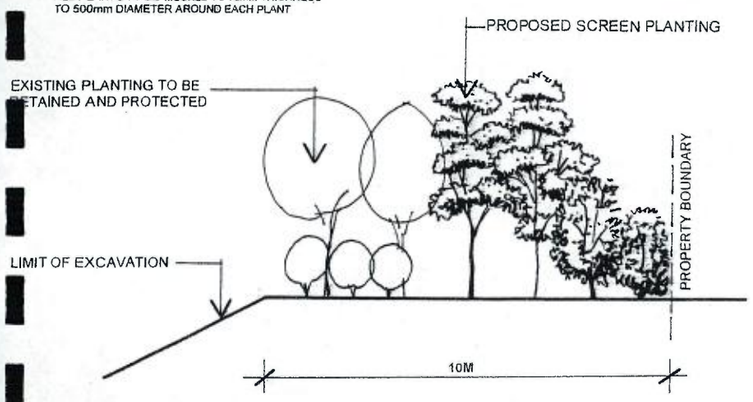
2 TYPICAL 30M WIDE BUND PLANTING DETAIL 1:200



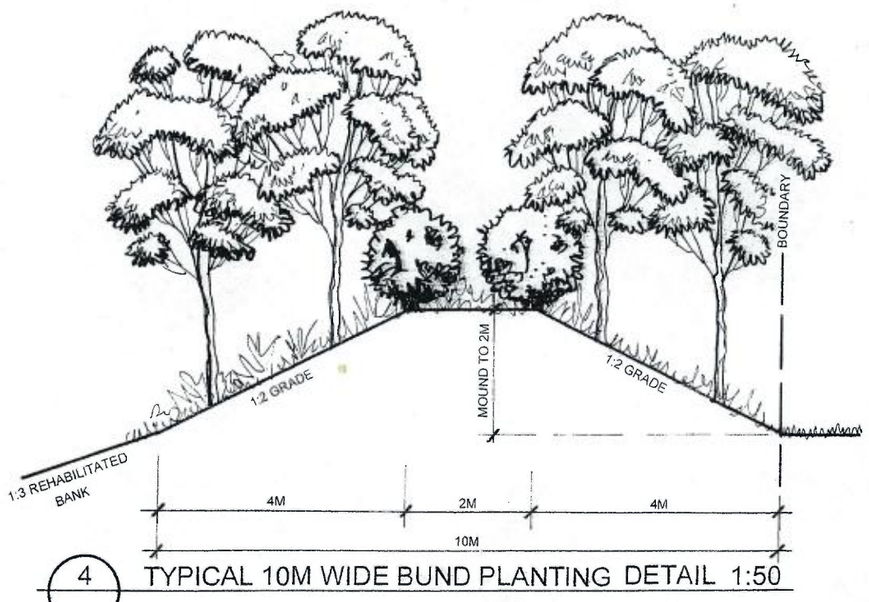
6 TREATMENT OF FINAL EXCAVATED SURFACES 1:10

NOTES:

- ALL PLANT SPECIES ENDEMIC TO THE SITE
- ALL PLANTS TO BE TUBE STOCK SIZE
- ALL PLANTS TO BE MUCHED TO 75mm THICKNESS TO 500mm DIAMETER AROUND EACH PLANT



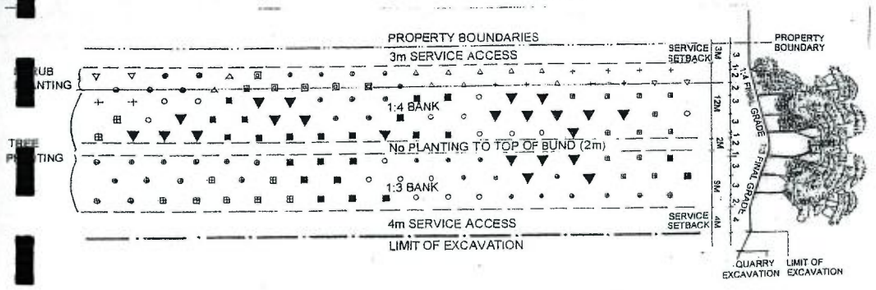
3 TYPICAL SCREEN PLANTING DETAIL WITHIN 10M SETBACK TO BOUNDARY NTS



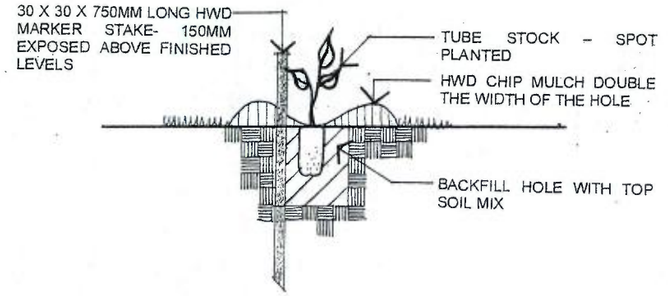
4 TYPICAL 10M WIDE BUND PLANTING DETAIL 1:50

NOTES:

- TREES & SHRUBS TO BE PLANTED IN COPSES WITH A MINIMUM NUMBER OF 5 & A MAX OF 1 PER COPSE
- PLEASE NOTE THAT THIS MATRIX IS TYPICAL & PLANTS SHOULD BE SET-OUT AS SHOWN



5 TYPICAL PLANTING SET-OUT TO BUNDS (Matrix) 1:500



7 TYPICAL TUBE STOCK PLANTING DETAIL 1:10

GRASS SEED MIX

The grass seed component of the hydromulch mix shall, depending on the season, be made up of the following grasses: -

- **Autumn / Winter Mix**

Oats	15Kg/ha
Rye Grass	10Kg/ha
White Clover	5Kg/ha
Red Clover	5Kg/ha

- **Summer / Spring Mix**

Japanese Millet	20Kg/ha
Dobson Ryegrass	8Kg/ha
White Clover	3Kg/ha
Red Clover	3Kg/ha

Grass seed mixes for areas where a permanent grass cover is required shall also contain: -

• Rhodes Grass	5Kg/ha
• Hulled Couch	5 Kg/ha

PLANT SCHEDULE

TYPE: SANDSTONE-SHALE TRANSITION FOREST

BOTANICAL NAME	COMMON NAME	ULTIMATE HEIGHT
Trees		
Allocasuarina littoralis	Black She-Oak	10M
Angaphora coslata	Smooth Barked Appie	15M
Angaphora floribunda	Rough Barked Apple	15M
Eucalyptus acmenoides	White Mahogany	18M
Eucalyptus agglomerata	Blue-leaved Stringybark	15M
Eucalyptus eugenioides	Thin leaved - Stringybark	15M
Eucalyptus gummifera	Red Bloodwood	10M
Eucalyptus notabilis	Blue Mountains Mahogany	15M
Eucalyptus punctata	Grey Gum	12M
Eucalyptus paniculata	Red Mahogany	18M
Syncarpia glomulifera	Turpentine	18M
Shrubs		
Acacia longifolia	Sydney Golden Wattle	5M
Acacia parramattensis	Parramatta Green wattle	5M
Banksia spinulosa	Short Leaved Banksia	1M
Kunzea ambigua	Thick Bush	2M
Leptospermum polygalifolium	Yellow Tea Tree	3M
Leptospermum trinerium	Cherry Ballart	3M
Hakea sericea	Bushy Needlebush	3M

North point

Issue	Rev.	Revision Description	Date
A		D.A. ISSUE	OCT 99

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MAROOTA

Title
EARTH BUNDS & PLANTING DETAILS

Scale:		SMA Proj. No:		
Drawn	Checked	Coordinated	PM Approval	Director Verification
Date				

Job Number - Drawing Number: MP-02
Issue: A

INITIAL BOUNDARY SCREEN PLANTING AND EARTH BUND WALLS (REFER PLAN MP-01 A)

10M SETBACK

10M SETBACK

CLAY DRYING AREA

EXISTING DAM

PROGRESSIVELY REHABILITATED CELLS MASS PLANTED USING INDIGENOUS NATIVE SPECIES – REFER TO PROPOSED PLANT SCHEDULE (1A,1B,1C,1D)

EXISTING DAM

FUTURE STAGE 2 EXTRACTION AREA

STAGE 1

OLD NORTHERN ROAD

EXISTING DAM

ACTIVE EXTRACTION CELL (1F)

STOCK PILE & DRYING CELL (1E)

PROTECTION ZONE FOR ENDANGERED TREES

INITIAL BOUNDARY SCREEN PLANTING AND EARTH BUND WALLS (REFER PLAN MP-01 A)

FUTURE EXTRACTION CELLS FOR STAGE 1 – (1G,1H,1I,1J,1K)

30m SETBACK

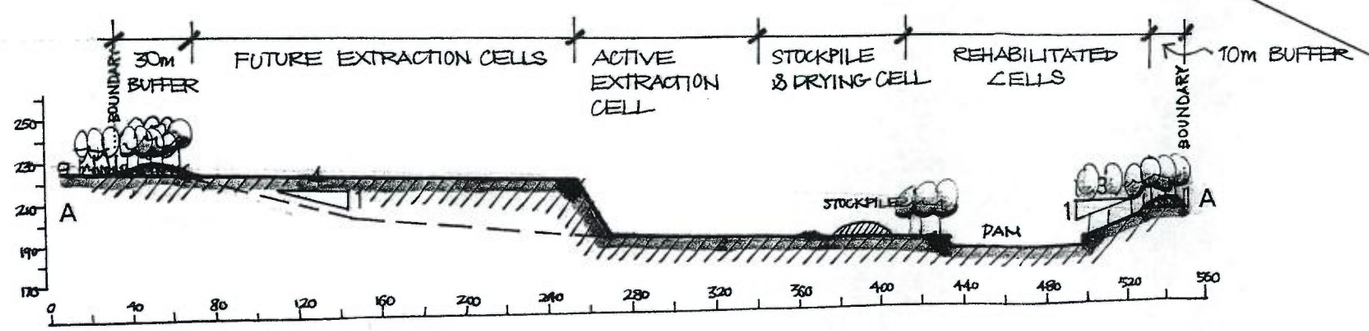
30m SETBACK

ROBERTS ROAD

INITIAL BOUNDARY SCREEN PLANTING AND EARTH BUND WALLS (REFER PLAN MP-01 A)

LEGEND

- REHABILITATED AREAS USING SELECTED NATIVE SEED
- STOCK PILE & DRYING CELL
- ACTIVE CELL
- PROTECTION ZONE FOR ENDANGERED SPECIES
- BOUNDARY SETBACK WITH MASS PLANTING USING TUBE STOCK INDIGENOUS NATIVE SPECIES
- BOUNDARY SETBACK WITH MASS PLANTED EARTH BUND WALL USING TUBE STOCK (REFER 7,MP-01 A)
- CUT / EARTH BANK
- STOCKPILES
- STAGE 1 / STAGE 2 BOUNDARY



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SCALE

North point

Issue	Rev.	Revision Description	Date
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Title

YEAR 3 PROGRESSIVE REHABILITATION PLAN & SECTION - STAGE 1 WORKS

Scale:		SMA Proj. No:		
Drawn	Checked	Coordinated	PM Approval	Director Verification
Date				

Job Number - Drawing Number: MP-03

Issue: A

10M WIDE SETBACK –
TO BE PLANTED WITH SELECTED
INDIGENOUS NATIVE PLANTS
(REFER DETAIL 3, MP-02 A)

10M WIDE EARTH BUND TO
2M HT PLANTED WITH NATIVE
VEGETATION

10M SETBACK

PROGRESSIVELY REHABILITATED
CELLS MASS PLANTED USING
INDIGENOUS NATIVE SPECIES –
REFER TO PROPOSED PLANT
SCHEDULE (2A)

STOCKPILE &
DRYING CELL (2B)

EXISTING DAM

30m SETBACK

ACTIVE EXTRACTION
CELL (2C)

**REHABILITATED
STAGE 1**

PROTECTIVE ZONE:
6 EXISTING ACACIA BYNOEANA TO
BE PROTECTED AND RETAINED

INITIAL BOUNDARY SCREEN
PLANTING AND EARTH BUND WALLS
(REFER PLAN MP-01 A)

OFFICE / ACCESS

FUTURE EXTRACTION CELLS FOR
STAGE 1 – (2D)

ROBERTS ROAD

30M WIDE SETBACK –
WITH 3M HT EARTH BUND WALL
MASS PLANTED WITH SELECTED
INDIGENOUS NATIVE PLANTS
(REFER DETAIL 2, MP-02 A)

30m SETBACK

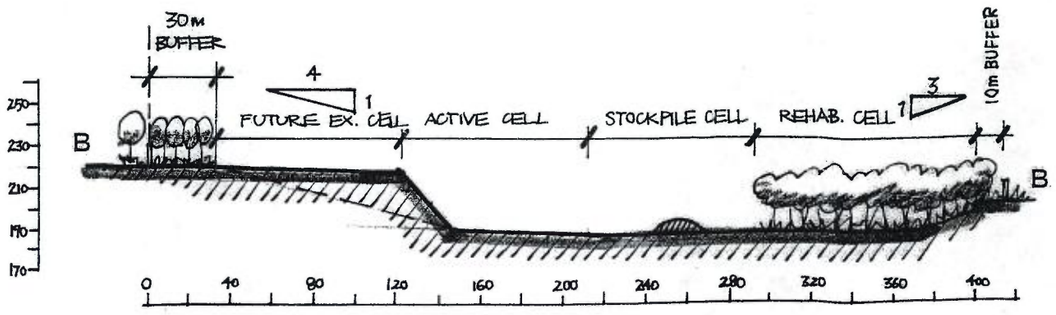
30m SETBACK

OLD NORTHERN ROAD

INITIAL BOUNDARY SCREEN
PLANTING AND EARTH BUND WALLS
(REFER PLAN MP-01 A)

LEGEND

- REHABILITATED AREAS USING SELECTED NATIVE SEED
- STOCK PILE & DRYING CELL
- ACTIVE CELL
- PROTECTION ZONE FOR ENDANGERED SPECIES
- BOUNDARY SETBACK WITH MASS PLANTING USING TUBE STOCK INDIGENOUS NATIVE SPECIES
- BOUNDARY SETBACK WITH MASS PLANTED EARTH BUND WALL USING TUBE STOCK (REFER 7,MP-01 A)
- CUT / EARTH BANK
- STOCKPILES
- STAGE 1 / STAGE 2 BOUNDARY



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SCALE

North point

Issue	Rev.	Revision Description	Date
A		D.A. ISSUE	OCT 99

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Project
**LOT 1 + 2 DP 228308
LOT 2 DP 312327
MAROOTA**

Title
YEAR 8 PROGRESSIVE REHABILITATION PLAN & SECTION - STAGE 2 WORKS

Scale:		SMA Proj. No:		
Drawn	Checked	Coordinated	PM Approval	Director Verification
Date				

Job Number - Drawing Number: MP-04
Issue: A

EXISTING NURSERY AND SHADE HOUSES TO BE RETAINED

• FACILITIES TO BE USED FOR PLANT PROPAGATION FOR USE IN SCREENING

10M WIDE SETBACK – WITH 2M HT EARTH BUND WALL MASS PLANTED WITH SELECTED INDIGENOUS NATIVE PLANTS (REFER DETAIL 4, MP-02 A)

NATIVE SCREEN PLANTING

OLD TELEGRAPH ROAD

BENCH MARK NAIL IN BITUMEN RL 209.42 AHD

1:3 GRADE PLANTED BANK

EXISTING DAM

EXISTING VEGETATION TO BE RETAINED AND PROTECTED

EXISTING BUNDING TO BE RETAINED

EXISTING VEGETATION TO BE RETAINED AND PROTECTED

PROTECTIVE ZONE: 6 EXISTING ACACIA BYNOEANA TO BE PROTECTED AND RETAINED

REHABILITATED SITE

INITIAL BOUNDARY SCREEN PLANTING (REFER PLAN MP-01 A)

1:4 GRADE PLANTED BANK

EXISTING DAM TO BE DEMOLISHED & REPLACED WITH NATIVE SCREEN PLANTING

ROBERTS ROAD

ACCESS ROAD

30M WIDE SETBACK – WITH 3M HT EARTH BUND WALL MASS PLANTED WITH SELECTED INDIGENOUS NATIVE PLANTS (REFER DETAIL 2, MP-02 A)

NORTHERN ROAD

EXISTING VEGETATION TO BE RETAINED AND PROTECTED

EXISTING DWELLING TO BE DEMOLISHED & REPLACED WITH NATIVE SCREEN PLANTING

EXISTING SIGN TO REMAIN

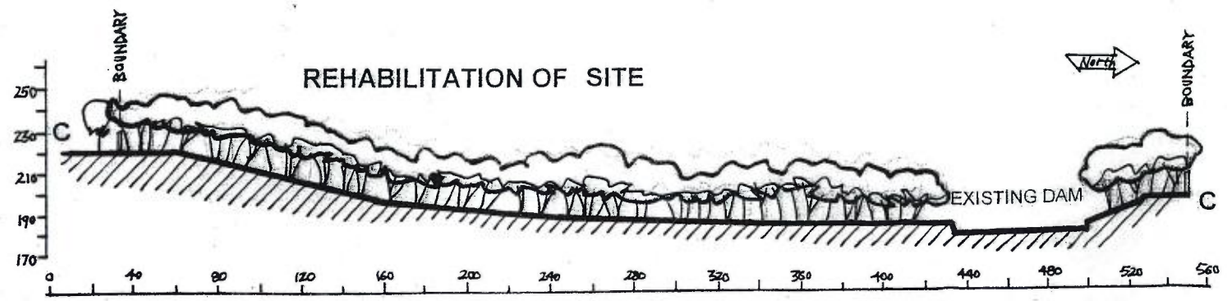
EXISTING DWELLING TO BE DEMOLISHED & REPLACED WITH NATIVE SCREEN PLANTING

BENCH MARK NAIL IN BITUMEN RL 220.27 AHD

LEGEND

- REHABILITATED AREAS USING SELECTED NATIVE SEED
- PROTECTION ZONE FOR ENDANGERED SPECIES
- CUT / EARTH BANK
- PROPOSED EARTH BUND
- PROPOSED EXTENT OF EXCAVATION

REHABILITATION OF SITE



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SCALE

North point

Issue	Rev.	Revision Description	Date
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Project

LOT 1 + 2 DP 228308
LOT 2 DP 312327
MAROOTA

Title

FINAL LANDFORM / REHABILITATION PLAN

Scale:		SMA Proj. No:		
Drawn / Date	Checked	Coordinated	PM Approval	Director Verification

Job Number - Drawing Number: MP-05

Issue: A

Strategy for Rehabilitation

for a Proposed Quarry
at Lot 2, DP 312327
and Lots 1 & 2, DP 228308
Roberts Road, Maroota

Prepared by:

Sean Harris
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August 1999

Contents

Figures

Tables

1 Introduction

This rehabilitation strategy has been undertaken by Morse McVey and Associates Pty Ltd at the request of Nexus Environmental Planning. It relates to development of a quarry at Lot 2 in DP 312327, and Lots 1 and 2 in DP 228308, Roberts Road, Maroota (figure 1). It relates to rehabilitation from an erosion control perspective only.

The strategy is based on a preliminary investigation of the soils, topography and hydrology of the site, including water quality modelling. It is understood that the information will provide input to an Extraction Program Plan and form part of an Environmental Impact Statement for the proposed development.

The report is in three parts, including:

Part 1: this introductory section
Part 2: Rehabilitation Strategy (erosion control perspective only)
Part 3: Bibliography

Field work was undertaken by the company's Mr Sean Harris on 2 March 1999. Five soil samples were taken and sent to the Department of Land and Water Conservation's Research Centre at Scone, a NATA-registered laboratory. Tests included particle size analysis (both chemical and mechanical dispersion), dispersion percentage and classification under the Unified Soil Classification System. Other physical and chemical information is taken from Murphy (1992) or the result of our own analysis. Results of these tests and some derived information are presented in Appendix 1 of the Soil and Water Management Plan.

