Particle Size Distribution	AS 1289 Test 3.6.1 (Wet Sieve Procedure)
Liquid Limit	AS.1289 Test 3.1.1 or AS 1289 Test 3.9
Plastic Limit	AS.1289 Test 3.2.1
Plasticity Index	AS.1289 Test 3.3.1 AS.1289 Test 3.3.2
Linear Shrinkage	AS.1289 Test 3.4.1
Dry Density	AS 1289 Test 5.2.1
Soaked CBR	AS 1289 Test 6.1.1* *Compacted to 95% (min) Maximum Dry Density obtained by AS 1289 5.2.1 & with 9kg surcharge.

Earthworks and Formation

ESC 410 Version 1.0 Issue Date: September, 2006

Purpose

This Standard establishes requirements for earthworks and formation for new track construction and major reconstruction of existing track.

It is applicable to main lines and sidings owned by RailCorp.

Table of Contents

Owner Principal Engineer Geotechnical

Approved By:	John Stapleton Group Leader Standards	Authorised By:	Jee Choudhury Principal Engineer

1. Scope and Application

This document establishes the earthworks and formation requirements for new construction and major reconstruction of main lines and sidings owned by RailCorp.

2. Version History

First issue in this format.

This document replaces:

C 1100 Earthworks Construction Procedures

TS 3421 General Standards for Formation and Earthworks

TS 3422 Standard for Formation Capping Material

3. References

3.1. Australian and International Standards

AS 1289 Methods of Testing Soils for Engineering Purposes

3.2. RailCorp Documents

ESC 215 Transit Space

ESC 350 Retaining Walls and Platforms

ESC 420 Track Drainage

SPC 411 Earthworks Materials

3.3. Other References

Nil.

4. Definitions

Rail Level:	Theoretical level of the running surface of the rails. In the case of superelevated track it is the low rail.
Formation Level:	Finished level at the centre of the formation preparatory to laying ballast. It includes the required capping layer.
Earthworks Level:	Level at the centre of the earthworks prior to placing of the capping layer.
Formation Width:	Width at formation level.
Shoulder Distance:	Distance from the track centreline to the edge of the formation.
Capping Layer:	Layer of compacted material that provides an impermeable seal to the earthworks.
Structural Zone:	The upper zone of the embankment. Thickness varies from 500mm to 1000mm, depending on the CBR of the general fill.
General Fill:	The lower zone of the embankment.

5. Width of Property (Right of Way)

The width of property for new lines shall be a minimum of 40 metres and increased if necessary to allow for a 4m access road on each boundary at normal ground level in addition to the necessary earthworks for the formations and associated drainage.

For new lines, the track shall be designed in the centre of the property. Single tracks to be ultimately duplicated are to be aligned 2 m off the centre of the property.

The width of the right of way shall also provide for drainage as detailed in this document and associated specification.

Special consideration is to be given to additional land that may be required for deviation of creeks.

Underground cables for signalling and communications are to be located in natural ground, and not in the shoulder areas of the formation.

In multiple tracks and other restricted locations, cable connections to signals may be located in the formation, provided the formation capping is properly restored after completion of the cable laying works.

6. Formation

The formation for single track mainlines and single track sidings shall comply with the appropriate dimensions shown on Drawing SP 521 in Appendix 1.

The formation for multiple track mainlines and multiple track sidings shall comply with the appropriate dimensions on Drawing SP 522 in Appendix 2.

Shoulder distances shall comply with Appendix 3.

Track centres shall be in accordance with ESC 215 “Transit Space”.

Where reduced shoulder distances exist due to physical constraints, an assessment is to be made of the need for safety refuges, handhold devices and limited clearance signs. The requirements are specified in ESC 350 “Retaining Walls and Platforms”.

7. Embankments

Embankment materials shall comply with Engineering Specification SPC 411 Earthworks Materials.

The earthworks in embankments shall be placed and compacted to a level 30 millimetres above the base of the capping layer.

