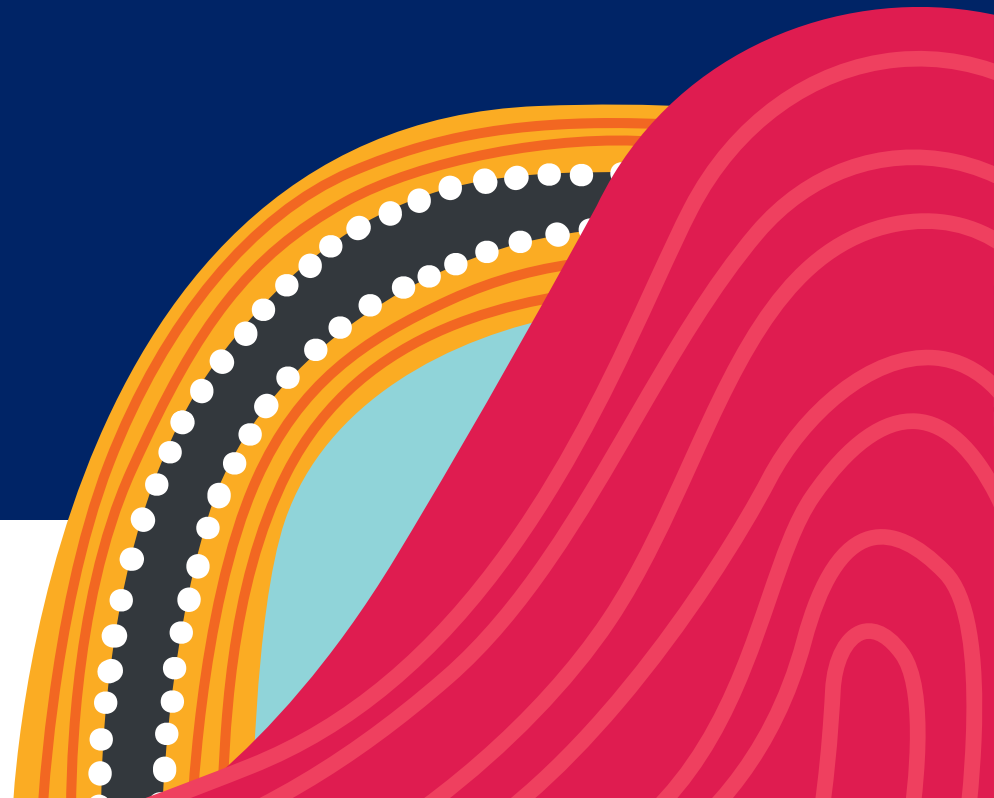
International Symposium: Coal Combustion Products Harvesting Challenges and Opportunities

Fly Ash Usage on TfNSW Projects

Challenges and Opportunities

Sam Henwood
Director Ground Engineering
Infrastructure and Place



NSW GOVERNMENT

transport.nsw.gov.au

Acknowledgement of Country

Transport pays respect to Elders past and present, and recognises and celebrates the diversity of Aboriginal peoples and their ongoing cultures and connections to the lands and waters of NSW.

Contents

01

Fly Ash Usage

Fly Ash Usage

Where can TfNSW use Fly Ash and some other coal combustion products?