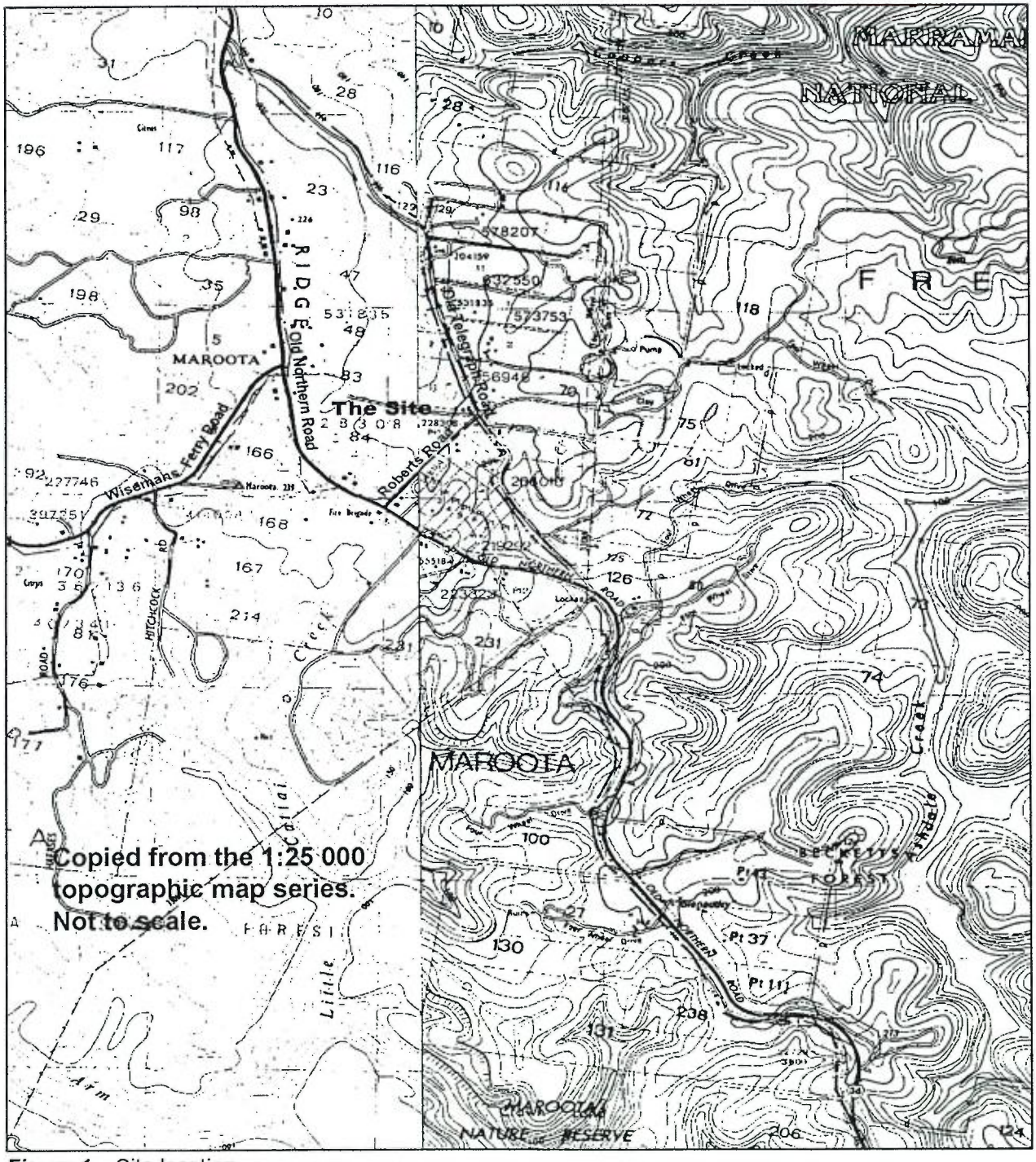

Figure 1 Site location

2 Rehabilitation Strategy (Erosion and Sediment Control Perspective)

2.1 Introduction

This Strategy should be read with Woodward-Clyde's *Conceptual Mine Plan* (1999) and, in particular, Drawings A8602019-0002-G-004 through to and including A8602019-0002-G-011 (hereafter referred to as Drawings 004 to 011). It relates to development of a quarry at Roberts Road, Maroota at:

- Lot 1 & 2 DP228308
- Lots 2 DP312327.

All soil and water management works will be undertaken following the *Soil and Water Management Plan* and in consideration of guidelines in Department of Housing (1998) (the "Blue Book") (especially Chapter 7) except where specified otherwise here.

The lands are characterised by gently undulating, long, smooth slopes up to 10 per cent gradient. Typical land uses of the surrounding properties on the Maroota Soil Landscape (Murphy, 1992) include orchards, market gardens and grazing of sheep, cattle and horses. The subject lands are under pasture.

The proposed extraction operations involve the sequential extraction of cells in two stages:

(i) starting at the northern boundary next to the process water dam and working southward to Old Northern Road; and

(ii) starting in the northwestern corner of the site and working southward to Old Northern Road.

Each cell will be approximately 200 by 50 metres wide (1 hectare in area) and it is anticipated that three extraction cells will be open at any one time. As each new cell is opened up for sand extraction, the cell where sand extraction is completed will be temporarily used for clay drying and the cell where the previous clay drying pond was located will be rehabilitated. Rehabilitation will consist of re-distribution of stockpiled topsoil and harvested clay material from the clay drying ponds.

The strategy minimises the area of disturbance and enables progressive rehabilitation. Land that has ceased to be directly involved in the extraction processes will be reshaped to suitable contours, have fertile topsoil spread over the surface, and be returned to native vegetation and ancillary uses.

It is expected that 70 percent of developed land will be revegetated with native trees and shrubs, 23 percent will be returned to unimproved pasture and 7 percent will remain as the dam. Refer to the Landscape Architect Report for the a detailed analysis of the species to be used.

2.2 Site Constraints

The key constraints to rehabilitation of the lands after the sand and gravel extraction include:

(i) on sandy soils:
- acidity in most profiles
- sodicity in all layers
- low fertility
- high permeability
- poor moisture holding capacity
- moderate sheet erosion hazards on steep slopes (>20%)
- high gully erosion hazards under concentrated flows; and

(ii) on clay soils:
- seasonal waterlogging and low wet strength
- low permeability
- high sheet erosion hazards on steep slopes (>20%)
- very high gully erosion hazards under concentrated flows.

These limitations can be relatively easily managed by:

- ensuring maximum slope gradients of:
  - 4(H):1(V) on northerly and westerly aspects
  - 3(H):1(V) on southerly and easterly aspects
- respreading the topsoil with the clay residue from the sand processing operations

2.3 Topsoil Management

2.3.1 Topsoil management will follow a general plan to strip topsoil layers from a minimum work cell area of about one hectare. Stockpiles will be formed as bunds and located as shown on Drawings 005 to 010. Bunds will not exceed 3 metres in height, with a minimum crest width of 3 metres and batters of 2(H):1(V). They will be revegetated for the duration of operations. As the excavation operations move to a new cell, stockpiled topsoil and clay from the drying ponds will be spread over the cell at the required level.

2.3.2 Before stripping topsoil, bulky vegetation will be cleared and stockpiled for respreading as mulch. Bulkier materials will be chipped before stockpiling.

2.3.3 Topsoil will be stripped in moist condition to avoid pulverisation and dust.

2.3.4 Topsoil will be removed and replaced in two layers according to its organic matter content. Organic matter is reflected in the darker colour of the upper 50 to 100 mm of soil. The darkened layer will be replaced uppermost over about 200 to 250 mm of lighter coloured material spread over a ripped surface.

2.3.5 Topsoil will be respread to an even, but roughened surface with moderate

compaction for optimum seedbed tilth.

2.3.6 Wherever revegetation of the newly spread topsoil is to be based on agricultural species, soil testing will be undertaken first to assess lime and fertiliser requirements.

2.4 Rehabilitation

2.4.1 Where practicable, schedule the construction program so that the time from starting land disturbance activities to completion of final rehabilitation (landscaping) is a duration of less than 24 months. Here, rehabilitation means achieving a C-factor (Revised Universal Soil Loss Equation) of less than 0.1 and set in motion a program that should ensure it will drop permanently, by vegetation, paving, armouring, etc. to less than 0.05 within a further 60 days. Of course, local water restrictions might affect this in drought times.

2.4.2 While C-factors are likely to rise to 1.0 during the work's Program, they should not exceed those given in Table 2.1 within the specified times.

Table 2.1 Maximum acceptable C-factors at nominated times during works

Lands	Maximum *C*-factor	Remarks
Waterways and other areas subjected to concentrated flows, post construction	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows are limited to those shown in Table 5.1 of the "Blue Book". Foot and vehicular traffic are prohibited in these areas.
Stockpiles, post clearance	0.1	Applies after ten working days from completion of formation.
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later.

Note: *working days* does not include public holidays, weekends or days when work is not possible due to wet weather.

2.4.3 The requirements of Conditions 2.4.1 and 2.4.2 can be achieved in the short term (temporary protection for up to six months) with either:

- a suitable soil binder, e.g.
  - Terra-Control® or equivalent in areas of sheet flow, e.g. topsoil stockpiles
  - anionic bitumen emulsion sprayed over hessian cloth (at 0.5 L/m^2) in areas of concentrated flow, e.g. diversion banks and waterways
- a temporary vegetative cover.

2.4.4 Where practical, phase works so that:

- minimal land is exposed to the forces of soil erosion at any one time
- site stabilisation measures are progressively installed throughout the development phase.

2.4.5 The revegetation program will ensure:

- the availability of acceptable soil materials
- correct site preparation
- the selection of the most suitable establishment techniques
- the selection of appropriate plant species, fertiliser(s) and ameliorant(s)
- the application of sufficient water for germination and to sustain plant growth if rainfall is insufficient
- an adequate maintenance program.

Proper investigation of each of these matters will be undertaken on a site-specific basis.

2.4.6 A cover crop of suitable annual cereal species will be used on areas being revegetated with native species (Table 2.2). Supplementary planting and inoculation will be undertaken if required.

2.4.7 Areas where improved grass cover are required (Table 2.2), will be limed, fertilised and sown according to seasonal recommendations of NSW Agriculture or Department of Land and Water Conservation.

Table 2.2 Plants for Revegetation

Plant Type	Selection Criteria
Perennial grasses and legumes	• dense prostrate habit capable of carrying surface water
annual cereals and grasses	• non persistence for temporary cover • quick ground cover and reduction of surface erosion hazards • cover protection for establishment of natives
native grasses	• non invasive, low maintenance for natural areas • fire tolerance, aesthetics and habitat at sites near to Marramarra National Park
native trees and shrubs	• upwind of operations • where appropriate, any rows will be placed normal to prevailing wind direction for dust prevention • sown wherever slopes exceed 33% from the horizontal • sown as screens from noisy or unsightly operations and equipment • sown as buffer to the egress of sediment toward protected environments maintained by National Parks and Wildlife Service, Department of Land and Water Conservation or like organisation.

2.4.8 Surfaces that must accept high flows will be turfed with reinforced sods so that they can safely carry design flows on completion and following Table 5.1 of the "Blue Book".

2.4.9 Areas not satisfactorily revegetated will be investigated to find out the reason for failure. Then, appropriate remedial action will be undertaken, including replacing any lost topsoil and resowing the site if required.

2.4.10 Extraction will occur within defined areas. Adequate control measures will be used to ensure that extraction operations only occur within these defined areas.

2.4.11 Clearly visible barriers will be installed to limit access to vegetative buffer zones and rehabilitation areas.

2.4.12 Control measures to minimise wind erosion will be used in disturbed areas throughout the duration of the development. Dust and site disturbance will be kept to a minimum always.

2.4.13 Once extraction for a cell is completed, backfilling of excavated areas will use clay residue and topsoil retained onsite.

2.4.14 Maintain any erosion and sediment control measures in a functioning condition until all earthworks are completed and the site rehabilitated. Where appropriate, remove soil conservation structures as the last activity in the site stabilisation program.

2.4.15 Final landform contours will endeavour to reflect the surrounding terrain.

2.4.16 Monitoring of soil conservation works will be conducted at least once per year with findings documented and submitted to council

3 Bibliography

Department of Housing (1998). *Managing Urban Stormwater: Soils and Construction.* Department of Housing, Sydney.

Ethridge, LT (1980). *Geological Investigation and Resource Assessment of the Maroota Tertiary Alluvial Deposit,* Department of Mineral Resources Geological Survey Report GS1980/201.

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Rosewell, CJ and Turner, LB (1992). *Rainfall Erosivity in New South Wales.* Technical Report No. 20. Department of Land and Water Conservation, Sydney.

Rosewell, CJ (1993). *SOILOSS, A Program to Assist in the Selection of Management Practices to Reduce Erosion.* Department of Land and Water Conservation, Sydney.

Appendix 15

NEXUS ENVIRONMENTAL PLANNING PTY LTD

REPORT ON
PROPOSED EXTRACTIVE INDUSTRY AT LOT 2, DP 312327 AND LOTS 1 AND 2. DP 228308 CNR. ROBERTS ROAD AND OLD NORTHERN ROAD,

MAROOTA

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Job No.: 9152
Report No.: 28/99

OCTOBER 1999

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- The internal access road providing access to the sand extraction operation from Roberts Road is located about 0.29 Km east of the intersection with Roberts Road / Old Northern Road.

- The existing sand extraction operation has Land and Environment Court approval for a maximum of 25 laden truck movements and 25 unladen truck movements per day.

- A twelve hour traffic count was made on 22/10/98 in Roberts Road and totalled 251 movements including 78 heavy truck movements.

- Trucks from the site travel south (40%) along Old Northern Road and west (60%) along Wisemans Ferry Road to market. Both roads are State Arterial main roads.

- Automatic counters were placed in Old Northern Road south of Roberts Road (Station 4) and in Wisemans Ferry Road west of Old Northern Road (Station 3) to record hourly traffic volumes by direction and vehicle classification on week days and weekend days. At Stations 4 and 3 the average number of heavy vehicles on a weekday was 213 and 211 respectively.

- About 80 and 91.5 percent of the 24 hour daily truck movements occurred between 6.00 am and 6.00 pm at the two Stations 3 and 4 respectively. The number of truck movements on Saturdays was 75 and 64 percent of the average weekday total at Stations 3 and 4 respectively.

- Old Northern Road and Wisemans Ferry Road have sealed pavements 6.4 metres wide and unsealed gravel shoulders varying in width from 1.5 to 2.5 metres and carry average daily volumes of 1923 and 1706 respectively and carry over 10 percent heavy vehicles. Based upon Austroads Rural Road Design standards, the desirable width of the sealed pavement should be 7 metres.

- Roberts Road has a sealed pavement 5.7 metres wide for its full length.

- The Roberts Road / Old Northern Road intersection is operating in Region A for right turns and Region B for left turns (Austroads Figure 5.23a) and provides a satisfactory level of service.

- The traffic study has addressed the RTA written requirements and transport requirements of Councils DCP No 500, and the Director General's requirements (DUAP).

EXECUTIVE SUMMARY
(continued)

- The processed materials from the quarry will be transported by 3 axle rigid trucks, 3 axle rigid trucks and dog trailers and triaxle semi trailers. The total maximum production days per year excluding Sundays total 286. The Development Application has applied for a maximum of 50 laden truck loads per day and a 5 ½ day week. Assuming an average payload of 20 tonnes per truck, the site could produce a maximum of 1000 tonnes per day and 286,000 tonnes per year of processed sand.

- About 40 percent of the trucks carrying processed material will travel south along Old Northern Road and 60 percent will travel west on Wisemans Ferry Road. The maximum number of truck movements per hour will be 20.

- The maximum daily increase in heavy trucks Monday to Friday is estimated to be 64.1 per cent on Roberts Road, 14.25 per cent on Wisemans Ferry Road at Station 3 and 9.37 per cent on Old Northern Road at Station 4.

- Assuming an annual growth rate of 2 per cent in Old Northern Road the intersection of Roberts Road and Old Northern Road will continue to operate at Level of Service A in Region A of Austroads Figure 5.23a. No improvements will be required.

1.0 INTRODUCTION

1.1 Background

This report on traffic and transportation aspects of the proposed quarry and processing operations on **Lot 2 DP 312327** and **Lots 1** and **2 DP 228308** at Maroota, has been prepared for the EIS being undertaken by Nexus Environmental Planning Pty Ltd. Maroota is located some 40 km north of Parramatta as shown in **Figure 1**, Regional Location Map.

The site of the quarry and processing operations is shown in **Figure 2** Locality Plan.

1.2 Scope of Report

This report addresses the transport issues described in Section 3 of this report and describes our investigation and findings in respect of the following matters:-

- Existing traffic volumes on the proposed haul routes.
- Estimated hourly and daily truck movements generated by the continuing operations.
- Distribution of trucks to the State Arterial Road System.
- Proposed Access to and from the site.
- Performance of Roberts Road/ Old Northern Road intersection.
- Standard of internal access road and need for improvements.
- Impacts of increased truck traffic on the State Roads and nearby residential areas.
- Safety issues and measures to improve safety.

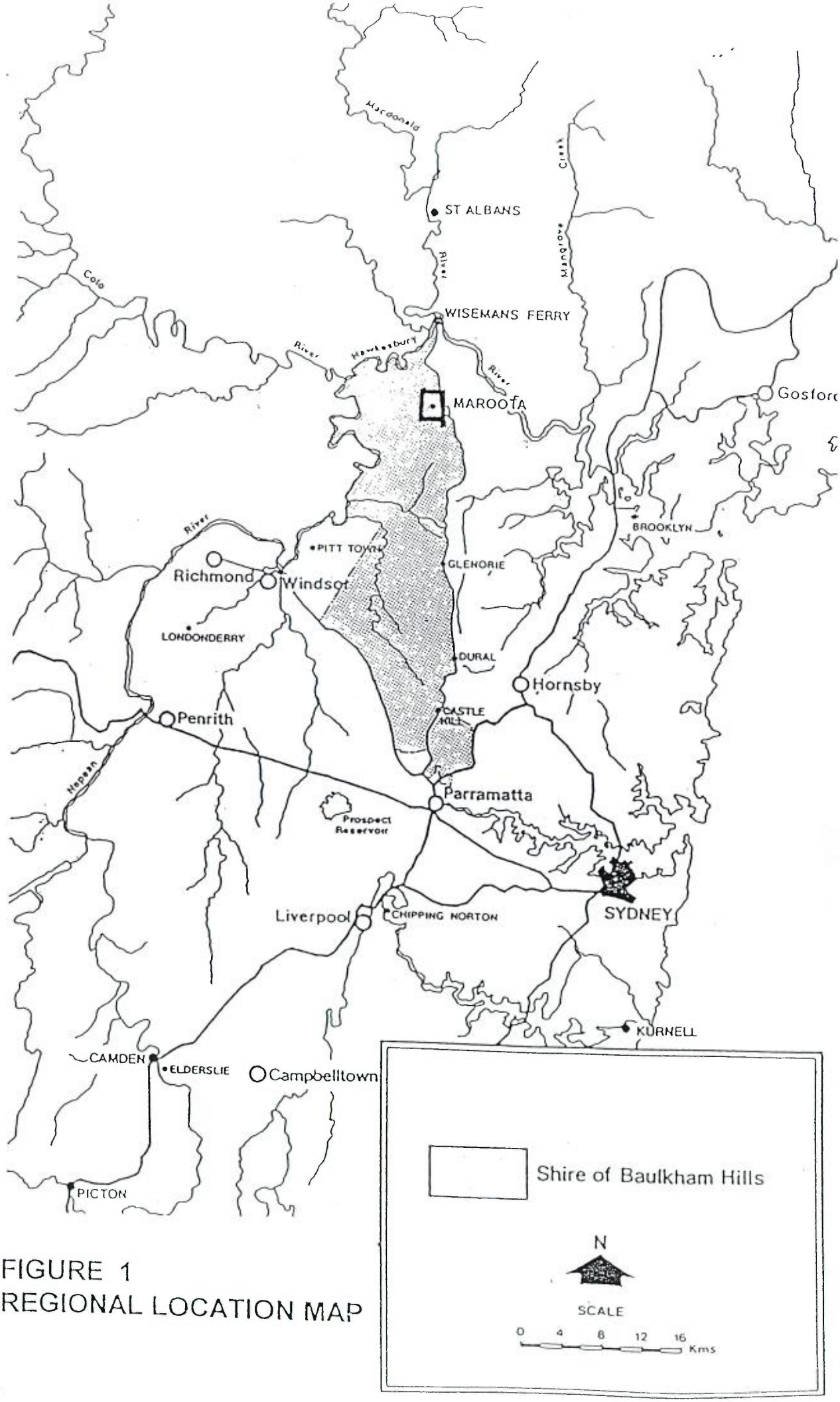
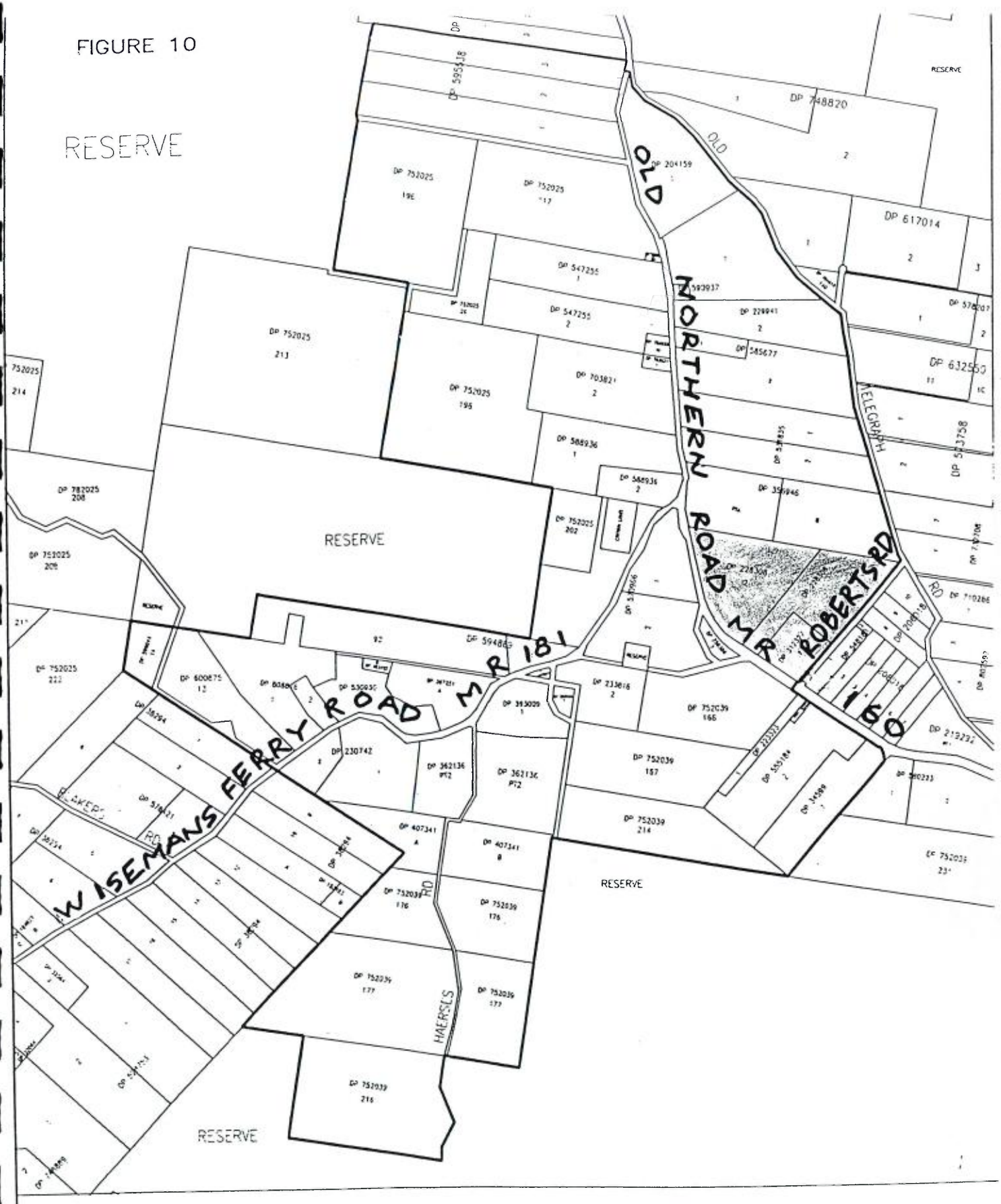


FIGURE 1
REGIONAL LOCATION MAP

FIGURE 10



N SCALE 1 : 20000 LOCALITY MAROOTA

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SUPERVISING DRAFTSMAN	L Aslin	DATE 19/8/96
PLANNING OFFICER	P Zadeion	DATE 19/8/96
FILE No. CCL.	M 12853 Pt. 1.	