Compaction standards shall be as follows:

Compaction A:	-	Cohesive soils - Not less than 100% maximum dry density as determined by AS.1289 Tests 5.1.1 and 5.3.1 (Standard Compaction)
	-	Rock fill or cohesionless soils - No visible deflection of surface under 10 tonne vibratory rollers after 6-8 passes. Relative density shall not be less than 75%.
Compaction B:		Not less than 95% maximum dry density as determined by AS.1289 Tests 5.1.1 and 5.3.1 (Standard Compaction).

The embankment shall consist of two zones of embankment material:

- Structural Zone
- General Fill

The zones of the embankment shall be defined by the thickness of the structural zone (H) at the top of the embankment as determined by the following relationship with the general fill in the embankment:

- for general fill with CBR*3-8%, H = 500mm
- for general fill with CBR*1-3%, H = 1000mm.

* (Soaked California Bearing Ratio, Standard Compaction).

Material for use in the structural zone shall comply with SPC 411.

Embankments shall be compacted to:

General Fill:	Below Structural Zone = Compaction B
Structural Zone:	To 500mm or 1000mm below formation layer (i.e. Earthworks Level) = Compaction A

Embankment batter slopes shall be as shown on the Drawings. Unless shown otherwise, the standard batter slope for embankments shall be 2:1 (horizontal:vertical), subject to confirmation by site specific stability analysis taking account of materials, height and foundation conditions.

Immediately prior to the placement of the capping, the fill shall be trimmed by grading to the final profile and compacted by a minimum of three passes of a smooth steel drum roller which has a static mass not less than 10 tonnes.

The finished, rolled surface shall be true to profile to a tolerance of +0 to -30mm, and shall be free of depression and ruts.

No traffic shall be allowed on the finished surface.

8. Cuttings

8.1. Excavation

Excavation shall be carried out to the lines, levels, dimensions and slopes shown on the Drawings.

The excavated faces shall be neatly trimmed and the top edges of the cuttings neatly rounded.

Under cutting of slopes or excavation of the toe of batters at a slope steeper than specified will not be permitted under any circumstances.

Excavation shall be carried out in such a manner as to prevent erosion or slips, working faces shall be limited to safe heights and slopes, and surfaces shall be drained to avoid ponding and erosion.

Overhanging, loose or unstable material likely to slip should be cut back removed or stabilised.

Rock cuttings and exposed rock surfaces shall be excavated so as to obtain smooth, uniformly trimmed surfaces.

Excavation at the base of cutting shall be finished at a level to suit the capping thickness,

normally 150mm, and with crossfalls shown on the drawings. Tolerance on levels is between +0 and -50mm.

In addition the finished surface shall not deviate from the bottom of a 3 metre straight edge laid in any direction by more than 25mm.

8.2. Batter Slopes

Batter slopes in rock cuttings in excess of 3m high and closer than 6m from the track centreline shall be determined on the advice of a Geotechnical Engineer.

Unless shown otherwise on the Drawings, cutting slopes should be in accordance with the following guidelines:

		Slope		
Material		**Horizontal**	**:**	**Vertical**
1.	Sand	2	:	1
2.	Wet clay, loose gravel	2	:	1
3.	Sandy clay, boulders and clay compact gravelly soil, talus	1.75	:	1
4.	Poor rock	1.5	:	1
5.*	Sound shale dipping sharply towards railway formation, tight cemented gravel	1	:	1
6.*	Ordinary rock	1	:	1
7.*	Solid well bedded rock	0.25	:	1

Typical (minimum) cutting slopes

* Maximum height without bench - 7m.

* Batter slopes in rock shall be confirmed by a Geotechnical Engineer.

The slopes shown above are subject to confirmation by site specific stability analysis taking account of materials, height and excavation conditions.

Batters in cuttings shall be carried around curves in an even and regular manner. Finished batters shall not have a slope steeper than that specified.

8.3. Compaction

Compaction of the top 150mm layer in the base of cuttings or of material required to fill over-excavation shall be 95 per cent maximum dry density as determined by AS 1289 Test 5.2.1 or shall be solid rock.

9. Capping Layer

Capping material shall comply with Engineering Specification SPC 411 Earthworks Materials.

The capping material shall be suitably damp during transit from the source to the worksite to prevent segregation.

The capping layer shall be constructed in layers. No single layer shall have a compacted thickness greater than 150 millimetres or less than 75 millimetres.