Earthworks

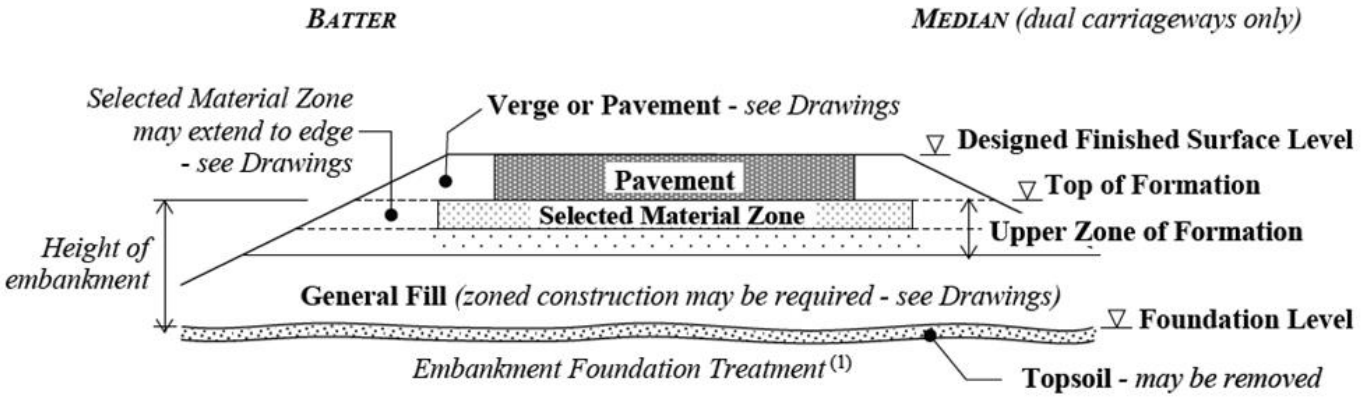
- Road and Rail

Pavements

- Rigid and Flexible

Structures

- Concrete (structural and general purpose)



Note:

(1) *See Figures R44.4(a) to R44.4(e) for details of embankment foundation treatment types.*

Figure R44.1(b) – Embankment Nomenclature

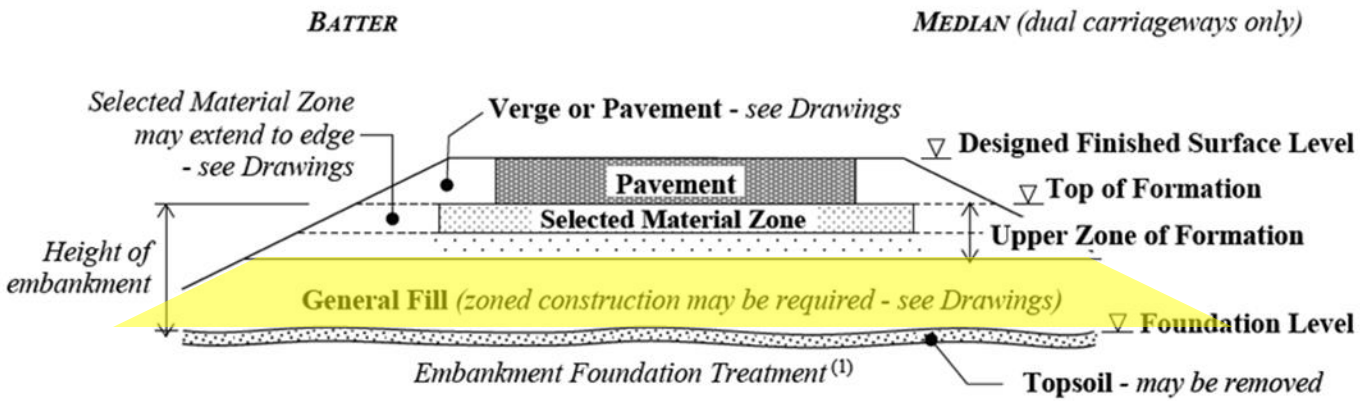
02

TfNSW Specifications

Specifications

Where can TfNSW use Fly Ash and some other coal combustion products?