FIG 2
LOCALITY PLAN LOTS 1&2 DP 228308
AND LOT 2 DP 312327

2.0 EXISTING TRAFFIC CONDITIONS

2.1 Existing Traffic Volumes

1) Old Northern Road/Roberts Road Intersection.

Twelve hour traffic volume and classification counts were made at the intersection of Old Northern Road and Roberts Road to determine the highest hourly volumes and turning movements at the intersection in order to confirm the extent and type of improvements necessary to meet RTA and Austroad Standards.

12 HOUR VOLUME

The 12 hour traffic volume was low (251) in Roberts Road and thirty one percent of the total volume (78) were heavy trucks. It is relevant to note that the number of heavy trucks allowed in the existing consent for Dr. Martin was 50 per day.

PEAK HOUR VOLUMES

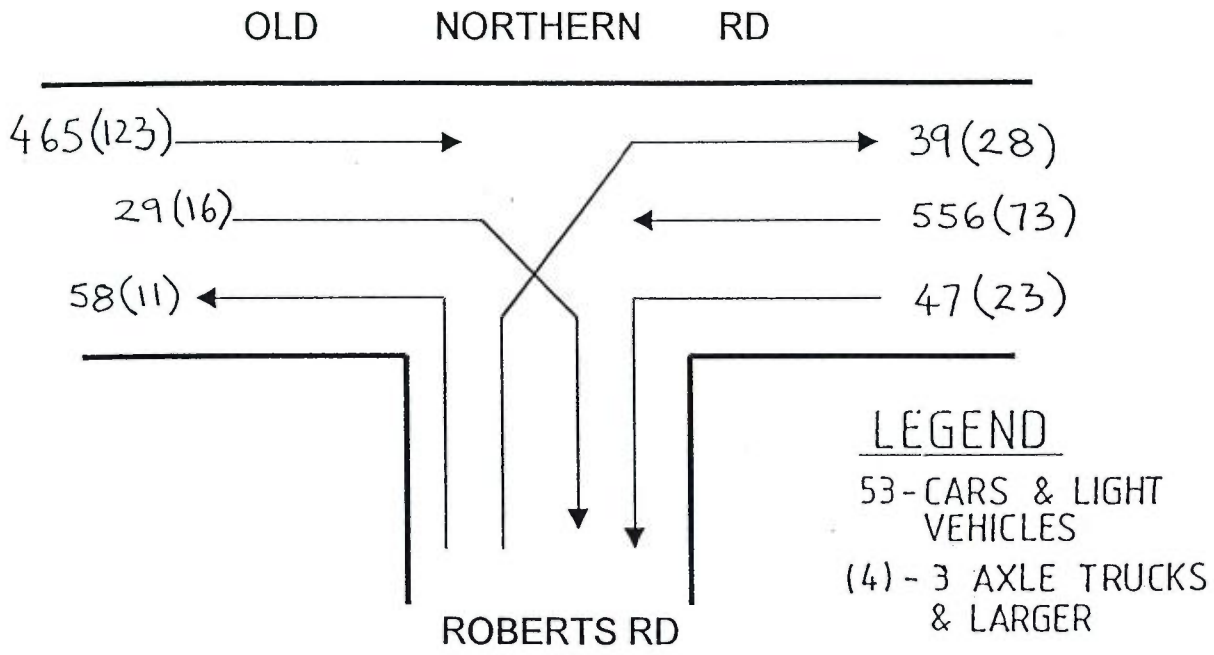
The am and pm peak hours were from 7.00 - 8.00 am and 4.30 - 5.30 pm. The two way through traffic volumes in Old Northern Road ranged from 71 vphr to 168 vphr between 6.00 am and 6.00 pm. The twelve hour count showing cars and light vehicles and heavy trucks and the two peak hour counts are shown in **Figures 3A** and **3B** respectively.

2) Weekday and Weekend Volumes on State Arterial Roads

Automatic counters were placed at two locations (See **Figure 4**) on the haul road network from the subject site to determine the time pattern and volumes of light vehicle and heavy truck movements over a full 7 days including a weekend. Light vehicles are cars and 2 axle trucks, vans etc and heavy vehicles are three or more axle trucks such as the fleet used for the transport of sand from extractive operations in the area. A classification chart is included in **Appendix D.**

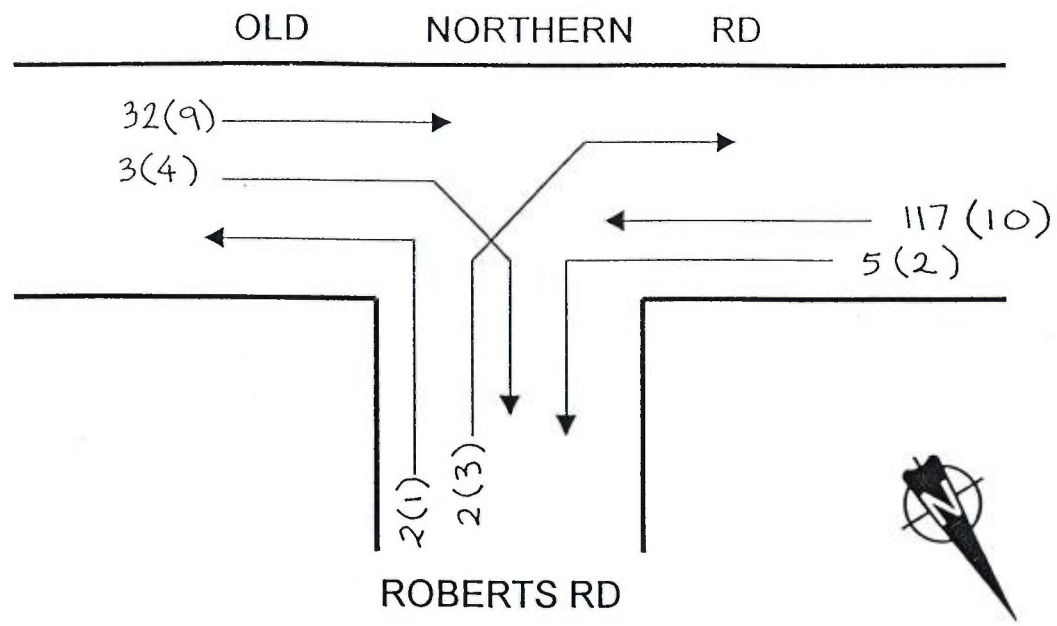
The average weekday and weekend two way daily traffic volumes at **Stations 3** and **4** were as follows:-

Average Daily Volumes	Old Northern Road MR 160 Station 4	Wiseman Ferry Road MR 181 Station 3
Average Weekday		
Total Vehicles	1923	1706
Light Vehicles	1710	1495
Heavy Vehicles	213	211
Average Weekend		
Total Vehicles	2285	1927
Light Vehicles	2178	1824
Heavy Vehicles	107	103

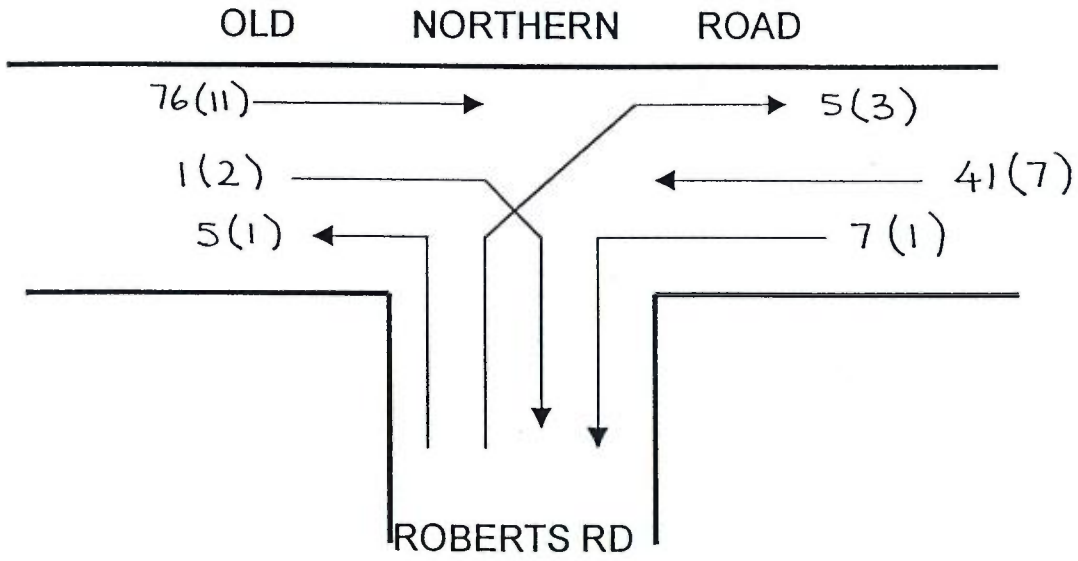


12 HOUR INTERSECTION TRAFFIC
VOLUME COUNT 6:00am – 6:00pm

FIG 3A
12 HOUR TRAFFIC VOLUMES
22-10-98



MORNING PEAK HOUR TRAFFIC
VOLUMES 7:00 – 8:00 am



AFTERNOON PEAK HOUR TRAFFIC
VOLUMES 4:30 – 5:30pm

FIG 3B
EXISTING PEAK HOUR
TRAFFIC VOLUMES
22-10-98

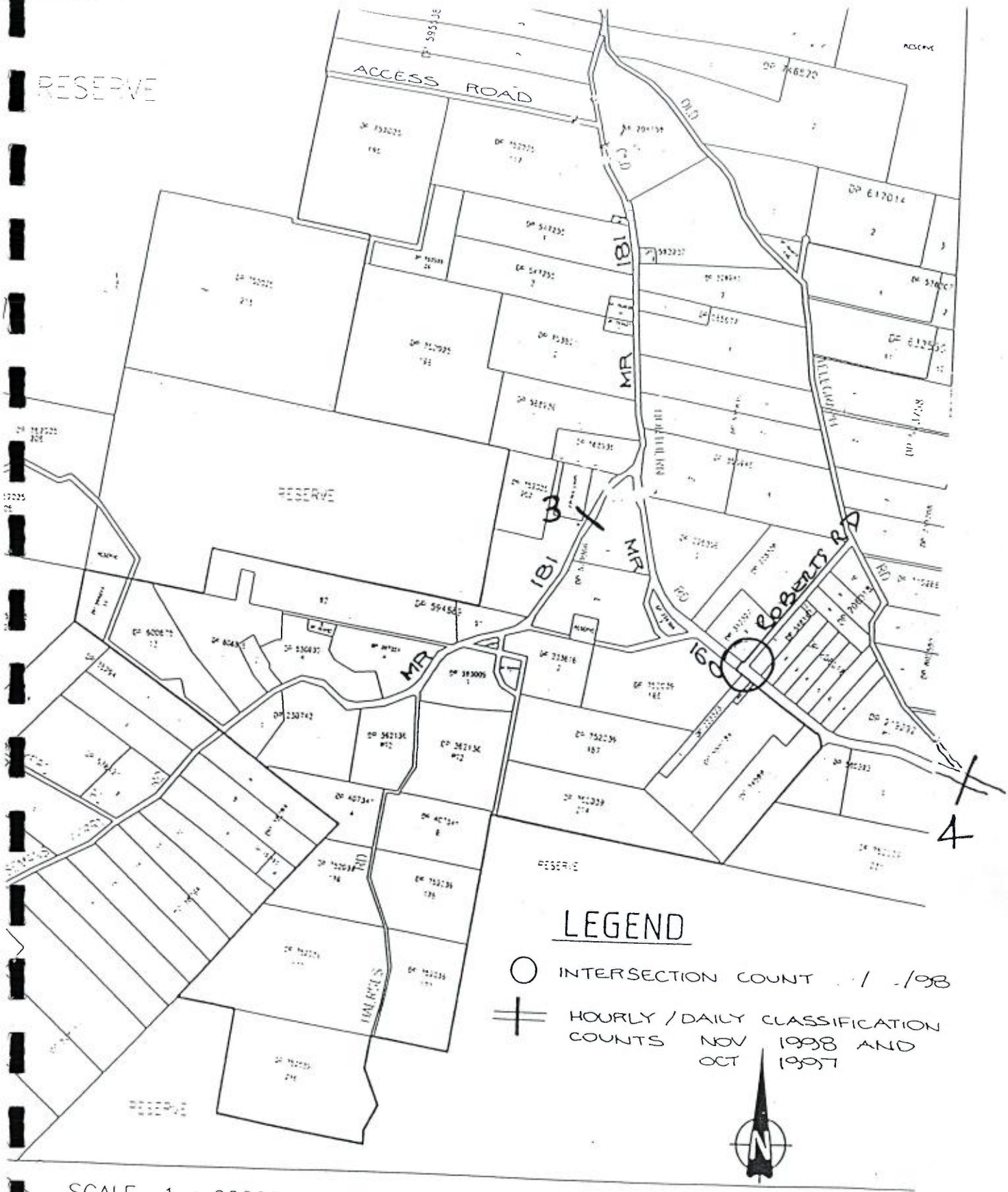


FIG 4
TRAFFIC COUNTING STATIONS

2.2 Pattern of Truck Movements on Transport Routes in Maroota

The complete counts of light and heavy vehicles for each hour of the day by direction for one week in October 1997, at survey **Stations 3** and **4** are included in **Appendix B.**

The average number of heavy truck movements Monday to Friday by hour of day from 6.00 am to 6.00 pm and for the 24 hour period at each survey location are contained in **Table C1** in **Appendix C**.

Similar data for Saturdays is contained in **Table C4** in **Appendix C.**
The main findings were:-

Station 3- **Wisemans Ferry Road**

Total heavy truck movements over 24 hours on weekdays averaged 109.4 eastbound and 101.2 westbound. However, the average truck movements over 12 hours were significantly higher westbound (95.8) compared with eastbound (70.8). The peak hourly movement westbound (average over 5 days) was 14.0 between 6.00 – 7.00am, whereas the peak hourly movement eastbound (average over 5 days) was 9.0 between 8.00 and 9.00 am.

Station 4- **Old Northern Road**

The average heavy week day truck volumes northbound were higher than southbound over 24 hours (112 compared with 101.4) and also over 12 hours between 6.00 am and 6.00 pm.

The peak hourly volume was 17.2 (average over 5 days) southbound from 6.00 am to 7.00 am. The peak hourly volume northbound (average over 5 days) was 12.8 from 10.00 am to 11.00 am.

The counts show that about 80 percent and 91.5 percent of the 24 hour daily truck movements occurred between 6.00 am and 6.00 pm at survey locations 3 and 4 respectively. The total number of truck movements on Saturdays was 75 percent of the daily Monday to Friday total at Station 3 and 64 percent at Station 4. However, the number of light vehicles was significantly greater on Sundays **(Appendix B)** at Station 4 than on other days.

2.3 Road Inventory

Old Northern Road has a sealed pavement about 6.4 metres wide and unsealed gravel shoulders which vary in width from about 1.5 to 2.5 metres. Wisemans Ferry Road is of a similar standard to Old Northern Road. The edges of the sealed pavement are subject to higher loading by heavy vehicles travelling near the edges of the road pavement and require higher maintenance to repair the broken edges. The road pavement is generally in reasonable condition.

Based upon Table 4.1 in Austroads Rural Road Design the desirable sealed pavement width in Old Northern Road and Wisemans Ferry Road is 7.0 metres because the AADT traffic volumes are well in excess of 1000 veh/day.

Photographs P2 and **P3,** indicate the general pavement conditions, shoulders and line marking in Old Northern Road, in the vicinity of Roberts Road.

Roberts Road is a sealed local road and has a pavement width of 5.7 metres. The pavement condition, geometric alignment and line marking are shown in **Photograph P5.** The internal access road to the sand extraction site is located on the northern side of Roberts Road about 290 metres east of Old Northern Road.

2.4 Operation of Roberts Road/Old Northern Road Intersection.

This intersection has been up-graded recently to provide a sheltered right turn bay in Old Northern Road as shown in **Photograph P4**. The pavement striping continues on the northern side of Roberts Road as shown in **Photograph P6**. The full extent of pavement markings south and north of Roberts Road can be seen in **Photograph P1**.

A layout of Roberts Road and Old Northern Road Intersection has been compiled from site measurements and is drawn to scale in **Figure 5.**

An analysis of the performance of the intersection under existing am and pm peak hour volumes from **Figure 3B** has been made using INTANAL Version 3.17. The intersection is operating at Level of Service A in both peak hours as shown in Table 2.4

TABLE 2.4

INTANAL RESULTS
Old Northern Road / Roberts Road

Scenario	Peak Hour	DoS	LoS	Max Delay (sec/veh)	Critical Movement
Existing	Am	0.01	A	7.7	Right turn from Roberts
	Pm	0.02	A	7.0	Right turn from Roberts

NOTE: **DoS** Degree of Saturation
LoS Level of Service

PHOTO P2 - View south along Old Northern Road from northern end of striped median about 130 metres north of Roberts Road. Opening in median at Roberts Road on left.

PHOTO P3 - View south along Old Northern Road from end of striped median about 124 metres south of Roberts Road

PHOTO P5 - View east along Roberts Road from Old Northern Road.

PHOTO P4 - View south along Old Northern Road from Roberts Road.

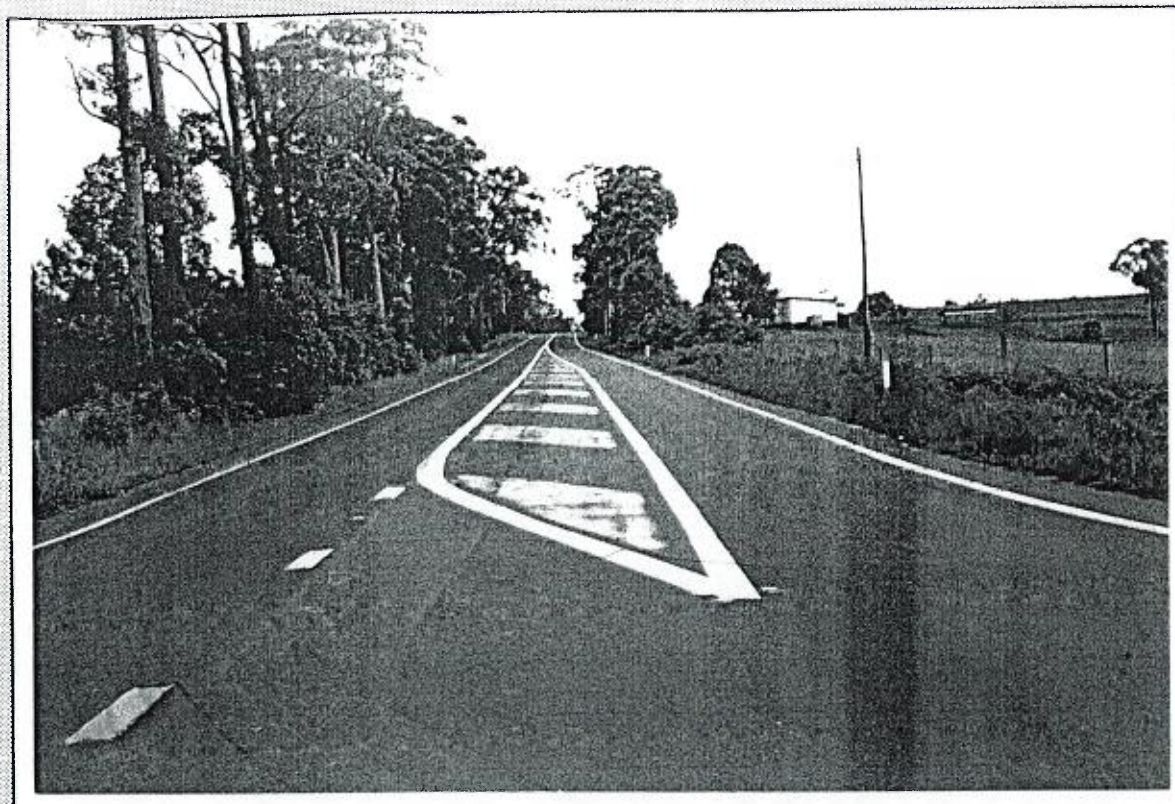


PHOTO P6 - View north along Old Northern Road from Roberts Road.