The material shall be spread in uniform horizontal layers so as to achieve the specified compacted thickness for the full width of the capping layer.

Spreading shall be undertaken by a method that will ensure segregation does not occur, and so as not to rut or disturb the compacted material beneath it.

Where required for compaction purposes, water shall be added as necessary to achieve optimum moisture content and mixed uniformly with the capping material by approved mechanical means.

Compaction shall achieve a minimum density of 95 per cent maximum dry density as determined by AS 1289 Test 5.2.1.

Rock and rock fines shall be distributed throughout each layer so that all voids are filled. The top of the final layer shall be graded and trimmed, and material shall be added as necessary to produce an even impermeable surface.

The following tolerances are required for the capping layer:

9.1. Width

The width from the design centreline shall be not less than the dimensions for shoulder distance required by Appendix 3.

9.2. Level

The finished surface of the capping shall be within 25mm of the level shown on the drawings and:

- The algebraic difference of the deviations from the correct level for any two points 20 metres apart on the centreline shall not exceed 15mm.
- The deviation from a three (3) metre straight edge laid on the surface parallel to the centreline shall not exceed 10mm.

9.3. Transverse Slope

When tested with a three (3) metre straight edge laid perpendicular to the centre line the deviation from design profile shall not exceed 10mm concavity.

10. Drainage

The basic requirements for drainage are shown on the drawings in the Appendices.

Cess drains, sub-surface drains and top drains to cuttings are to comply with the requirements in ESC 420 “Track Drainage”.

11. Train Examination Areas

Where nominated, train examination areas are to be provided. The minimum requirement is to cover these areas with a 50mm layer of 10mm single sized aggregate as shown on Drawings SP 521 and SP 522.

The train examination area is not to be assumed as available for road access purposes.

12. Walkways

Where nominated, walkways are to be provided for staff to walk along the track cess. The minimum requirement is to cover walkways with a 50mm layer of 10mm single sized aggregate as shown on Drawings SP 521 and SP 522.

13. Earthworks near Structures

Care shall be exercised in constructing earthworks within 5m of structures to avoid damage to the structures.

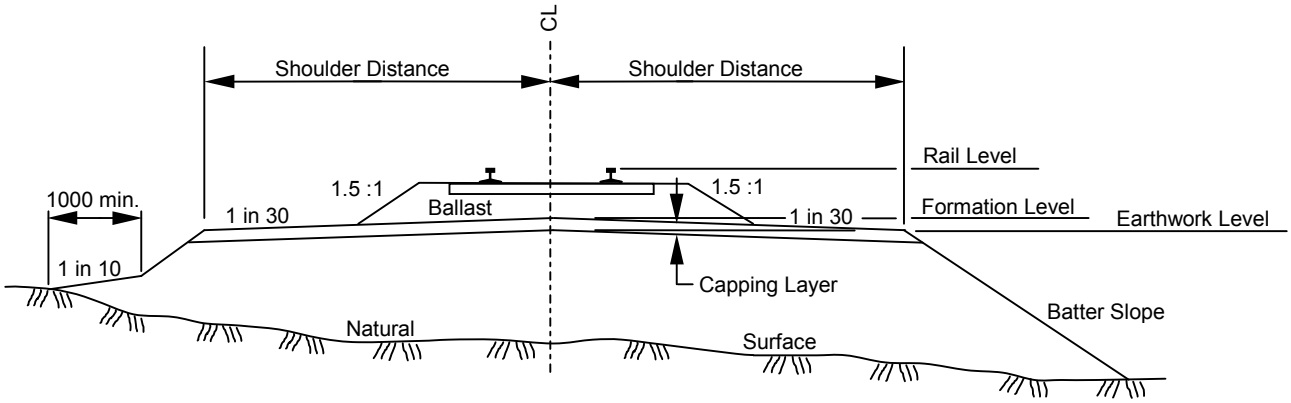
Non-vibratory compaction equipment should be used within this distance and adjacent to the structure further limitations, as defined in the Table, apply.

Free draining filter material encapsulated in geotextile fabric should be placed adjacent to weep-holes, horizontally for at least 300mm from, and vertically for 450mm above the weep-hole.