R44 Earthworks: Fly Ash and other coal combustion products



Note:

(1) *See Figures R44.4(a) to R44.4(e) for details of embankment foundation treatment types.*

Figure R44.1(b) – Embankment Nomenclature

NSW GOVERNMENT | Transport for NSW

QA SPECIFICATION R44

EARTHWORKS

TS 02158.1
IC-QA-R44

VERSION FOR:
DATE:

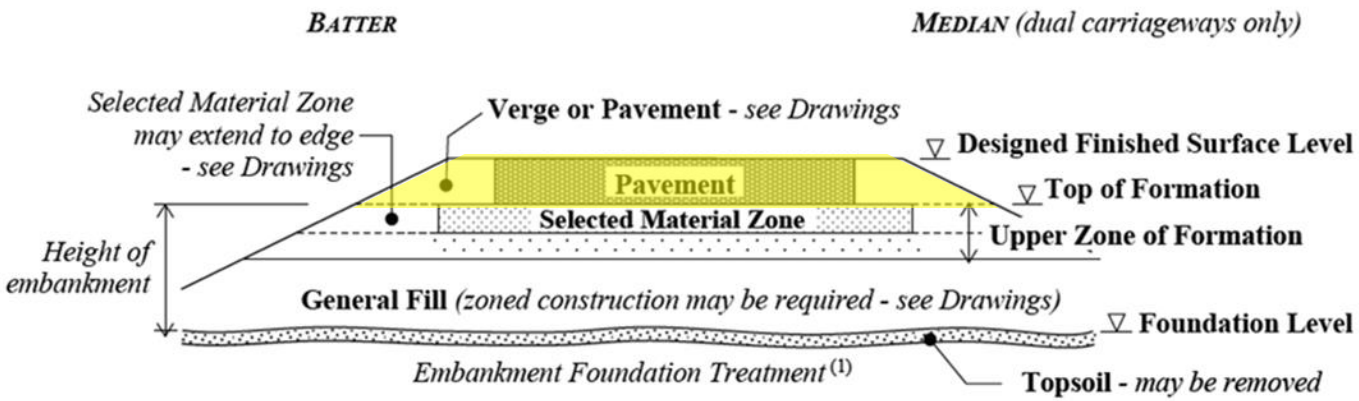
Edition 6 / Revision 0
June 2023

TRANSPORT FOR NSW

Specifications

Where can TfNSW use Fly Ash and some other coal combustion products?

QA 3051 Granular Pavement Base and Subbase Materials: Fly Ash and Bottom Ash



Note:

(1) *See Figures R44.4(a) to R44.4(e) for details of embankment foundation treatment types.*

Figure R44.1(b) – Embankment Nomenclature

NSW GOVERNMENT | Transport for NSW

QA SPECIFICATION 3051

GRANULAR PAVEMENT BASE AND SUBBASE MATERIALS

VERSION FOR:
DATE:

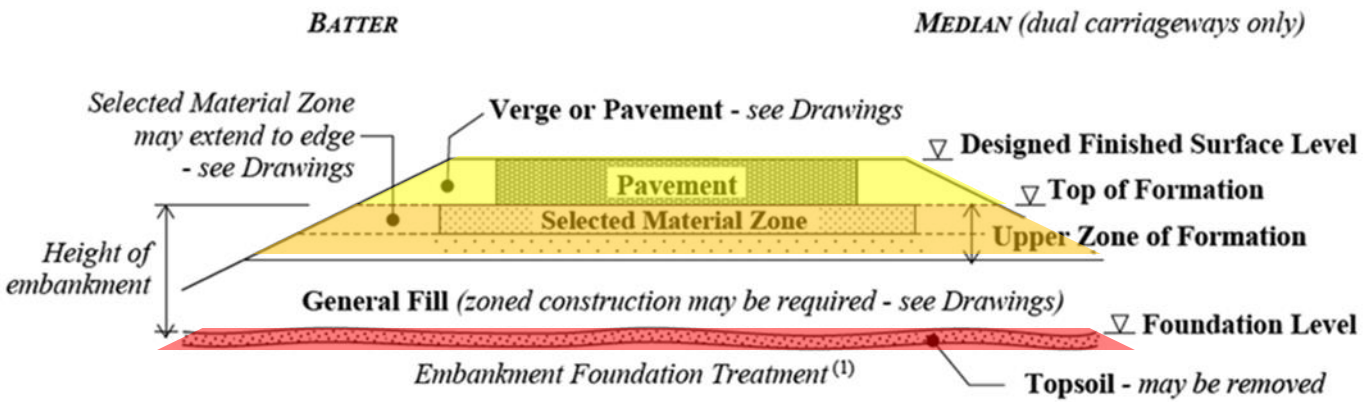
Edition 7 / Revision 1
June 2020

TRANSPORT FOR NSW

Specifications

Where can TfNSW use Fly Ash and some other coal combustion products?

QA 3211 Cementitious Materials, Binders and Fillers: Fly Ash



Note:

(1) *See Figures R44.4(a) to R44.4(e) for details of embankment foundation treatment types.*

Figure R44.1(b) – Embankment Nomenclature

NSW GOVERNMENT | Transport for NSW

QA SPECIFICATION 3211

CEMENTITIOUS MATERIALS, BINDERS AND FILLERS

TS 03323.1:1.01
IC-QA-3211

VERSION FOR:
DATE:

Edition 5 / Revision 2
July 2024

TRANSPORT FOR NSW

03

Earthworks

Earthworks – Challeng and Opportunities

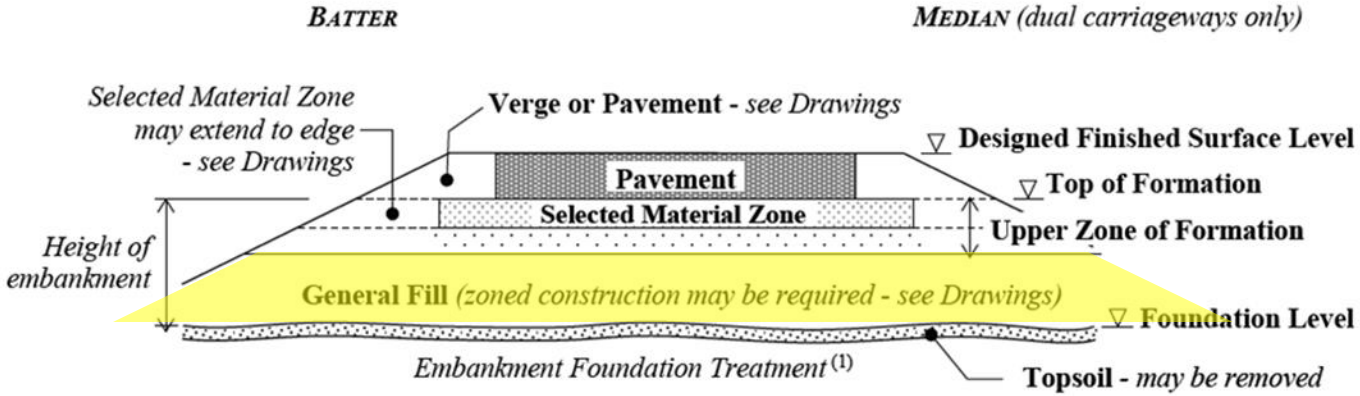


Figure R44.1(b) – Embankment Nomenclature

R44 Earthworks

General fill

Material placed as fill in embankments for other than Foundation or Structural Treatments.

Earth fill

Material composed of fine and coarse particles, which when placed and compacted produces a dense embankment deriving its stability from the packing of the fine particles around the coarser material.

Earthworks – Challenges and Opportunities

R44 General Fill – Earth Fill

- **Unsuitable**
- **Contaminated Material**
- **Hybrid Fill**

Source of photos: TfNSW R44 Earthworks Training Course

Earthworks – Challenges and Opportunities

What is Unsuitable (Background to R44)

It is useful to divide unsuitable into three categories:

1. **Inherently unsuitable** (eg peat, muck and some silts) that would normally be spoiled.