PHOTO P1 - View north along Old Northern Road from southern end of striped median. Opening in median at Roberts Road on right.

2.5 Vehicle Access to Site

The site entry gate is on the northern side of Roberts Road and is located some 290 metres east of Old Northern Road. The sight distance from the entry road is excellent in both directions along Roberts Road.

The entry road is an unsealed gravel road.

3.0 TRANSPORT ISSUES TO BE ADDRESSED

3.1 RTA Requirements

The following requirements were contained in a letter dated 1/10/98 from the Development Impact Leader, Road Safety and Network Branch, RTA to Nexus Environmental Planning Pty Limited:-

"The Roads and Traffic Authority would like to see the EIS address the following matters:

1. ***the proposed means of access to/from the site. The RTA would request that the new development only gain access via Roberts Road. A right turn bay currently exists on Old Northern Road, depending on the amount of generated traffic the RTA may require the developer to extend the right turn bay;***
2. ***likely daily traffic movements generated by the development;***
3. ***an assessment of the likely impact of truck traffic upon nearby residential areas;***
4. ***details of the anticipated route of trucks through the metropolitan road network; and***
5. ***the number of employees on site and the possibility of developing a transport management plan to reduce the total number of private vehicle trips to an from the site."***

3.2 Baulkham Hills Shire Council DCP No 500

In a letter dated 24/9/98 to Nexus Environmental Planning, the Manager Development Control, Baulkham Hills Shire Council advised that extractive industries are permissible with Council Consent within a Rural 1(b) zone in Baulkham Hills LEP 1991. The subject sites also fall within the boundaries of Sydney Regional Environmental Plan (SREP) No. 9 (Extractive Industry (No 2) which identifies the Maroota Area as having a valuable mining resource.

In accordance with the Environmental Planning and Assessment (EP & A) Regulation 1994 (as amended), the proposed designated development application is required to be accompanied by an Environmental Impact Statement (EIS).

Among the matters required to be addressed was the following related to transport namely:-

- Summary of proposal against Baulkham Hills Development Control Plan No. 500 – Extractive Industries; a copy of **Section 2-3 Transport** which specifies Element Objectives, Performance Criteria and Prescriptive

3.2 (continued)

Measures is included in **Appendix E** to this report. Reference under Prescriptive Measures is made to **State Environmental Policy No 11 – Traffic Generating Developments** and this document is also included in **Appendix E**

3.3 Director-General's Requirements, Department of Urban Affairs and Planning

These requirements were included in a letter dated 24/7/98 from the Acting Director Sustainable Development and Assessment to Nexus Environmental Planning Pty Limited.

The Key Issues referred to Baulkham Hills DCP No 500 - Extractive Industry and the Departments EIS Guideline "Extractive Industries Quarries". The relevant part of the latter document which deals with traffic and road Issues is reproduced as follows:-

E. The environmental issues

The following specific issues are nominated as being potentially important when assessing impacts, and for decision-making in relation to quarries. The outline of the issues is not exhaustive and the degree of relevance of each will vary. The EIS should only deal with relevant issues as applicable to the particular proposal.

Assessment of potential impacts

The following should be included for any potential impact which is relevant for the assessment of a specific proposal:

- **a description of the existing environmental conditions (baseline conditions)**
- **a detailed analysis of the potential impacts of the proposal on the environment; the analysis should indicate the level of confidence in the predicted outcomes and the resilience of the environment to cope with the impacts**
- **the proposed mitigation, management and monitoring program, including the level of confidence that the measures will effectively mitigate or manage the impacts.**

With each issue, the level of detail should match the level of importance of the issue in decision-making.

3.3 Continued

1. Traffic and road issues.

A traffic impact study should be undertaken for all operations involving significant numbers of truck movements including:

a) the estimated average and maximum hourly, daily and weekly truck movements: proposed truck types and sizes; if trucks will arrive or leave in convoy or queue to enter the site or need to wait outside the quarry gate.
b) proposed truck routes and possible alternative routes or transport modes, e.g. conveyer belts, rail
c) the physical condition of the roads or bridges on the proposed routes and upgrading proposals
d) the measures to prevent sediment transport off-site via transport vehicles including shakedown areas or properly controlled truck wash facilities
e) the potential impact on the road maintenance program
f) road safety issues; include:
   i) other major road users, peak periods of use and potential conflicts; use of the truck routes by school buses and the location of schools and bus stops
   ii) any sight distance constraints for:
   - turning traffic into or from the quarry access road
   - any relevant uncontrolled intersections, road junctions or railway crossings

   iii) proposed measures to improve safety including:
   - any possible realignment of roads
   - any need to improve sight distance or intersections or crossings
   - any need to restrict hours of truck movement, the number of trucks per day or the load size on certain routes.

4.0 THE FUTURE EXTRACTION AND PROCESSING OPERATIONS

4.1 Extraction and Processing Operations

The existing activities are described in **Section 2** of the **Report on the Conceptual Mine Plan**, prepared by Woodward-Clyde for Nexus Environmental Planning Pty Limited.

A reduced copy of the Detail and Contour Plan Lots 1 and 2 DP 228308 and Lot 2 DP 312327 prepared by William L. Backhouse, surveyors is included as **Figure 6.**

The site infrastructure comprises a site office, weighbridge and a processing plant. Sand materials are currently excavated from a shallow open pit (located near the northern boundary) using sluicing and dredging methods. The soil/water slurry is pumped to the processing plant where the sand is separated (washed and screened) and stockpiled. The sand is sold and transported off-site for use as building material. The residue clay slurry is pumped from the plant into sedimentation ponds and then into drying beds from which the clay soils are dredged and stockpiled separately. Liberated water from the ponds/beds is drained back into the excavation pit for re-use in the process operation.

4.2 Production Rate of Processed Sand

The future extraction operations are described in **Section 4** of the **Report on the Conceptual Mine Plan**, prepared by Woodward-Clyde and are to involve the following:-

"a) Sand materials are to be excavated using self-loading scrapers and transported to the process plant. In areas where the underlying sands/clays cannot be effectively excavated using the scrapers, the surface would be initially ripped using a dozer.

b) Process water for washing/screening will be primarily sourced from a water dam constructed at the location of the existing excavation pit (adjacent to the northern boundary). A suitable pump-out facility will be installed adjacent to the dam perimeter to meet process demands.

c) Processed sand is to be stockpiled adjacent to the plant area prior to transportation off-site using articulated highway trucks. Front-end loader/s are to be used to load the trucks.

d) The residue clay/silt slurry is to be delivered by gravity to designated drying areas in previously mined areas. During later

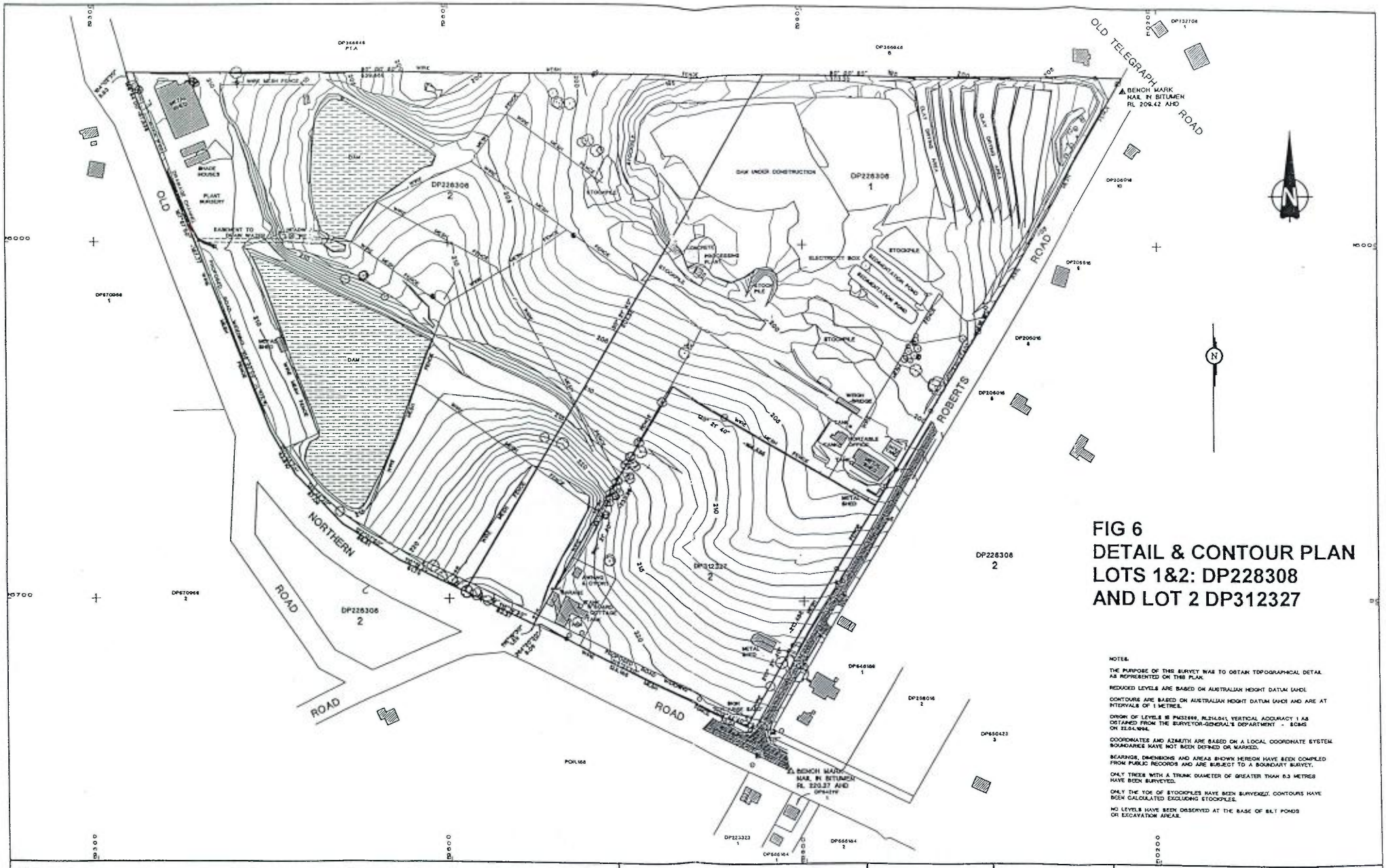


FIG 6
DETAIL & CONTOUR PLAN
LOTS 1&2: DP228308
AND LOT 2 DP312327

NOTES.

THE PURPOSE OF THIS SURVEY WAS TO OBTAIN TOPOGRAPHICAL DETAIL AS REPRESENTED ON THIS PLAN.

REDUCED LEVELS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD).

CONTOURS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD) AND ARE AT INTERVALS OF 1 METRES.

ORIGIN OF LEVELS IS PM32699, RL214.041, VERTICAL ACCURACY 1 AS OBTAINED FROM THE SURVEYOR-GENERAL'S DEPARTMENT - SCIMS ON 22.04.1994.

COORDINATES AND AZIMUTH ARE BASED ON A LOCAL COORDINATE SYSTEM. BOUNDARIES HAVE NOT BEEN DEFINED OR MARKED.

BEARINGS, DIMENSIONS AND AREAS SHOWN HEREON HAVE BEEN COMPILED FROM PUBLIC RECORDS AND ARE SUBJECT TO A BOUNDARY SURVEY.

ONLY TREES WITH A TRUNK DIAMETER OF GREATER THAN 0.3 METRES HAVE BEEN SURVEYED.

ONLY THE TOE OF STOCKPILES HAVE BEEN SURVEYED. CONTOURS HAVE BEEN CALCULATED EXCLUDING STOCKPILES.

NO LEVELS HAVE BEEN OBSERVED AT THE BASE OF SILT PONDS OR EXCAVATION AREAS.

LEGEND

BENCH MARK	△	PIPE INVERT	
COMMUNICATIONS PIT		POWER POLE	○
DUST GAUGE		SIGN	
GAS MARKER		TREE	
MANHOLE			
MONITORING WELL		WATER SERVICE	

DETAIL SURVEY
LAND CONTAINED IN CERTIFICATE OF TITLE
1/228308, 2/228308 & 2/312327.
OLD NORTHERN ROAD
MAROOTA
IN THE LOCAL GOVERNMENT AREA OF
BAULKHAM HILLS
RE: NEXUS ENVIRONMENTAL PLANNING

RATIO NTS	SURVEYED BA, DM & PC.
LEVEL DATUM AHD	DRAWN BW
DATE 14.01.1999	CAD FILE CH3160S1.DWG
SHEET 1 OF 1	REFERENCE CH3160

WILLIAM L. BACKHOUSE Pty. Limited
REGISTERED SURVEYORS, PLANNERS & DEVELOPMENT CONSULTANTS.
ACN 003 000 708
Suite 8, 38 Brookhollow Ave.,
Norwest Business Park, Baulkham Hills
P.O. Box 601 Castle Hill 2154
DX 8483 Castle Hill
Telephone: (02) 9634 2566
Facsimile: (02) 9899 4286
e-mail: wlbhouse@ozemail.com.au

4.2 (continued)

stages, it is envisaged that the slurry will be pumped as these stages will be at higher elevation than the plant. Liberated/free water will be drained into the water dam for re-use in the process plant. The stockpiled clay materials will be used for the rehabilitation of the mined ares."

The mine will operate 5 ½ days per week. The total maximum production days per year total 286.

The Development Application has applied for a maximum of 50 laden truck loads per day. Assuming an average payload of 20 tonnes the site could produce a maximum of 1000 tonnes per day and 286,000 tonnes per year. However, the effects of adverse weather conditions and variable market demand could reduce the daily production to an average of 600 tonnes in 30 truck loads.

The processing plant, sand stockpile, access road, weighbridge, site office and site entrance will be located as shown in **Figure 7.**

4.3 Estimated Daily Truck Movements

Processed material will be transported to market in rigid 3 axle trucks, 3 axle rigid trucks and dog trailers and triaxle-axle semi trailers. Based upon previous records, it is expected that the average laden truck leaving the site will initially carry 20 tonnes payload of processed material.

The proposed daily operating hours at the site will be 6.00 am to 6.00 pm, Monday to Friday and 6.00 am to 1.00 pm on Saturday. A maximum of 50 laden truck movements per day is applied for. This will amount to an annual total of 286,000 tonnes of processed sand.

4.4 Distribution of Trucks to Main Road System

We have been advised that 40 per cent of trucks carrying processed material from the site will travel south along Old Northern Road. These trucks will pass through survey **Counting Station 4** in Old Northern Road.

The remaining 60 percent of trucks will travel west on Wisemans Ferry Road and pass through **Counting Station 3**

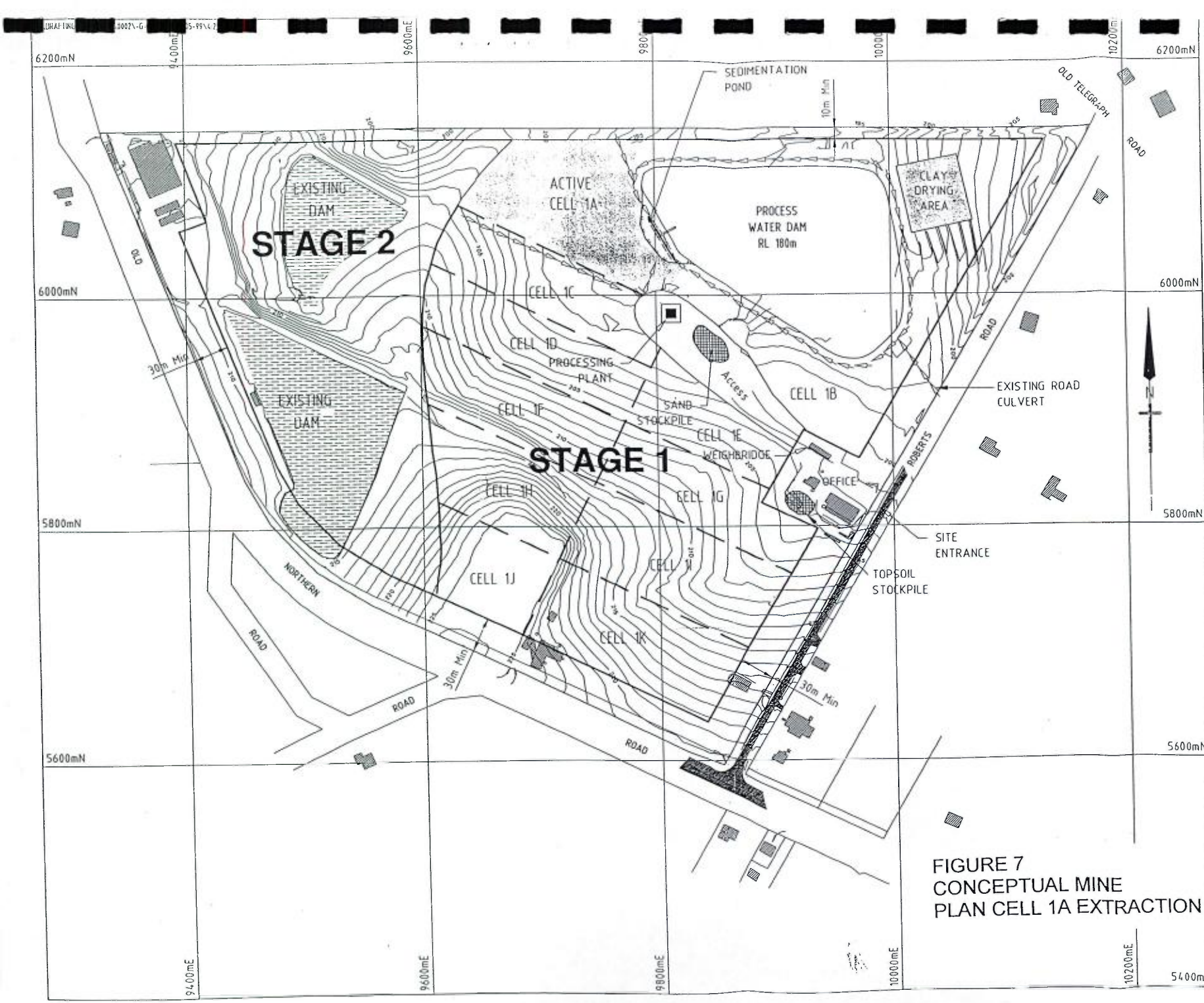


FIGURE 7
CONCEPTUAL MINE
PLAN CELL 1A EXTRACTION

DRAWN IBS REVISION B
CHECKED SCALE 1 : 1500
APPROVED CAD FILE No -G-005
STATUS FINAL DATE

LEGEND

STORMWATER COLLECTION DRAINS

ACTIVE CELL AREA

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED REGISTERED SURVEYORS & PLANNERS DETAIL SURVEY LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327 OLD NORTHERN ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	AMENDMENTS	IBS	JUNE 99

0 20 40 60 80 100 120
SCALE - 1 : 1500 (Metres) (A1)

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT
LOT 1 & 2, DP228308, LOT 2, DP312327, MAROOTA
DEVELOPMENT APPLICATION
CONCEPTUAL MINE PLAN

TITLE
CELL 1A EXTRACTION

A3

Woodward Clyde

4.4 (Cont...)

The number of laden and unladen trucks travelling in Wisemans Ferry Road and Old Northern Road has been estimated for each hour of the day Monday to Friday between 6.00 am to 6.00 pm and Saturdays between 6.00 am and 1.00 pm, based upon the 60/40 split. The increased hourly truck movements from and to the site are as follows:-

TIME PERIOD		INCREASED NUMBER OF LADEN AND UNLADEN TRUCKS PER HOUR.		
		MONDAY TO FRIDAY	SATURDAY	
6.00 am - 7.00 am	-	6	6	(6am-7am)
7.00 am - 8.00 am	-	6	4	(7am-8am)
8.00 am – 5.00 pm	-	4	4	(8.00-11.00 am)
5.00 pm – 6.00 pm	-	2	2	(11am-12noon)
			1	(12 noon-1pm)
Total Daily		50	25	

The increased volumes of development generated trucks are shown in **Table C2** (Monday to Friday) and **Table C5** (Saturday). Existing and increased development truck volumes are shown in **Table C3** (Monday to Friday) and **Table C6** (Saturday).

The access road from the site to Roberts Road and the site entrance are shown in the Conceptual Mine Plan prepared by Woodward-Clyde and included as **Figure 7** in this report.

4.5 Projected Increase in Hourly and Daily Truck Movements on Main Road Network

As shown in **Table C3** the maximum hourly generation rates inbound and outbound through Roberts Road on an average weekday will be between 3.00 am and 4.00 pm Monday to Friday. The truck movements are expected to be lower in the peak direction of flow during the normal 7.00 am to 8.00 am peak hour and in both directions in the 4.30 pm to 5.30 pm commuter peak hour.