Select back fill material complying with the requirement for capping material except that a minimum of 60% shall be retained on a 2.36mm sieve, shall be used adjacent to structures as follows:

Structure	**Minimum Width & Height of Selected Fill**	**Compaction Method**
Bridge abutment and wing walls	2m wide for full height	Hand held compaction equipment for full structure height for a distance of 2/3 H (H = overall height of structure)
Pipe Culverts	300mm width each side and above top pipes	Hand held compaction equipment for distance D from pipe to top of pipe (D= diameter of pipe)
Box culverts & culvert wing walls & retaining wall	H/3 wide for full height (H= overall height)	Hand held compaction equipment for full structure height for a distance 2/3 H from wall (H = overall height)

Appendix 1 – Single Track Formation (SP 521)



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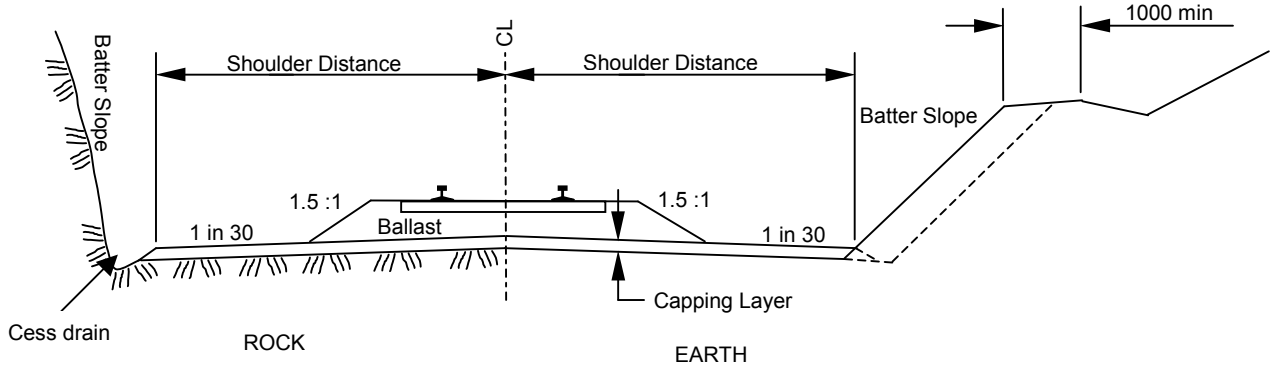
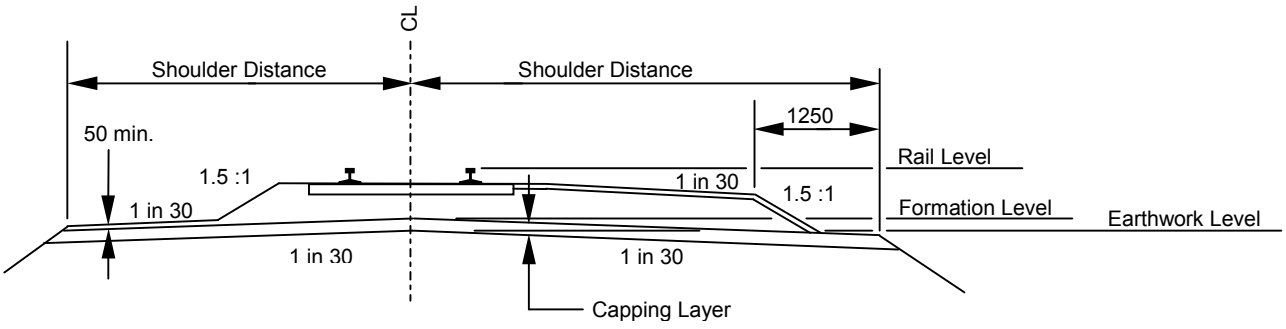


CUTTING

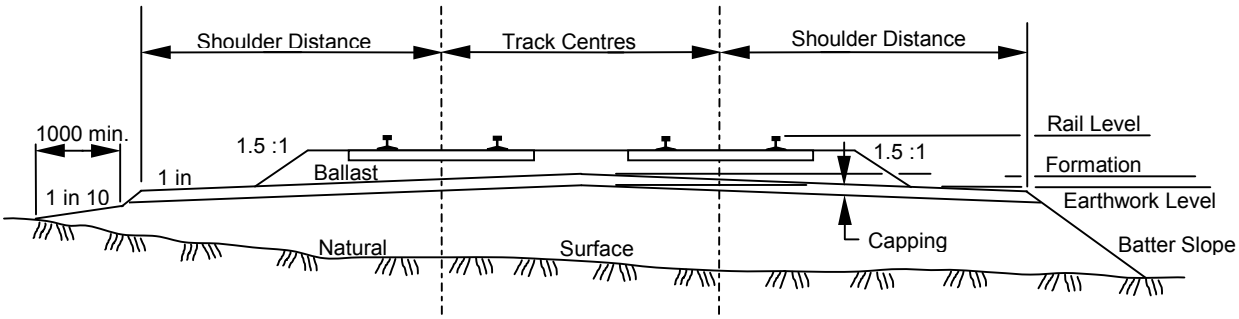


Typical section where shunters' and guards' walkways are required.

Typical section where examinations areas are specified.

SPECIAL WIDTH REQUIREMENTS

Appendix 2 – Multiple Track Formation (SP 522)



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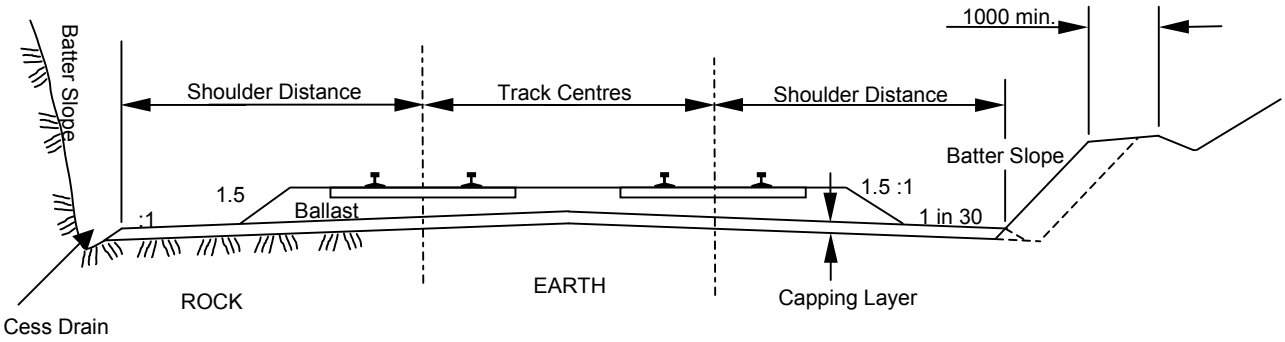

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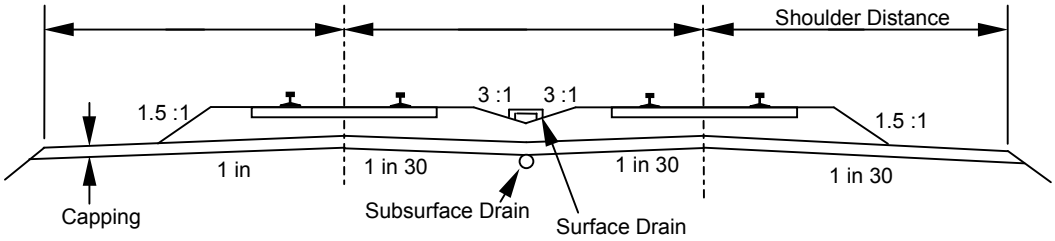
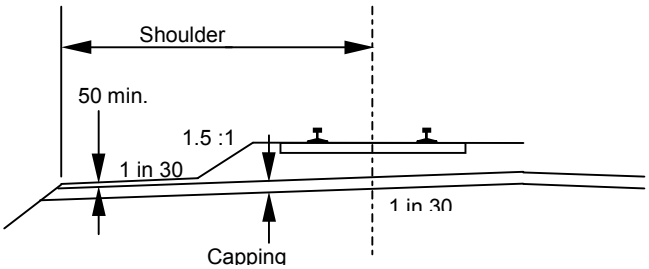


CENTRE DRAIN



Typical section where shunters' and guards' walkways are required.