During busy times the site could generate up to a maximum of 50 laden and 50 unladen truck movements per day and the corresponding peak hourly rate would be 10 laden out and 10 unladen returning between 6.00 am and 7.00 am on weekdays as shown in **Table 4.5**. However, since the applicant currently has approval for a maximum of 25 laden and 25 unladen trucks daily, the estimated maximum daily increase will be 25 laden and 25 unladen trucks. The estimated hourly increase in laden and unladen trucks is contained in **Table C2** in **Appendix C.**

4.5 Projected Maximum Hourly and Daily Truck Movements on Main Road Network (Cont...)

TABLE 4.5 Maximum Hourly Truck Movements

TIME	IN (Empty)	OUT (Loaded)
6-7 am	10	10
7-8 am	8	8
8-9 am	5	5
9-10 am	3	3
10-11 am	3	3
11-12 am	3	3
12-1 pm	3	3
1-2 pm	3	3
2-3 pm	3	3
3-4 pm	3	3
4-5 pm	3	3
5-6 pm	3	3
TOTAL	50	50

NOTE: MAXIMUM 20 MOVEMENTS PER HOUR IN ANY HOUR AFTER 7. AM.

The generation rates for Saturdays will be lower than weekdays. There will be no truck traffic generated on Sundays.

The existing trucks, estimated increased development trucks and total trucks by direction by hour of the day, are shown in Tables C1, C2 and C3 for weekdays and in Tables C4, C5 and C6 for Saturdays.

The number of existing daily truck movements Monday to Friday (averaged) and Saturdays, increase generated by the proposed Development and total heavy truck movements are shown in **Table 4.6.**

Since pavement design thicknesses are based upon the expected number of equivalent standard axle loadings it is relevant to consider the increase in heavy truck movements.

The figures have been totalled to show the increase for a full week (7 days) at each counting station location and the percentage increase compared with existing heavy truck volumes at each location.

Table 4.6 Increased Heavy Truck Traffic Generated by Development on Weekdays and Saturdays

PERIOD	ROBERTS ROAD		
Monday to Friday (5 days)	Exist 390	Increase 250	Total 640
Saturday	12	25	37

Table 4.6 (continued)

PERIOD	WISEMANS FERRY ROAD STATION 3			OLD NORTHERN ROAD STATION 4		
	Exist	Increase	Total	Exist	Increase	Total
Monday to Friday (5 days)	1053	150	1203	1067	100	1167
Saturday	158	15	173	134	10	144

Summary	Daily Increase In Heavy Trucks			
	Monday to Friday		Saturday	
Route	Number	Percent	Number	Percent
Roberts Road	50	64.1	25	208.3
3 Wisemans Ferry Road west of Old Northern Road	30	14.25	15	9.49
4 Old Northern Road south of Roberts Road	20	9.37	10	7.46

4.6 Operation of Roberts Road / Old Northern Road Intersection

Allowing for variations in weather and market demand, the resource extraction is likely to be completed within fifteen years. Based upon an annual growth rate of 2 percent in Old Northern Road through traffic volumes could increase by 34.6 per cent over fifteen years. The maximum hourly distribution of trucks to and from the site assuming a similar pattern to the existing site and hourly limits as stated in Section 4.4 are listed in Table C2 for Mondays to Fridays and Table C5 for Saturdays.

The estimated maximum future peak hour volumes in 15 years, expressed in (passenger car units) pcu's at the intersection of Roberts Road and Old Northern Road are shown in **Figure 8.**

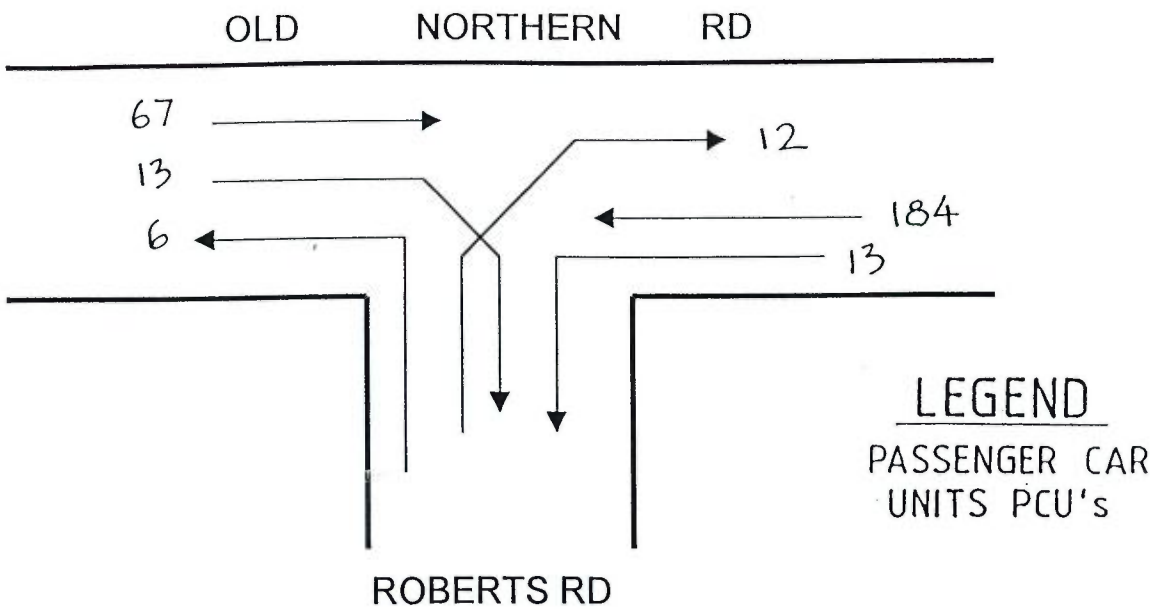
Using INTANAL Analysis the intersection will continue to operate at Level of Service A . The results are as tabulated below:-

SCENARIO	PEAK HOUR	Dos	Los	Max Delay Sec/veh	Critical Movement
Future	am	0.02	A	8.2	Right Turn From Roberts
	pm	0.02	A	7.2	Right Turn from Roberts

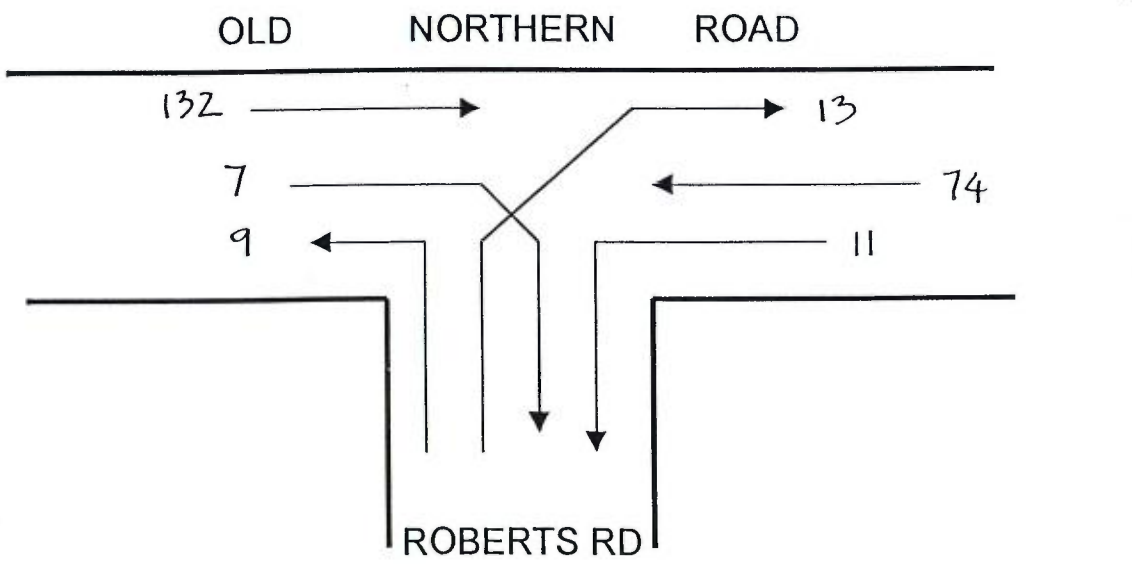
NOTE: EACH TRUCK FACTORED BY 2 TO ACHIEVE EQUIVALENT PASSENGER UNITS FOR ANALYSIS PURPOSE.

4.7 Internal Access Road

Based upon Section 2.3 Transport in Baulkham Hills shire Council DCP No. 500, the standard of construction of the Internal Access Road should have a carriageway width of 12 metres as shown in **Figure 4** of that document. A carriageway width of 10 metres is recommended as discussed in Section 5.1.



MORNING PEAK HOUR TRAFFIC
VOLUMES 7:00 – 8:00 am



AFTERNOON PEAK HOUR TRAFFIC
VOLUMES 4:30 – 5:30pm

FIG 8
FUTURE PEAK HOUR TRAFFIC VOLUMES

5.0 TRAFFIC IMPACTS OF PROPOSED DEVELOPMENT

5.1 Internal Access Road

The internal access road will extend from the site entrance in Roberts Road to the processing plant as shown in **Figure 7.** The existing access road is in poor condition and needs to be upgraded. Off road type vehicles such as scrapers do not use this road and therefore the road pavement should be designed for heavy trucks. On an average weekday over the estimated 15 year life of the project, the number of heavy truck movements will be 60 per day. Although the future total traffic volumes will be less than 100 vehicles per day the percentage of heavy trucks will be around 60 per cent and therefore a pavement width of 7 metres should be provided based upon Austroads **Table 4.1** Traffic Lane Widths for Undivided Sealed Roads.

It is desirable that the road pavement be sealed with a hot flush bitumen seal to eliminate dust. A suitable typical cross section for the internal haul road is shown in **Figure 10.** It is recommended that the road be signposted for 60 km/hour operation for safety and environmental reasons.

5.2 Operation of Roberts Road/Old Northern Road Intersection

Traffic counts over a number of years show that Annual Average Daily Traffic Volumes in Old Northern Road at Maroota are increasing at 2 per cent per annum. The estimated intersection turning volumes at Roberts Road / Old Northern Road on a week day after 15 years are shown in **Figure 8.**

An INTANAL analysis contained in Section 4.6, shows that the current intersection which has been upgraded recently to include a sheltered right turn bay will continue to operate at Level of Service A to the end of the project.

The sight distance in Old Northern Road and south of Roberts Road as indicated in **Figure 5** and **Photographs P4** and **P6** are considered satisfactory for the sign posted speed of 100 Km/hour.

No intersection improvements except for double centreline markings in Roberts Road for 30 metres from Old Northern Road are required.

5.3 Increased Truck Traffic in Main Road System

The increase in heavy truck traffic generated by this development is estimated to be 30 truck movements per day (Monday to Friday) in Wisemans Ferry Road west of Old Northern Road and 20 truck movements per day in Old Northern

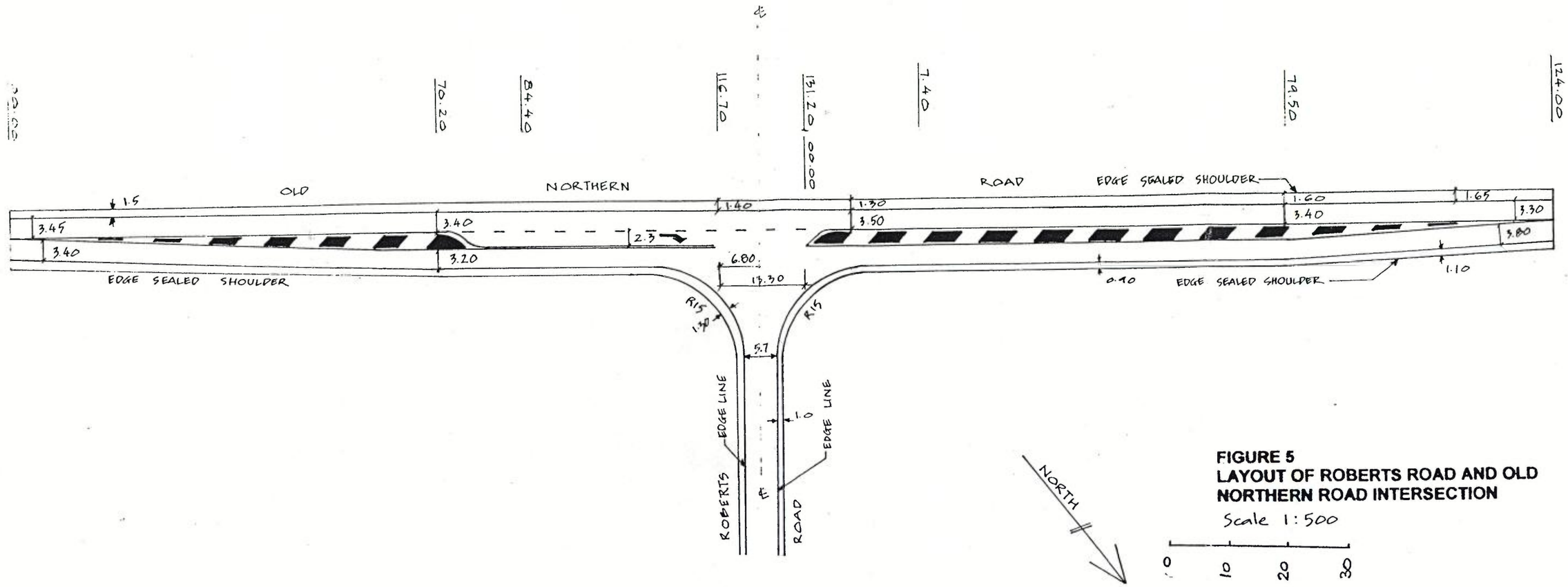
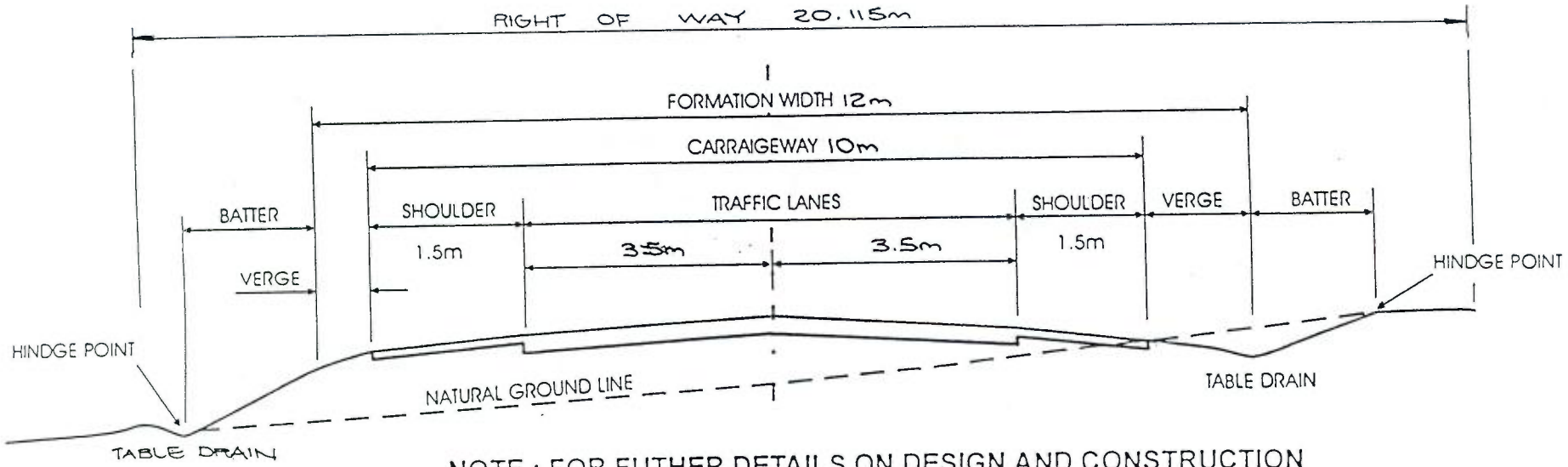


FIGURE 5
LAYOUT OF ROBERTS ROAD AND OLD NORTHERN ROAD INTERSECTION



NOTE : FOR FUTHER DETAILS ON DESIGN AND CONSTRUCTION PLEASE REFER TO ATTACHMENT 1.

FIG 10
TYPICAL CROSS SECTION OF INTERNAL ACCESS ROAD

NTS

5.3 (continued)

Road south of Roberts Road. These increases amount to 14.25 per cent and 9.37 percent respectively.

This truck traffic will not pass any schools or residential dwellings in the Maroota area.

These increases are relatively small and will not reduce the Level of Service at the Roberts Road / Old Northern Road intersection and in Wisemans Ferry Road and Old Northern Road.

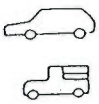
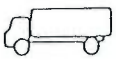
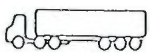
APPENDICES

APPENDIX A

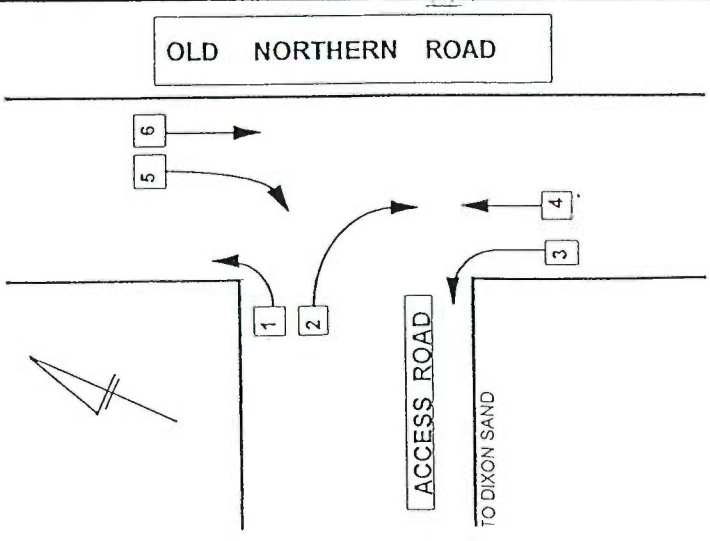
Lyle Marshall & Assoc. ph. 9953 2599 JOB No.9152 (9153VTC1.XLS) OLD NORTEHRN RD, MAROOTA

DATE: 17.12. 98 WEATHER: fine COUNTER NAME: E. SNITKOVSKAIA

TYPE OF VEHICLE

A		B	C			
Cars, Utilities, Station Wagons, Panel Vans, Motor Bikes.	Light Commercial vehicles 2-AXLE up to 6.6 m LONG. Vans, Flat Top Trucks.	2-AXLE RIGID TRUCKS & VANS, TANKERS over 6.6m LONG.	3-AXLE RIGID TRUCKS VANS & TANKERS	4-AXLE SEMI-TRAILERS.	5-AXLE SEMI-TRAILERS.	6-AXLE SEMI-TRAILERS.
						

TIME AM	TYPE	1	2	3	4	5	6	TOTALS
6.00	A	1		2	7	1	20	31
	B					1	1	2
6.30	C		8	2				10
6.30	A			2	16	2	31	51
	B				3			3
7.00	C		1	1	2			4
7.00	A		2	2	21		40	65
	B							0
7.30	C		1	1	1		1	4
7.30	A				11	2	35	48
	B				3		1	4
8.00	C		1				1	2
8.00	A		1	1	29		30	61
	B				1		1	2
8.30	C			1			2	3
8.30	A	1			16	2	42	61
	B				4		1	5
9.00	C		1	3			2	6
9.00	A			1	12		29	42
	B							0
9.30	C		4	1			1	6
9.30	A		1		19		26	46
	B				1			1
10.00	C		2		1			3

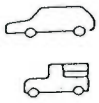
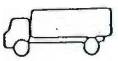
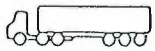


APPENDIX A

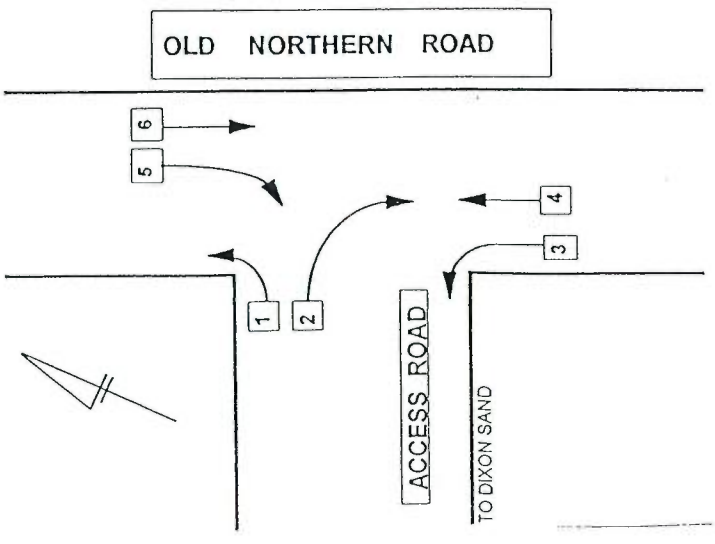
Lyle Marshall & Assoc. ph. 9953 2599 JOB No.9152 (9153VTC2.XLS) OLD NORTHERN RD, MAROOTA

DATE: 17.12.98 WEATHER: FINE COUNTER NAME: E. SNITKOVSKAIA

TYPE OF VEHICLE

A		B	C			
Cars, Utilities, Station Wagons, Panel Vans, Motor Bikes.	Light Commercial vehicles 2-AXLE up to 6.6 m LONG. Vans, Flat Top Trucks.	2-AXLE RIGID TRUCKS & VANS, TANKERS over 6.6m LONG.	3-AXLE RIGID TRUCKS VANS & TANKERS	4-AXLE SEMI-TRAILERS.	5-AXLE SEMI-TRAILERS.	6-AXLE SEMI-TRAILERS.
						