SPECIAL WIDTH REQUIREMENTS

Appendix 3 – Shoulder Distance

Shoulder distance	
Plain track	mm
Main line (Electrified or non-electrified)	4250
Siding (Electrified)	4250
Siding (non-electrified)	3000
Main line or siding with parallel access road (Electrified)	6200
Main line or siding with parallel access road (Non-electrified)	5500
Special Requirements	
Shunters and guards parallel walkways	4250
Train Examination areas	5500
Train Examination areas with parallel access road	7750
Clear width of road from back of any structure	3000

Appendix E
General Approvals for Immobalisation

‘GENERAL APPROVALS OF IMMOBILISATION’
PUBLISHED IN THE NSW GOVERNMENT GAZETTE

Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* (Waste Regulation) specifies that EPA may approve the immobilisation of specified contaminant(s) contained in a particular type of waste. Approvals of the immobilisation of contaminants may be given in the following ways:

- the EPA can issue general approvals which would apply to all waste generated that has the properties specified in the approval, or
- for a specific waste as a result of an individual application received by the EPA.

In either case, an approval is subject to such conditions determined by the EPA, and remains in force until such time as it is revoked by the EPA.

Approvals of immobilisation may specify conditions relating to the subsequent storage, treatment or disposal of the waste. For example, in certain cases the EPA will consider specific conditions (such as the segregation of such waste from all other types of waste in a monofill or a monocell) in order to achieve a greater margin of safety against a possible failure of the immobilisation in the future. These conditions must not be contravened, otherwise a penalty may be imposed.

The following is the substance of the legal provisions in Clause 28 of the Waste Regulation in respect of ‘Immobilisation of contaminants in waste’:

- The EPA may approve the immobilisation of contaminants in waste by issuing a general approval or a specific approval. Such approvals have the effect of enabling the waste to which the approval relates to be assessed and classified in accordance with the procedures set out in Technical Appendix 1 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) which are also accessible at this web site.
- A general approval may be given by way of notice published in the Gazette. A specific approval may be given after an application is made to the EPA.
- In giving an approval, the EPA is required to identify a person (or class of persons) to whom the approval relates (the responsible person).
- A general approval may be amended or revoked by the EPA by notice published in the Gazette.
- If an approval is given, the responsible person must comply with the conditions to which the approval is subject; otherwise they will have committed an offence.

For details on how to use general approvals that are already in place, see Technical Appendix 2 of the Waste Guidelines.

It is important to note that wherever EPA approval has been given for the immobilisation of the contaminant(s), the waste can be classified according to its TCLP test results alone. If the immobilisation of a contaminant for which TCLP limits are not specified in the guidelines is approved, the EPA will advise on the management options that are available for such materials.

The following twenty three (23) pages reproduce the text of the ten (10) ‘general approvals of immobilisation’ granted so far by the EPA. General approval 2005/14 was published in the NSW Government Gazette on 29 July 2005.

GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

A) APPROVAL NUMBER

1999/03

B) SPECIFICATION OF WASTE STREAM

Cattle-dip contaminated soil.

C) CONTAMINANTS APPROVED AS IMMOBILISED

Arsenic.

D) TYPE OF IMMOBILISATION

Natural.

E) MECHANISM OF IMMOBILISATION

Arsenic compounds are mineralised through adsorption and incorporation onto and within the naturally occurring minerals present in the cattle-dip contaminated soil.

F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  None

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for Arsenic listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of cattle-dip contaminated soil. With respect to Arsenic cattle-dip contaminated soil may be classified according to their respective leachable concentration (TCLP) values alone.

  Any contaminants listed in Table A4 of the Waste Guidelines (other than Arsenic) that are contained within cattle-dip contaminated soil must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

  The cattle-dip site soil must not contain any free liquids as defined in the Waste guidelines.

- *Disposal Restrictions*

  Cattle-dip contaminated soil subject to this approval must not be co-disposed with putrescible waste (monocell or monofill disposal is recommended).

The interpretation of the above disposal restrictions should be referred to Part 5 of Technical Appendix 2 of the Waste Guidelines.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of Cattle-dip contaminated soil, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which the contaminated soil is disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

Environment Protection Authority
Per: Roz Hall
Manager Waste Policy
By Delegation

GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

A) APPROVAL NUMBER

1999/04

B) SPECIFICATION OF WASTE STREAM

Activated carbon waste.

C) CONTAMINANTS APPROVED AS IMMOBILISED

All contaminants listed in Table A4 of the Waste Guidelines with the exception of Total Petroleum Hydrocarbons C_6 - C_9 and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985.

D) TYPE OF IMMOBILISATION

Natural

E) MECHANISM OF IMMOBILISATION

The contaminants are immobilised through absorption and adsorption onto and within the extensive network of pores inside the activated carbon granules which offer a surface area of up to 1000 square metres per gram.

F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  Powdery activated carbon wastes must be bagged or drummed or otherwise contained, such as in closed cartridges, to avoid dust generation during handling.

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for all contaminants listed in Table A4 (with the exception of Total Petroleum Hydrocarbons C_6 - C_9 and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985) listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of activated carbon waste. With respect to all contaminants listed in Table A4 (with the exception of Total Petroleum Hydrocarbons C_6 - C_9 and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985) activated carbon waste can be classified according to their respective leachable concentration (TCLP) values alone (when specified in Table A4).

  Total Petroleum Hydrocarbons C_6 - C_9 and any chemicals subject to control under the *Environmentally Hazardous Chemicals Act* 1985 that are contained in activated carbon waste must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.

The activated carbon waste must not contain any free liquids as defined in the Waste Guidelines.

- *Disposal Restrictions*

  None.

- *Record keeping requirements*

  The responsible person is required to keep records of the management and disposal of activated carbon waste, which is assessed as industrial waste or hazardous waste, for a period of at least 3 years from the date which the timber waste is disposed of off site.

- *Waste Management Requirements*

  The responsible person should ensure the landfill is permitted by conditions in its licence to receive waste subject to immobilisation approvals with the above disposal restrictions.

G) RESPONSIBLE PERSON

The person or class of persons to whom this general approval relates is the person who carries out the assessment and classification for the purpose of this approval. The responsible person must comply with the conditions of this approval.

Environment Protection Authority
Per: Roz Hall
Manager Waste Policy
By Delegation

GENERAL APPROVAL OF THE IMMOBILISATION OF CONTAMINANTS IN WASTE

Pursuant to the provisions in Clause 28 of the *Protection of the Environment Operations (Waste) Regulation 1996* the New South Wales Environment Protection Authority has authorised the following general approval of the immobilisation of contaminants in waste:

A) APPROVAL NUMBER

1999/05

B) SPECIFICATION OF WASTE STREAM

Ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials.

C) CONTAMINANTS APPROVED AS IMMOBILISED

Benzo(a)pyrene (BaP) and Polycyclic aromatic hydrocarbons (PAHs)

D) TYPE OF IMMOBILISATION

Natural

E) MECHANISM OF IMMOBILISATION

The combustion of carbonaceous materials, such as coal, can take place at 700 to 1500 degrees Celsius. Residual PAHs and BaP present in ash generated at these temperatures are immobilised within a vitrified carbonaceous and siliceous matrix.

Any PAHs and BaP present in coal are strongly bound within the coal's carbonaceous matrix.

F) CONDITIONS OF APPROVAL

- *Packaging Requirements*

  Powdery ash waste must be bagged or drummed or otherwise contained to avoid dust generation during handling.

- *Waste Assessment Requirements*

  The total concentration (SCC) limits for PAHs (total) and BaP listed in Table A4 of the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes* (Waste Guidelines – EPA 1999) do not apply to the assessment of ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials. With respect to BaP, ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials can be classified according to their leachable concentration (TCLP) values alone.

  Any contaminants that are listed in Table A4 of the Waste Guidelines (other than PAHs (total) and BaP) that are contained within the ash, ash-contaminated natural excavated materials or coal-contaminated natural excavated materials must be assessed in accordance with Technical Appendix 1 of the Waste Guidelines.