TIME AM/PM	TYPE	1	2	3	4	5	6	TOTALS
10.00	A	1		1	20		13	35
	B		1		1		1	3
10.30	C		1	2	1		2	6
10.30	A	1			16		19	36
	B							0
11.00	C		2	2				4
11.00	A	2		1	26		29	58
	B				1			1
11.30	C		1	3	1		2	7
11.30	A			2	23		14	39
	B						1	1
12.00	C		1	5				6
12.00	A			1	24		12	37
	B				2		1	3
12.30	C		3	3	3		1	10
12.30	A		1	1	18	1	17	38
	B				1		2	3
1.00	C		4		1		1	6
1.00	A				15		19	34
	B							0
1.30	C				2			2
1.30	A				21		11	32
	B							0
2.00	C		1	2			2	5

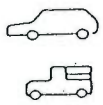


APPENDIX A

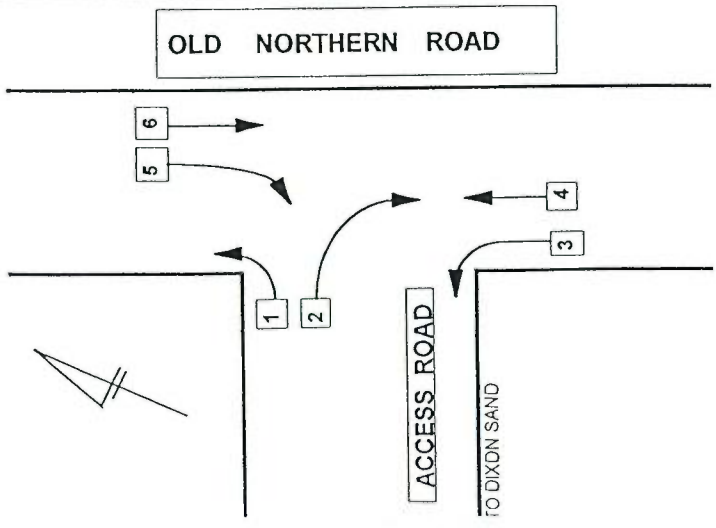
Lyle Marshall & Assoc. ph. 9953 2599 JOB No.9153 (9153VTC3.XLS) OLD NORTEHRN RD, MAROOTA

DATE:17.12.98 WEATHER: FINE COUNTER NAME: E. SNITKOVSKAIA

TYPE OF VEHICLE

A		B	C			
Cars, Utilities, Station Wagons, Panel Vans, Motor Bikes.	Light Commercial vehicles 2-AXLE up to 6.6 m LONG. Vans, Flat Top Trucks.	2-AXLE RIGID TRUCKS & VANS, TANKERS over 6.6m LONG.	3-AXLE RIGID TRUCKS VANS & TANKERS	4-AXLE SEMI-TRAILERS.	5-AXLE SEMI-TRAILERS.	6-AXLE SEMI-TRAILERS.
						

TIME PM	TYPE	1	2	3	4	5	6	TOTALS
2.00	A			1	24		23	48
	B				3		1	4
2.30	C		1		1		1	3
2.30	A				25		26	51
	B						2	2
3.00	C		1	1				2
3.00	A				26		23	49
	B				3		1	4
3.30	C			1		1	2	4
3.30	A				21		35	56
	B						1	1
4.00	C		1	1	3		3	8
4.00	A	1	2		38		22	63
	B				1			1
4.30	C		1				2	3
4.30	A		1	2	37		23	63
	B				3		5	8
5.00	C		1	1	1			3
5.00	A	4	2	2	38		25	71
	B							0
5.30	C						2	2
5.30	A	2	1		33		27	63
	B						1	1
6.00	C						2	2



APPENDIX A

APPENDIX B

Traffic Counting Supplies & Service (02) 476-6266
Hourly Volume By Day
Week commencing : Wednesday, 15/10/1997

Site: 139
Location: 3
Direction: West bound

Day	Tue		Wed		Thur		Fri		Sat		Sun		Mon	
Time	21/10		15/10		16/10		17/10		18/10		19/10		20/10	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
00.00	2	1	1	0	0	0	1	0	7	0	13	1	2	0
01.00	1	0	2	0	2	0	2	0	5	0	7	0	1	0
02.00	1	0	1	0	0	0	2	0	4	0	5	0	0	0
03.00	0	0	0	0	0	0	2	0	1	0	7	0	0	0
04.00	1	0	2	0	2	0	1	0	2	0	1	0	3	0
05.00	8	1	11	2	9	0	9	2	12	1	4	0	13	1
06.00	27	13	30	13	25	15	28	9	19	13	14	0	20	9
07.00	31	6	47	7	39	6	32	3	46	8	17	1	42	7
08.00	52	10	56	6	59	13	51	9	50	9	28	1	45	7
09.00	37	7	36	10	59	6	48	6	69	12	47	1	44	6
10.00	50	12	38	9	47	3	47	7	57	4	43	2	44	8
11.00	42	4	41	8	44	14	47	6	58	10	52	0	52	11
12.00	45	7	47	11	49	7	51	7	55	7	44	0	42	7
13.00	49	11	44	10	38	10	55	8	59	5	55	3	50	9
14.00	47	9	56	10	48	8	49	3	59	4	67	2	55	8
15.00	68	6	88	13	75	10	87	14	75	2	65	3	71	8
16.00	79	9	82	5	71	7	59	8	55	1	84	4	75	8
17.00	56	5	54	1	72	5	72	2	48	1	67	3	60	3
18.00	42	3	44	1	50	1	59	1	31	0	40	1	45	1
19.00	21	1	20	0	27	2	29	4	25	2	25	0	22	0
20.00	11	1	14	0	20	0	23	0	23	0	20	1	13	0
21.00	16	0	11	2	16	1	10	0	18	0	10	0	14	1
22.00	7	0	10	0	7	0	14	1	11	0	4	0	8	0
23.00	8	0	3	0	9	0	3	0	17	0	8	1	4	0
TOTAL	701	106	738	108	768	108	781	90	805	79	727	24	725	94

* Legend

C : Cars and light Vehicles T : Heavy Trucks

APPENDIX B

Traffic Counting Supplies & Service (02) 476-6266
Hourly Volume By Day
Week commencing : Wednesday, 15/10/1997

Site: 139
Location: 3
Direction: East Bound

Day	Tue		Wed		Thur		Fri		Sat		Sun		Mon	
Time	21/10		15/10		16/10		17/10		18/10		19/10		20/10	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
00.00	2	1	3	0	1	0	6	0	4	0	12	0	2	0
01.00	1	0	2	0	2	0	3	0	2	0	12	1	2	0
02.00	0	0	3	0	0	0	2	0	1	0	2	0	2	1
03.00	2	0	1	0	2	0	5	0	1	0	1	0	1	0
04.00	10	2	6	1	3	1	5	2	7	3	4	0	7	2
05.00	42	15	44	21	38	18	35	15	26	13	11	2	41	16
06.00	67	8	57	4	61	9	58	7	30	8	8	0	58	8
07.00	75	6	91	9	84	9	61	3	39	9	21	3	76	3
08.00	75	9	69	8	59	11	64	11	53	13	46	1	57	6
09.00	52	8	41	4	39	4	48	4	36	4	31	1	59	9
10.00	42	10	46	5	43	6	53	7	72	7	65	1	44	7
11.00	44	8	41	10	44	8	48	4	77	7	90	0	46	5
12.00	41	5	45	9	36	4	44	4	57	5	79	2	28	2
13.00	39	7	43	10	50	7	40	5	71	2	91	2	42	12
14.00	44	3	47	4	47	7	60	4	67	3	75	5	50	6
15.00	41	3	50	6	43	7	48	7	60	0	63	1	33	3
16.00	36	2	47	6	48	3	59	8	68	0	76	2	47	3
17.00	49	1	35	0	42	1	44	0	72	3	65	1	49	5
18.00	23	3	32	1	42	1	51	2	44	0	60	1	34	0
19.00	14	2	21	1	24	1	27	1	37	0	22	0	22	1
20.00	8	0	10	1	7	0	20	0	72	0	11	0	11	0
21.00	8	0	2	0	18	0	11	3	157	1	7	0	9	1
22.00	4	0	8	0	5	1	15	0	142	0	7	0	10	0
23.00	2	0	7	0	1	0	11	0	61	1	1	0	2	0
TOTAL	721	93	754	100	739	98	818	87	1256	79	860	23	732	169

*** Legend**

C : Cars and light Vehicles T : Heavy Trucks

APPENDIX B

Traffic Counting Supplies & Service (02) 476-6266
Hourly Volume By Day
Week commencing : Wednesday, 15/10/1997

Site: 140
Location: 4
Direction: South Bound

Day	Tue		Wed		Thur		Fri		Sat		Sun		Mon	
Time	21/10		15/10		16/10		17/10		18/10		19/10		20/10	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
00.00	0	0	3	0	0	0	3	1	1	0	16	0	5	2
01.00	2	0	5	2	5	1	3	1	2	0	18	0	4	1
02.00	2	0	6	1	1	0	5	0	3	0	11	0	5	2
03.00	4	1	1	0	4	1	4	1	1	1	11	1	3	1
04.00	7	0	7	1	10	4	10	2	3	0	8	0	9	1
05.00	36	2	33	0	36	3	36	4	11	1	10	1	30	0
06.00	92	13	82	19	84	18	95	19	35	1	18	1	88	17
07.00	115	5	123	5	117	6	94	5	38	1	28	1	114	3
08.00	84	6	88	18	90	12	91	11	54	3	55	3	83	12
09.00	65	15	50	3	49	6	43	4	57	4	49	4	62	6
10.00	39	8	54	3	51	11	62	12	51	2	59	2	57	13
11.00	41	12	38	7	44	10	34	8	49	4	69	4	46	11
12.00	44	8	47	8	54	8	43	5	40	1	66	1	31	7
13.00	36	8	39	14	52	14	52	13	72	5	104	5	34	9
14.00	47	13	45	2	54	9	55	2	70	9	123	9	54	7
15.00	57	2	46	3	66	6	63	3	71	5	151	5	41	6
16.00	43	3	44	4	54	5	61	4	105	14	222	14	48	5
17.00	44	0	30	1	48	0	33	1	100	3	172	3	39	1
18.00	23	1	26	1	49	3	45	3	59	4	135	4	35	1
19.00	9	2	13	0	20	1	29	1	38	0	43	0	13	2
20.00	6	0	13	1	12	0	13	0	17	0	33	0	8	0
21.00	4	0	7	0	8	0	3	0	18	0	18	0	6	0
22.00	3	0	7	0	3	0	9	0	23	0	5	0	5	1
23.00	0	0	0	0	5	0	6	0	18	0	3	0	1	0
TOTAL	**803**	**88**	**807**	**93**	**916**	**118**	**892**	**100**	**936**	**53**	**1427**	**58**	**821**	**108**

*** Legend**

C : Cars and light Vehicles **T :** Heavy Trucks

APPENDIX B

Traffic Counting Supplies & Service (02) 476-6266
Hourly Volume By Day
Week commencing : Wednesday, 15/10/1997

Site: 140
Location: 4
Direction: NorthBound

Day	Tue		Wed		Thur		Fri		Sat		Sun		Mon	
Time	21/10		15/10		16/10		17/10		18/10		19/10		20/10	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
00.00	5	0	8	0	2	0	3	0	14	0	12	0	5	0
01.00	2	0	2	0	4	0	1	0	5	0	10	2	1	0
02.00	2	0	1	0	2	0	1	0	5	0	5	0	0	0
03.00	2	0	0	0	2	0	2	1	1	0	4	0	0	0
04.00	1	0	4	1	6	2	6	2	5	0	8	0	7	1
05.00	11	5	17	7	9	4	9	5	12	3	10	0	15	6
06.00	18	3	15	1	20	4	19	2	13	4	12	0	12	0
07.00	25	5	36	8	48	12	41	8	47	4	23	0	34	11
08.00	33	10	54	14	34	8	36	7	53	12	50	3	32	5
09.00	45	17	37	6	49	4	48	7	79	12	72	2	36	8
10.00	35	5	41	10	50	12	62	17	88	12	100	5	50	19
11.00	58	14	59	11	60	15	55	9	95	8	141	2	44	10
12.00	45	9	48	10	52	13	51	10	80	3	104	3	49	8
13.00	49	14	43	12	54	13	63	7	95	9	82	2	41	10
14.00	54	9	49	10	52	11	66	7	106	3	61	0	66	15
15.00	49	8	58	6	56	7	81	10	85	4	50	0	57	7
16.00	78	2	81	5	79	9	66	2	62	1	42	1	85	5
17.00	94	6	69	2	87	6	119	5	52	2	37	0	93	5
18.00	73	3	77	1	86	2	103	4	41	0	24	1	79	0
19.00	41	0	42	0	43	0	64	4	39	3	19	0	29	0
20.00	16	1	23	0	42	0	49	2	30	1	23	1	20	1
21.00	26	0	25	1	30	1	30	0	26	0	16	0	15	0
22.00	13	0	16	1	19	0	27	0	16	0	10	0	11	0
23.00	11	0	13	0	14	0	15	0	19	0	9	0	10	0
TOTAL	786	111	818	106	900	123	1017	109	1068	81	924	22	791	111

*** Legend**

C : Cars and light Vehicles **T :** Heavy Trucks

APPENDIX B

APPENDIX C

APPENDIX C

TABLE C1 EXISTING AVERAGE HOURLY HEAVY TRUCK VOLUMES MONDAY TO FRIDAY ON MAIN ROADS (Period 15.10.97 to 21.10.97) AND ROBERTS ROAD 22.10.98

Time	Wisemans Ferry Road		Old Northern Road		Roberts Road	
	Station 3		Station 4			
	East Bound	West Bound	North Bound	South Bound	East Bound	West Bound
6.00 - 7.00 am	7.2	14.0	2.0	17.2	0	0
7.00 - 8.00 am	6.0	3.6	8.8	4.8	6	4
8.00 - 9.00 am	9.0	9.0	8.8	11.8	6	7
9.00 - 10.00 am	5.4	7.0	8.4	6.6	1	2
10.00-11.00 am	7.4	7.8	12.8	9.4	1	0
11.00-12.00 am	7.0	8.6	11.8	9.6	3	5
12.00 - 1.00 pm	4.8	7.8	10.0	7.2	3	5
1.00 - 2.00 pm	8.2	9.6	11.2	11.6	4	1
2.00 - 3.00 pm	4.8	7.6	10.4	6.6	1	1
3.00 - 4.00 pm	5.2	10.2	7.6	4.0	9	8
4.00 - 5.00 pm	4.4	7.4	4.6	4.2	5	4
5.00 - 6.00 pm	1.4	3.2	4.8	0.6	0	2
(6.00am to 6.00 pm) TOTAL	70.8	95.8	101.2	93.6	39	39
(24 hours) TOTAL	109.4	101.2	112	101.4		

TABLE C2

ADDITIONAL MAXIMUM DAILY HEAVY TRUCKS GENERATED BY DEVELOPMENT AND HOURLY DISTRIBUTION TO MAIN ROADS AND ROBERTS ROAD.

MONDAYS TO FRIDAYS

Time	Roberts Road		Wisemans Ferry Road Station 3		Old Northern Road Station 4	
	Eastbound	Westbound	Westbound	Eastbound	Southbound	Northbound
6.00 - 7.00 am	3	3	1.8	1.8	1.2	1.2
7.00 - 8.00 am	3	3	1.8	1.8	1.2	1.2
8.00 - 9.00 am	2	2	1.2	1.2	0.8	0.8
9.00 - 10.00 am	2	2	1.2	1.2	0.8	0.8
10.00-11.00 am	2	2	1.2	1.2	0.8	0.8
11.00-12.00 am	2	2	1.2	1.2	0.8	0.8
12.00 - 1.00 pm	2	2	1.2	1.2	0.8	0.8
1.00 - 2.00 pm	2	2	1.2	1.2	0.8	0.8
2.00 - 3.00 pm	2	2	1.2	1.2	0.8	0.8
3.00 - 4.00 pm	2	2	1.2	1.2	0.8	0.8
4.00 - 5.00 pm	2	2	1.2	1.2	0.8	0.8
5.00 - 6.00 pm	1	1	0.6	0.6	0.4	0.4
TOTAL	25	25	15	15	10	10

TABLE C3

EXISTING PLUS DEVELOPMENT HEAVY TRUCK VOLUMES ON MAIN ROADS AND ROBERTS ROAD

MONDAY to FRIDAY

Time	ROBERTS ROAD		WISEMANS FERRY ROAD Station 3		OLD NORTHERN ROAD Station 4	
	East Bound	West Bound	East Bound	West Bound	North Bound	South Bound
6.00 - 7.00 am	3	3	9	15.8	3.2	18.4
7.00 - 8.00 am	9	7	7.8	5.4	10.0	6.0
8.00 - 9.00 am	8	9	10.2	10.2	9.6	12.6
9.00 - 10.00 am	3	4	6.6	8.2	9.2	7.4
10.00-11.00 am	3	2	8.6	9.0	13.6	10.2
11.00-12.00 am	5	7	8.2	9.8	12.6	10.4
12.00 - 1.00 pm	5	7	6.0	9.0	10.8	8.0
1.00 - 2.00 pm	6	3	9.4	10.8	12.0	12.4
2.00 - 3.00 pm	3	3	6.0	8.8	11.2	7.4
3.00 - 4.00 pm	11	10	6.4	11.4	8.4	4.8
4.00 - 5.00 pm	7	6	5.6	8.6	5.4	5.0
5.00 - 6.00 pm	1	3	2.0	3.8	5.2	1.0
(6.00am to 6.00 pm) TOTAL	**64**	**64**	**85.8**	**110.8**	**111.2**	**103.6**
(24 hours) TOTAL			**124.4**	**116.2**	**122**	**111.4**

TABLE C4

EXISTING HEAVY TRUCK VOLUMES ON MAIN ROADS AND ROBERTS ROAD.

SATURDAY

Time	Roberts Road		Wisemans Ferry Road Station 3		Old Northern Road Station 4	
	East Bound	West Bound	West Bound	East Bound	North Bound	South Bound
6.00 - 7.00 am	0	0	13	8	4	1
7.00 - 8.00 am	2	1	8	9	4	1
8.00 - 9.00 am	2	2	9	13	12	3
9.00 - 10.00 am	1	2	12	4	12	4
10.00-11.00 am	0	0	4	7	12	2
11.00-12.00 am	0	0	10	7	8	4
12.00-1.00 pm	1	1	7	5	3	1
1.00-2.00 pm	0	0	5	2	9	5
2.00-3.00 pm	0	0	4	3	3	9
3.00-4.00 pm	0	0	2	0	4	5
4.00-5.00 pm	0	0	1	0	1	14
5.00-6.00 pm	0	0	1	3	2	3
(6.00am – 6.00 pm) TOTAL	**6**	**6**	**76**	**61**	**74**	**52**
(24 Hours) TOTAL	**6**	**6**	**79**	**79**	**81**	**53**

TABLE C5

ADDITIONAL HEAVY TRUCKS GENERATED BY DEVELOPMENT AND HOURLY DISTRIBUTION TO MAIN ROADS AND ROBERTS ROAD.

SATURDAYS.

Time	Roberts Road		Wisemans Ferry Road Station 3		Old Northern Road Station 4	
	East Bound	West Bound	West Bound	East Bound	North Bound	South Bound
6.00 - 7.00 am	3	3	1.8	1.8	1.2	1.2
7.00 - 8.00 am	2	2	1.2	1.2	.8	.8
8.00 - 9.00 am	2	2	1.2	1.2	0.8	0.8
9.00 - 10.00 am	2	2	1.2	1.2	0.8	0.8
10.00-11.00 am	2	2	1.2	1.2	0.8	0.8
11.00-12.00 am	1	1	0.6	0.6	0.4	0.4
12.00-1.00 pm	0.5	0.5	0.3	0.3	0.2	0.2
1.00-2.00 pm	0	0	0	0	0	0
2.00-3.00 pm	0	0	0	0	0	0
3.00-4.00 pm	0	0	0	0	0	0
4.00-5.00 pm	0	0	0	0	0	0
5.00-6.00 pm	0	0	0	0	0	0
(6.00am - 6.00 pm) TOTAL	**12.5**	**12.5**	**7.5**	**7.5**	**5**	**5**
(24 Hours) TOTAL						

TABLE C6

EXISTING PLUS DEVELOPMENT HEAVY TRUCK VOLUMES ON MAIN ROADS AND ROBERTS ROAD

SATURDAYS

Time	Roberts Road		Wisemans Ferry Road Station 3		Old Northern Road Station 4	
	East Bound	West Bound	West Bound	East Bound	North Bound	South Bound
6.00 - 7.00 am	3	3	14.8	9.8	5.2	2.2
7.00 - 8.00 am	4	3	9.2	10.2	4.8	1.8
8.00 - 9.00 am	4	4	10.2	14.2	12.8	3.8
9.00 - 10.00 am	3	4	13.2	5.2	12.8	4.8
10.00-11.00 am	2	2	5.2	8.2	12.8	2.8
11.00-12.00 am	1	1	10.6	7.6	8.4	4.4
12.00-1.00 pm	1.5	1.5	7.3	5.3	3.2	1.2
1.00-2.00 pm	0	0	5	2	9	5
2.00-3.00 pm	0	0	4	3	3	9
3.00-4.00 pm	0	0	2	0	4	5
4.00-5.00 pm	0	0	1	0	1	14
5.00-6.00 pm	0	0	1	3	2	3
(6.00 - 1.00 pm) TOTAL	**18.5**	**18.5**	**83.5**	**68.5**	**79**	**57**
(24 Hours) TOTAL			**86.5**	**86.5**	**86**	**58**

Appendix 16

Soil and Water Management Plan

for a Proposed Quarry at Lot 2, DP 312327 and Lots 1 & 2, DP 228308 Roberts Road, Maroota

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1 Introduction

This *Soil and Water Management Plan* (*SWMP*) has been prepared by Morse McVey and Associates Pty Ltd at the request of Nexus Environmental Planning. It relates to development of a quarry at Lot 2 in DP 312327, and Lots 1 and 2 in DP 228308, Roberts Road, Maroota (figure 1). The *plan* is based on a preliminary investigation of the soils, topography and hydrology of the site, including water quality modelling. It is understood that the information will provide input to an Extraction Program Plan and form part of an Environmental Impact Statement for the proposed development.

The report is in four parts, including:

Part 1: this introductory section
Part 2: the *SWMP*
Part 3: Appendices
Part 4: Bibliography

Field work was undertaken by the company's Mr Sean Harris on 2 March 1999. Five soil samples were taken and sent to the Department of Land and Water Conservation's Research Centre at Scone, a NATA-registered laboratory. Tests included particle size analysis (both chemical and mechanical dispersion), dispersion percentage and classification under the Unified Soil Classification System. Other physical and chemical information is taken from Murphy (1992) or the result of our own analysis. Results of these tests and some derived information are presented in Appendix 1.

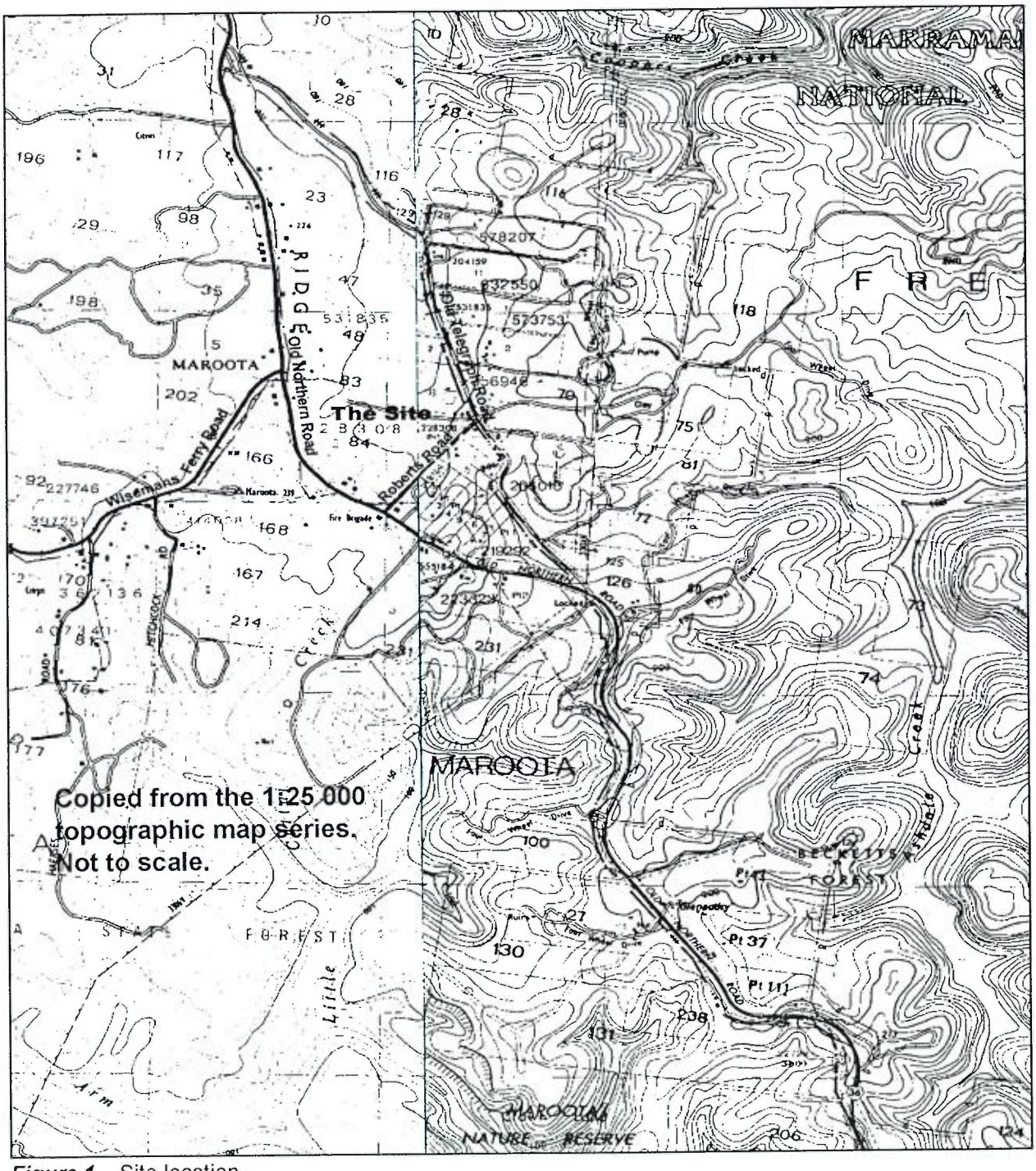


Figure 1 Site location

2 Soil and Water Management Plan

2.1 Background

2.1.1 This Commentary should be read with drawings accompanying a "Conceptual Mine Plan" prepared by Woodward-Clyde's *Conceptual Mine Plan* (1999), specifically Drawings A8602019-0002-G-004 through to and including A8602019-0002-G-011 (hereafter referred to as Drawings 004 to 011). Together, the Commentary and Drawings comprise a conceptual *SWMP* for development of a quarry at Roberts Road, Maroota at:

- Lot 1 & 2 DP228308
- Lots 2 DP312327.

2.1.2 The conceptual *SWMP* provides sufficient detail to show clearly that the works can proceed without undue pollution to receiving waters. A detailed plan will be prepared once consent if given and before works start.

2.1.3 The site is on the Maroota Soil Landscape (Murphy, 1992), with the soil materials being identified through a preliminary soil survey.

2.1.4 Important site physical characteristics are identified in Table 2.1.

Table 2.1 Important site physical characteristics

Constraint/Opportunity		Value
Rainfall erosivity		moderate ® = 2,290)
Topsoil (ma1) erodibility:	sheet flow	moderate (*K* = 0.025)
	concentrated flow	moderate
	wind	low
Subsoil erodibility: sheet flow:		
	ma3	low to moderate (*K*= 0.016 to 0.025)
	ma5	extremely high (*K* = 0.086)
Slope gradients		low (maximum of 10% in works area and for haul roads, excluding batters)
Calculated soil loss for works area:		
	ma1 to ma4	210 tonnes/ha/yr
	ma5	720 tonnes/ha/yr
Soil Loss Class:	ma1 to ma 4	very low (Class 1, except for batters)
	ma5	high (Class 5)
Soil texture group:	ma1	*Type C*
	ma3	*Type C*
	ma5	*Type F*
Percent dispersibility (whole subsoil)		significant in some ma3 materials (13%TDC)
Soil Hydrologic Group		Group B
Runoff coefficient:	volumetric	low (0.42, based on 90th percentile of 47.6 mm at Wilberforce, Table 6.5 of Dept Housing, 1998)
	peak flow	moderate (0.78) (Department of Housing, 1993)

Note: further information on terms used in this Table is in Appendix 2.

2.1.5 Many soil particles are very strongly stabilised, evidenced by the very large difference in mechanical versus chemical dispersion clay content at sites 3, 4 and 5. Further, flocculation is observed to occur very rapidly when sediment-laden waters enter sediment basins. The agent in both these matters is probably iron-based because pH is between 5 and 7 and electrical conductivity levels are very low.

2.1.6 The Soil Hydrologic Group for the soil materials is assumed to be B on non compacted surfaces and C on compacted surfaces.

2.1.7 The peak flow runoff coefficient (Department of Housing, 1993) for this site is 0.78 for Group B soils and 0.86 for Group C soils—used to size catch drains and energy dissipaters. It is based on a 20-year time of concentration storm event of 110 mm per hour.

2.1.8 The volumetric runoff coefficient (Department of Housing, 1998) for this site is 0.42 for Group B soils and 0.58 for Group C soils—used to size sediment retention basins. It is based on the rainfall depth for the 5-day, 90th percentile event at Wilberforce (47.6 mm/hr).

2.1.9 The likely soil loss is calculated with the Revised Universal Soil Loss Equation *(RUSLE)*. The value *R* and *K*-factors are given in Table 2.1. Other factors are:

- LS-factor is 2.81, assuming slope lengths of 80 metres and typical upper slope gradients for works areas of 10 per cent
- *P*-factor is 1.3
- the *C*-factor is assumed to be 1.0 for bare soil.

2.1.10 The sediment storage zone is calculated using the estimated soil loss for the site over two months because the *LS*-factor is greater than 2.0.

2.1.11 The locations of soil and water management structures on the drawings are intended to be approximate only.

2.2 General Instructions

2.2.1 Read the *SWMP* with the engineering plans and any other plans or written instructions issued in relation to development at the subject site.

2.2.2 Ensure contractors undertake all soil and water management works as instructed in this specification and constructed following the guidelines stated in Department of Housing (1998) (the "Blue Book").

2.2.3 Inform all subcontractors of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas.

2.3 Works Sequence

2.3.1 Undertake works in the following sequence (Conditions 2.3.2 to 2.3.3). Each subsequent stage is not to commence until the previous one is completed. The work's sequence assumes adoption of that outlined in the proposed *Extraction Strategy* of the *Conceptual Mine Plan* prepared by Woodward Clyde (1999).

2.3.2 Before any site disturbance proceeds within the Active Cell 1A (Drawing 005):

(i) construct the Process Water Dam and sedimentation pond according to the engineering plans;

(ii) construct earth banks (Stormwater Collection Drains) following SD 5-3 (Appendix 3) to divert surface runoff from the upslope catchment and from the active cell area into the sedimentation pond. Bank dimensions will be specified on a detailed *SWMP* prepared before works begin, designed to convey waters in the 20-year time of concentration storm event safely;

(iii) construct earth banks (SD 5-3) to divert the clay slurry from the processing plant to the existing clay drying area (to be delineated on the detailed plan - see Section 2.1.2); and

(iv) strip topsoil from the Active Cell 1A and stockpile it (SD 4-1) at a suitable location east of the processing plant for rehabilitation of the final stage of sand extraction, probably near the existing clay drying area (to be delineated on the detailed plan - see Section 2.1.2).

Then:

(v) undertake works following the engineering plans—these must not interfere with flow of waters in any earth banks; and

(vi) ensure suitable management practices are carried out to minimise areas being affected by wind and water erosion.

2.3.3 At completion of the extraction process in Active Cell 1A, operations will move progressively through the remaining cells in Stage 1 and 2 as shown on Drawings 006 to 010.

2.3.4 Three cells may be open at any one time, one each for extraction, clay drying ponds and rehabilitation. Normally, each cell is expected to progress through each of these stages in this order.

2.3.5 Before site disturbance proceeds within any cells:

(i) strip topsoil and stockpile (SD 4-1) it in the previously active cell (i.e., in Cell 1A when Cell 1B is being extracted);

(ii) construct earth banks (Stormwater Collection Drains) following SD 5-3 to divert surface runoff from the upslope catchment and from the active cell area into the sedimentation pond. Bank dimensions will be specified on a detailed *SWMP* prepared before works begin, designed to convey waters in the 20-year time of concentration storm event safely.

2.3.6 Then:

(i) decommission the existing clay drying ponds and relocate them to the previously active cell as shown on Drawing 006 to 010 (e.g. in Stage 1B, from the area east of the Process Water Dam to Cell 1A);

(ii) construct earth banks (SD 5-3) to divert the clay slurry from the processing plant to the new clay drying area (to be delineated on the detailed plan - see Section 2.1.2); and

(iii) rehabilitate lands previously used to stockpile topsoil and as the old clay drying area with clay residue materials and the previously stockpiled topsoil (e.g. in Stage 1B, rehabilitate the area east of the Process Water Dam).

2.3.7 Then:

(i) install barrier fencing to limit access to rehabilitated areas (to be delineated on the detailed plan - see Section 2.1.2)

(ii) undertake works following the engineering plans—these must not interfere with the flow of waters in any earth banks; and

(iii) ensure suitable management practices are carried out to minimise areas being affected by wind and water erosion.

2.4 Erosion Control

2.4.1 The soil erosion hazard on the site will be kept as low as practicable by minimising disturbance. Some ways of doing this are outlined in Table 2.2.

2.4.2 Extraction will take place within a defined work area and materials will be transported only within the site for processing.

2.4.3 Entry to land not involved directly in the extraction process will be prohibited and will be managed as natural grassland.

2.4.4 Limit vehicular access to the site to that essential for construction work.

Table 2.2 Limitations to Access

Land use	Access limitations	Comments
Extraction	Land disturbances beyond five (preferably two) metres from the edge of the operations shown on the work plans are prohibited.	All site workers should clearly recognise these areas and they should be clearly marked – suitable materials include barrier mesh, sediment fencing, etc. The project manager will determine their actual location on site. They can vary in position to conserve existing vegetation best while being considerate of the needs of efficient works activities.
Access roads	Roads and tracks are limited to a width that are the minimum necessary to allow safe operation of heavy equipment.	
Remaining lands	Land disturbances are prohibited except for essential management works.	

2.4.5 Where practicable, schedule the construction program so that the time from starting land disturbance activities to completion of final rehabilitation (landscaping) is a duration of less than 24 months. Here, rehabilitation means achieving a C-factor (Revised Universal Soil Loss Equation) of less than 0.1 and set in motion a program that should ensure it will drop permanently, by vegetation, paving, armouring, etc. to less than 0.05 within a further 60 days. Of course, local water restrictions might affect this in drought times.

2.4.6 While C-factors are likely to rise to 1.0 during the work's Program, they should not exceed those given in Table 2.3 within the specified times.

Table 2.3 Maximum acceptable C-factors at nominated times during works

Lands	Maximum *C*-factor	Remarks
Waterways and other areas subjected to concentrated flows, post construction	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows are limited to those shown in Table 5.1 of the "Blue Book". Foot and vehicular traffic are prohibited in these areas.
Stockpiles, post clearance	0.1	Applies after ten working days from completion of formation.
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later.

Note: *working days* does not include public holidays, weekends or days when work is not possible due to wet weather.

2.4.7 The requirements of Conditions 2.4.5 and 2.4.6 can be achieved in the short term (temporary protection for up to six months) with either:

- a suitable soil binder, e.g.
  - Terra-Control® or equivalent in areas of sheet flow, e.g. topsoil stockpiles

  - anionic bitumen emulsion sprayed over hessian cloth (at 0.5 L/m^2) in areas of concentrated flow, e.g. diversion banks and waterways
- a temporary vegetative cover.

2.4.8 Apply any soil binders employed following the manufacturers instructions.

2.4.9 A suggested listing of suitable plant species is shown in Table 2.4. Before sowing, additional tests should be undertaken to assess the requirements of ameliorants such as lime to help plant growth.

2.4.10

Table 2.4 Plant species for temporary cover

Sowing season	Seed mix
Autumn / Winter	oats @ 40 kg/ha Japanese millet @ 10 kg/ha
Spring / Summer	Japanese millet @ 20 kg/ha oats @ 20 kg/ha

2.4.11 While ever the *C*-factor is higher than 0.1, maintain the lands in a condition that resists removal by wind. This can be achieved by:
- keeping moist (not wet) by sprinkling with water
- where practicable, leaving the surface in a cloddy state.

2.4.12 Notwithstanding Conditions 2.4.5 and 2.4.6, schedule works so that the duration from the conclusion of land shaping to completion of final stabilisation is less than:
- 10 days on slopes steeper than 30 per cent
- 20 days on slopes less steep than 30 per cent.

2.4.13 Lands planted recently with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Follow-up seed and fertiliser will be applied as necessary in areas of minor soil erosion and/or inadequate vegetative protection.

2.4.14 Where practicable, keep foot and vehicular traffic away from all recently stabilised areas.

2.4.15 Stockpiles of topsoil (SD 4-1) to be located at least five metres from areas of likely concentrated or high velocity flows, especially drainage lines and access roads. If necessary, earth banks or drains will be constructed to divert localised run-on.

2.4.16 Replace soil materials in the same order they are removed from the ground. It is particularly important that all subsoils are buried and topsoils remain on the

- have one or more pegs placed on the floor to show clearly the level at which design capacity occurs and when sediment will be removed.

2.5.4 Dispose of sediment removed from any trapping device in locations where further erosion and consequent pollution to downslope lands and waterways will not occur.

2.5.5 Remove temporary soil and water management structures only after the land being protecting is stabilised.

(a) ***Sedimentation Pond***

2.5.6 A sedimentation pond (SD 6-4) will be used to remove coarse sediment from surface waters before entering the Process Water Dam minimise sediment build up in the Dam.

2.5.7 It will be constructed to approximate dimensions of 30 by 50 by 1.5 metres, located as shown on Drawing 005 and figure 5 of the *Process Water Dam Design* (Woodward-Clyde 1999). A solid (e.g. concrete or steel) baffle will be placed in it to help in the sedimentation process. This will capture 0.05 mm particles and coarser (about two thirds of all sediment) in the 0.25 $Q_{tc,\ 1yr}$ event.

2.5.8 It will not be clay-lined so some water is expected to be lost through infiltration. However, a layer of settled clay particles is expected to accumulate quickly within the base of the pond and reduce infiltration considerably.

2.5.9 Water will drain from the sedimentation pond to the Process Water Dam through a 500mm diameter HPDE pipe.

2.5.10 A 2-metre wide by a 0.3 metres deep concrete spillway will be installed at an elevation of 183.7 metres to minimise scouring of the wall should the capacity of the HPDE pipe be exceeded.

(b) ***Process Water Dam***

2.5.11 The Process Water Dam will provide a dual role of water storage for processing operations (lower section), and extra capacity to meet sediment control requirements for *Type F* soils (SD 6-4) (upper section) following the *Process Water Dam Design* (Woodward-Clyde 1999).

2.5.12 The dam will be non-draining—lined at least to the top of the zone used for sediment control.

2.5.13 The capacity required for storm water capture or surcharge is 8.88 ML

(Table 2.5). This is based on a non draining sediment basin using the 90th percentile, 5-day rainfall event of 47.6 mm at Wilberforce (Table 6.5 of Dept Housing, 1998) (Appendix 5).

2.5.14 A 20-metre wide and 1 metre deep spillway channel will be provided on the northern wall of the dam to allow flow into the existing natural watercourse at approximately 192 m AHD following the *Process Water Dam Design* (Woodward-Clyde 1999).

Table 2.5 Capacity of Process Water Dam and Sediment Basin

Dam components	Depth (m)	Capacity (ML)	AHD (m)
Spillway	na	na	192
Surplus storage capacity	8.5	166	183.5-192
Sediment basin storage	0.5	8.88	183.5
Process water dam storage	3.0	60	180 - 183

2.6 Other Matters

2.6.1 Revegetation aimed at revegetated bushland after sand extraction is complete, will be achieved by appropriate soil amelioration for low fertility, low pH and low pore water holding capacity where necessary (Appendix G, "Blue Book").

2.7 Site Monitoring & Maintenance

2.7.1 Waste receptacles will be emptied as necessary. Disposal of waste will be in a manner approved by the site superintendent.

2.7.2 The site superintendent will inspect the site at least weekly paying particular attention to:

(i) ensuring that drains operate properly and effect any necessary repairs;

(ii) removal of spilled sand or other materials from hazard areas, including lands closer than five metres from areas of likely concentrated or high velocity flows, especially waterways and access roads;

(iii) removal of trapped sediment whenever less than design capacity remains for the sediment basins;

(iv) ensuring rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate;

(v) constructing additional erosion and/or sediment control works as might become necessary to ensure the desired water control is achieved, i.e. make ongoing changes to the *Plan;*

(vi) maintaining erosion and sediment control measures in a functioning condition until all earthwork activities are completed and the site is rehabilitated; and

(vii) removal of temporary soil conservation structures as the last activity in the rehabilitation program.

2.7.3 The site superintendent will keep a log book, making entries at least weekly and immediately before forecast rainfall and/or site closure, recording:

- daily rainfall
- the condition of any soil and water management works
- applications of any flocculating agents to sediment retention systems
- volumes of water discharged from sediment retention systems
- remedial works.

The book will be kept on-site and made available to any authorised person on request.

3 Appendices

Appendix 1: Soil Test Results

Soils can be dispersed mechanically or chemically to derive particle size analysis. Some tests relate to the response of soils under field conditions and, so, mechanical dispersion is used. Other tests relate to the response of soils when dispersed with Calgon© or other agent.

Table 5.2 Relevant Soil Results based on Mechanical Dispersion

Site	Layer	Particle Size Analysis					Organic Matter (%) ¶	RUSLE Structure Grade (Rosewell, 1993)	*K*-factor § (Department of Housing, 1998)	pH	Unified Soil Classification	Emerson Aggregate Test
		Clay	Silt	Fine Sand	Coarse Sand	Gravel						
1	ma1	4	9	49	33	5	2.75	1	0.025	6.3	SM-SC	2(1)
2	ma3	16	9	45	30	<1	<1	1	0.025	5.5	SM-SC †	3(1)
4	ma3	1	15	21	58	5	<1	1	0.018	5.1	SM-SC	3(2)
5	ma3	1	4	32	62	1	<1	1	0.016	5.2	SM-SC †	3(1)
3	ma5	1	57	18	22	2	<1	4	0.086	5.6	CL	3(1)

¶ From Murphy (1992)
§ Assumes profile permeability Class 2 for layers ma1 to ma4 and Class 5 for ma5 (Rosewell, 1993).
† Samples from our field work were tested by the DLWC. We believe they incorrectly show this soil material as SC.

Table 5.1 Relevant Soil Results based on Chemical Dispersion

Site	Layer	Particle Size Analysis					1:5 soluble solids (ppm)	1:5 EC (dS/m)	Texture multiplier factor ¶	ECe	Salinity rating	Total dispersible solids	Dispersion percentage	Soil Group (Charman & Murphy, 1991 ¤)
		Clay	Silt	Fine Sand	Coarse Sand	Gravel								
1	ma1	8	12	40	35	5	12	0.018	17	0.306	non saline	5.9	42	J
2	ma3	20	10	41	29	<1	25	0.039	17	0.663	non saline	13	52	I
4	ma3	15	8	17	55	5	19	0.029	17	0.493	non saline	5.7	30	I
5	ma3	22	6	21	50	1	5	0.0078	17	0.133	non saline	1	4	I
3	ma5	56	19	3	20	2	12	0.018	8	0.144	non saline	3.3	5	C ‡

¶ From Hazelton & Murphy (1992)
¤ See Table 20.8 on page 281 of Charman & Murphy, 1991. Texture based on chemical dispersion.
‡ Assumes a linear shrinkage of less than 12% based on Murphy (1992). If higher than 12%, then it is G or H.

Appendix 2: Site and Soil Terms

R-factor

The rainfall erosivity factor, *R*, is a measure of the ability of rainfall to cause erosion. It is the product of two components: total energy (*E*) and maximum 30 minute intensity for each storm (I_{30}). However, Rosewell and Turner (1992) have identified a strong correlation between the *R*-factor and the 2-year ARI, 6-hour storm event. The *R*-factor is calculated using the Department of Conservation and Land Management's computer program, *RAINER*. This program computes the *R*-factor from interpolated rainfall values drawn directly from Pilgrim (1987). *RAINER* has assigned the subject lands an *R*-factor of 2,410.

K-factor

The soil erodibility factor, *K*, is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. Texture is the principle component affecting *K*, but structure, organic matter and permeability also contribute. In the RUSLE, it is a quantitative value experimentally determined. See Table 5.1

LS-factor

The slope length–gradient factor, *LS*, describes the combined effect of slope length and slope gradient on soil loss. It is the ratio of soil loss per unit area at any particular site to the corresponding loss from a specific experimental plot of known length and gradient. Our slope length for disturbance was based on a maximum of 80 metres, this being normal practice for properly managed sites. There was no reason to vary this as soil loss potential was found quite low. Slope gradients were based on field records of slope taken by clinometer from the eight sample sites depicted on the site map. Maximum slope in the works area (excluding batters that are discussed elsewhere) will be 10 per cent. Therefore, *LS* is assigned a value of 2.81.

P-factor

The erosion control practice factor, *P*, is the ratio of soil loss with a nominated surface condition ploughed up and down the slope. It is reduced by practices that reduce both the velocity of runoff and the tendency of runoff to flow directly downhill. At construction sites, it reflects the roughening or smoothing of the soil surface by machinery. The *P*-factor here is 1.3, that normally assigned to urban construction sites.

C-factor

The cover factor, *C*, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from continuously tilled, bare soil. The *C*-factor is

different from the runoff coefficient used in the rational method.

The most effective method of reducing the C-factor is maintenance, or formation of a good ground cover such as outlined in Chapter 7. The best practices (Table A4, figure A1) are those that reduce both the soil exposed to raindrop impact and the erosive effects of runoff. The C-factor assigned here is 1.0, typical of that for bare soil.

Soil Loss

The Soil Loss *(A)* for the site is shown on Table 2.1.

Soil Loss Class

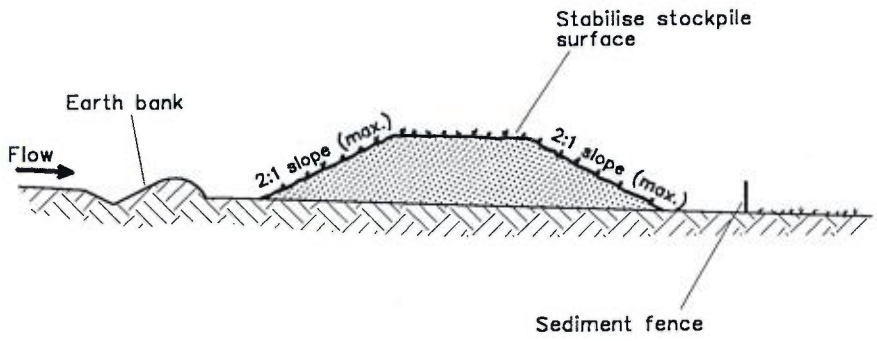
The Soil Loss Class system described here places sites into seven groups that differ because of varying calculated soil loss. These groups assume that a soil loss of 37.5 tonnes per hectare per fortnight (half-month) can be managed easily using conventional erosion and sediment control techniques (Morse and Rosewell, 1996).

The Soil Loss Classes
(adapted from Morse and Rosewell, 1996)

Soil Loss Class	Calculated soil loss (tonnes/ha/yr)	Erosion hazard
1	0 to 250	very low
2	251 to 300	low
3	301 to 375	low-moderate
4	376 to 500	moderate
5	501 to 750	high
6	751 to 1,500	very high
7	1,501 to 3 750	extreme

The Soil Loss Class for the site is shown on Table 2.1.

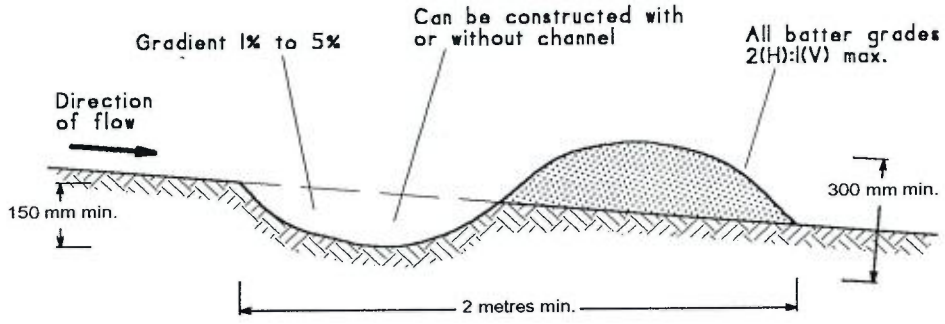
Appendix 3: Standard Drawings



Construction Notes

1. Locate stockpile at least 5 metres from existing vegetation, concentrated water flows, roads and hazard areas.
2. Construct on the contour as a low, flat, elongated mound.
3. Where there is sufficient area topsoil stockpiles shall be less than 2 metres in height.
4. Rehabilitate in accordance with the SWMP/ESCP.
5. Construct earth bank (Standard Drawing 5-2) on the upslope side to divert run off around the stockpile and a sediment fence (Standard Drawing 6-7) 1 to 2 metres downslope of stockpile.

STOCKPILES **SD 4-1**

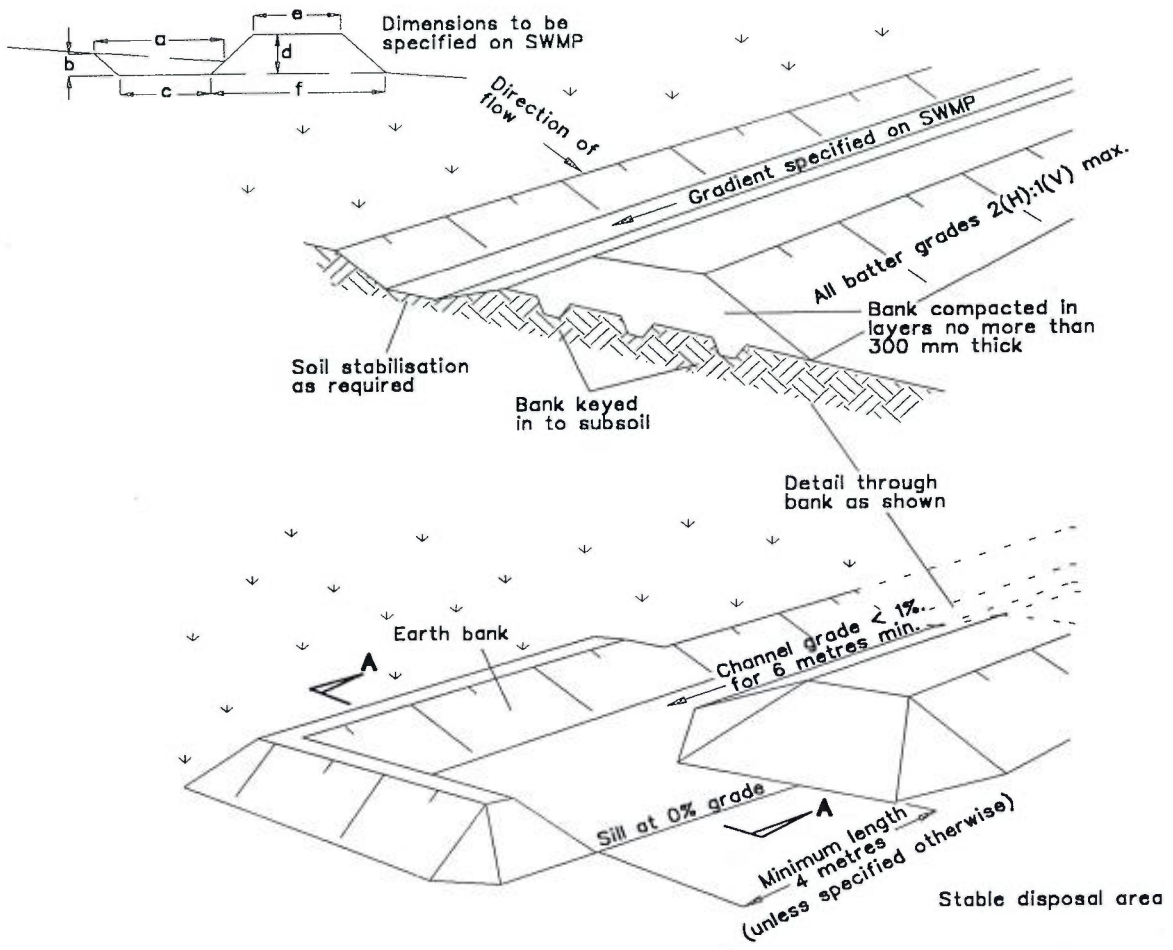


NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

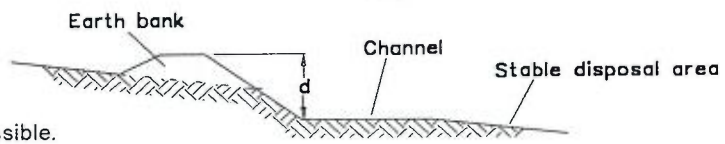
Construction Notes

1. Construct with gradient of 1 per cent to 5 per cent.
2. Avoid removing trees and shrubs if possible.
3. Drains to be of circular, parabolic or trapezoidal cross section as opposed to V-shaped.
4. Earth banks to be adequately compacted in order to prevent failure.
5. Permanent or temporary stabilisation of the earth bank to be completed within 10 days of construction.
6. All outlets from disturbed lands are to feed into a sediment basin or similar.
7. Discharge runoff collected from undisturbed lands onto either a stabilised or an undisturbed disposal site within the same subcatchment area from which the water originated.
8. Compact with a suitable implement in situations where they are required to function for more than five days.
9. Earth banks to be free of projections or other irregularities that will impede normal flow.

EARTH BANK (LOW FLOW) SD 5-2



Level Spreader (or Sill)

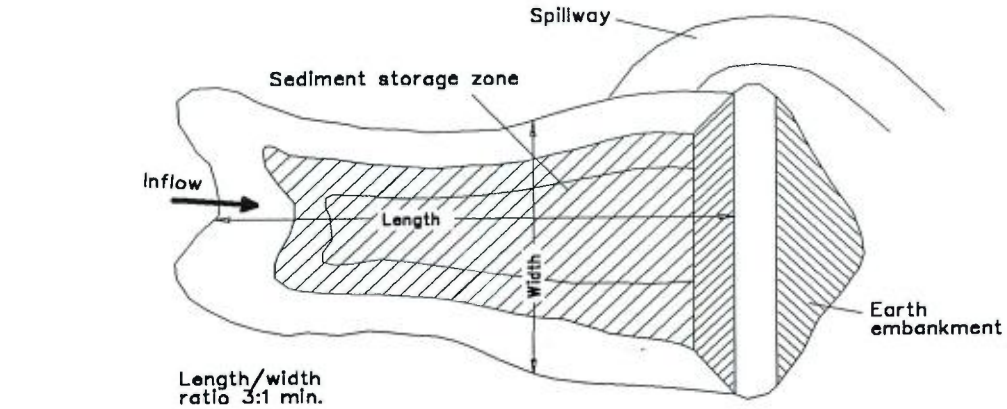


Section AA

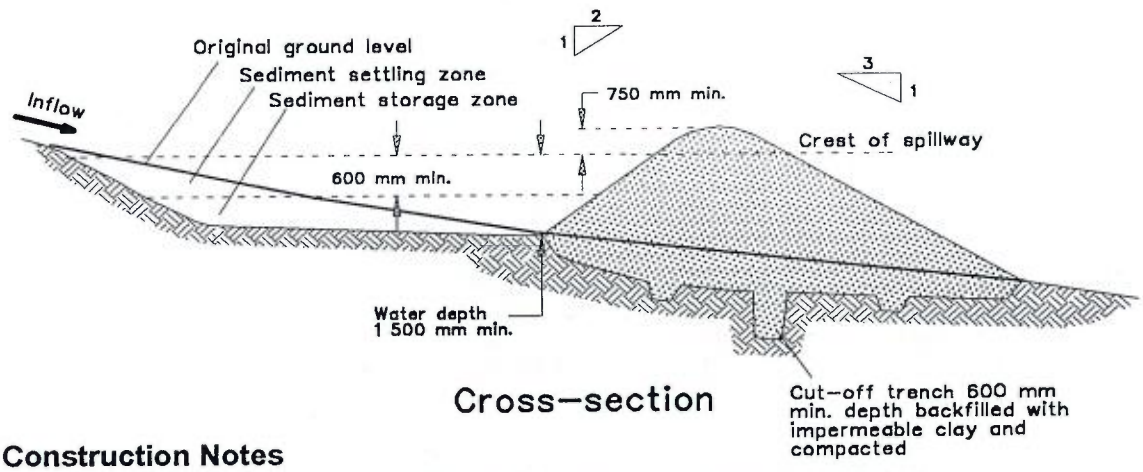
Construction Notes

1. Construct along gradient as specified.
2. Avoid removing trees and shrubs if possible.
3. Drains to be of parabolic or trapezoidal cross section as opposed to V-shaped.
4. Earth banks to be adequately compacted in order to prevent failure.
5. Permanent or temporary stabilisation of the earth bank to be completed within 10 days of construction.
6. All outlets from disturbed lands are to feed into a sediment basin or similar.
7. Discharge runoff collected from undisturbed lands onto either a stabilised or an undisturbed disposal site within the same subcatchment area from which the water originated.
8. Compact with a suitable implement in situations where they are required to function for more than five days.
9. Earth banks to be free of projections or other irregularities that will impede normal flow.

EARTH BANK (HIGH FLOWS) SD 5-3



Plan View



Cross-section

Construction Notes

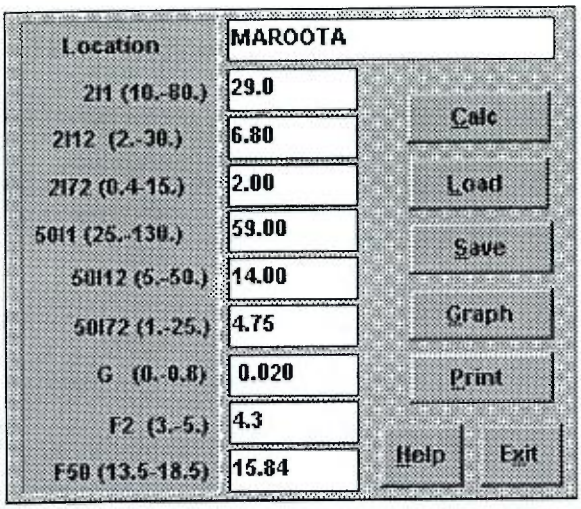
1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1 200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill according to the directions of the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping at least 100 mm deep to help bond compacted fill to existing substrate.
6. Spread fill in 100 mm to 150 mm layers and compact at optimum moisture content in accordance with the SWMP.
7. Install pipe outlet with seepage collars as specified in SWMP.
8. Form batter grades at 2(H):1(V) upstream and 3(H):1(V) downstream or as specified on SWMP.
9. Install riser pipe as specified on SWMP.
10. Construct emergency spillway 300 mm above sill height of riser pipe.
11. Rehabilitate structure in accordance with the SWMP.
12. Place a "Full of Sediment" marker to show when less than design capacity occurs and sediment removal is required.

EARTH BASIN - WET

(APPLIES TO *TYPE D* AND *TYPE F* SOILS ONLY)

SD 6-4

Appendix 4: IFD Tables for Maroota



ARI \ DUR	5m	6m	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h	User
1	73	68	56	40.6	32.9	22.3	15.0	11.8	7.85	5.23	3.32	2.05	1.50	0.00
2	95	89	73	53	42.7	29.0	19.5	15.3	10.2	6.79	4.34	2.71	2.00	0.00
5	125	117	95	69	56	37.9	25.5	20.1	13.4	8.93	5.83	3.72	2.78	0.00
10	142	133	109	79	64	43.2	29.1	23.0	15.3	10.2	6.74	4.35	3.28	0.00
20	166	155	126	91	74	50	33.8	26.7	17.8	11.9	7.91	5.16	3.91	0.00
50	196	184	150	108	88	59	40.0	31.6	21.0	14.1	9.48	6.25	4.77	0.00
100	220	206	168	121	98	66	44.7	35.3	23.6	15.8	10.7	7.10	5.45	0.00
User	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix 5: Calculations

Storm Flow Calculations

Peak flow or discharge is given by the Rational Formula:

$$Q_Y = 0.00278 \times C_{10} \times F_Y \times I_{Y,tc} \times A$$

where:
- Q_Y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years
- F_Y is a frequency factor for "Y" years
- A is the area of catchment in hectares (ha)
- $I_{Y,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Catchment area, A = 20.7 ha - *maximum developed catchment area*

Time of concentration (tc) = $0.76 \times (A/100)^{0.38}$ (Chapter 5 of *AR&R*, 1987)
= $0.76 \times (20.7/100)^{0.38}$
= 0.4177 hours
= 25 minutes

Peak flow runoff coefficient C_{10} = 0.78%

Table 9 Peak flow calculations

ARI storm event	Storm intensity (mm/hr)	Frequency factor (F_y)	Peak flow (m^3/s)
1 yr, tc	36.2	0.62	1.01
10 yr, tc	70	1.00	3.14
20 yr, tc	82	1.12	4.12
100 yr, tc	108	1.36	6.59

Sediment Basin Volume *– Type F & D soils (Dept. Housing, 1998)*

Basin Volume = Settling Zone Volume + Sediment Storage Zone volume

The settling zone volume for *Type F* and *D* soils is calculated to provide capacity to contain all runoff expected from up to the 90th percentile rainfall event. The settling zone volume (V) can be determined by the following equation:

$$V = 10 \times C_v \times A \,.\, R_{90\text{th ile, 5 day}} \ (m^3)$$

where 10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the 5 day period

R = is the 5-day total rainfall depth (mm) which is not exceeded in 90 per cent of rainfall events

A = area of catchment in hectares (ha)

V = $10 \times 0.42 \times 20.7 \times 47.6$

= 5,920 m^3

Total basin volume = V + 50%V

= 5,920 + 2,960

= 8,880 m^3

Additional volume for water storage = 60,000 m^3 (60 ML)

Basin volume = 8,880 m^3 + 60,000 m^3

= 68,880 m^3 (69 ML rounded)

Diversion Bank and Waterway Velocity

Width	Depth	Depth with 0.5m freeboard	Velocity
0.5	0.77	1.27	3.04
1	0.70	1.2	3.02
1.5	0.64	1.14	3.0
2	0.59	1.09	2.96
2.5	0.54	1.04	2.91
3	0.51	1.01	2.87
4	0.45	0.95	2.76
5	0.40	0.9	2.66
6	0.36	0.86	2.55
7	0.33	0.83	2.46
8	0.31	0.81	2.37
9	0.29	0.79	2.29
10	0.27	0.77	2.22

Assumptions:

maximum catchment area is 20.7 ha
maximum slope is 5%
side batters 3:1
Manning's n = 0.04
100 yr storm Peak flow 6.59 m^3/s

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