2. **Unsuitable by virtue of position.** This is the type that R44 deals with specifically (eg low CBR material in the cut floor). This material can usually be used as general fill but may require processing or mixing

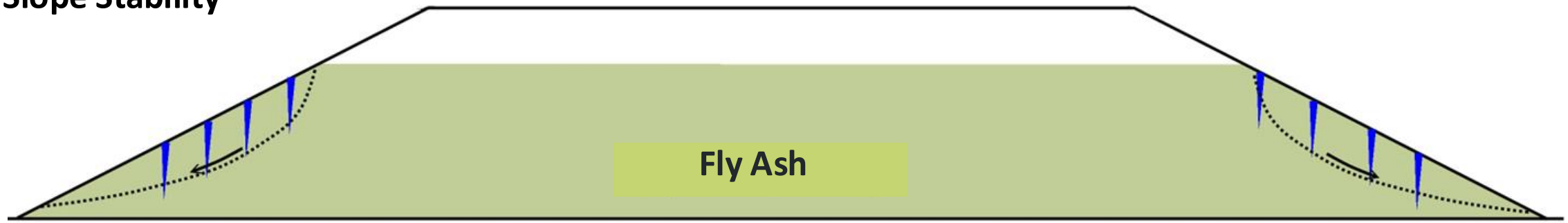
3. **"Unsuitably wet"** after rain or inundation – options include drying, stabilise, spoiling (if project has excess) or use as is – depends on many job specific considerations

Source of photos: TfNSW R44 Earthworks Training Course

Earthworks – Challenges and Opportunities

Other Considerations:

Slope Stability



Batter Tolerance

04

Granular Materials

Granular Materials - Challenges and Opportunities

QA 3051 Granular Pavement Base and Subbase Materials

- Constituent Material
- Performance considerations
- Commercial considerations

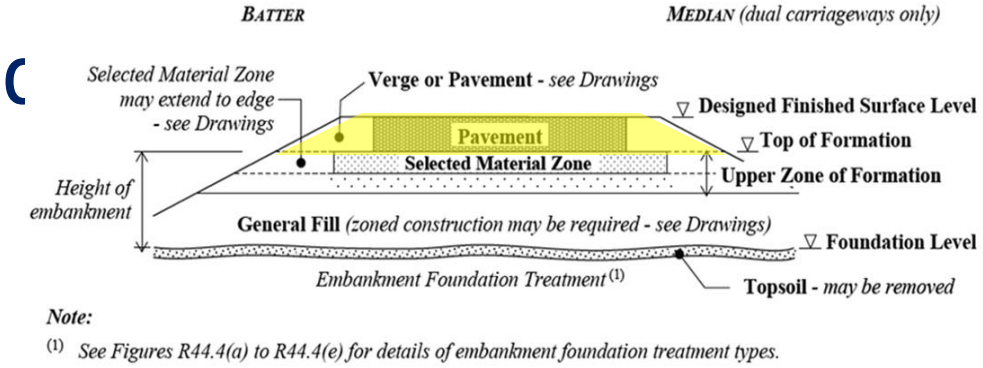


Figure R44.1(b) – Embankment Nomenclature

Table 3051.5 - Limits on Use of Recycled and Manufactured Materials as Constituent Materials

Material	Unbound or Modified Base and Subbase	Bound Base and Subbase
Slag (1)	max 100%	max 100%
Crushed Concrete (2)	max 100%	max 100%
Crushed Brick (3)	max 20%	max 10%
Recycled Asphalt Pavement (RAP) (4)	max 40%	max 40%
Fly Ash (5)	max 10%	max 10%
Furnace Bottom Ash (5)	max 10%	max 10%
Crushed Glass Fines (6)	max 10%	max 10%

Notes:

(5) The addition of fly ash or furnace bottom ash may not be acceptable if modification is to be carried out.

05

Cementitious Materials

Cementitious Materials - Challenges and Opportunities

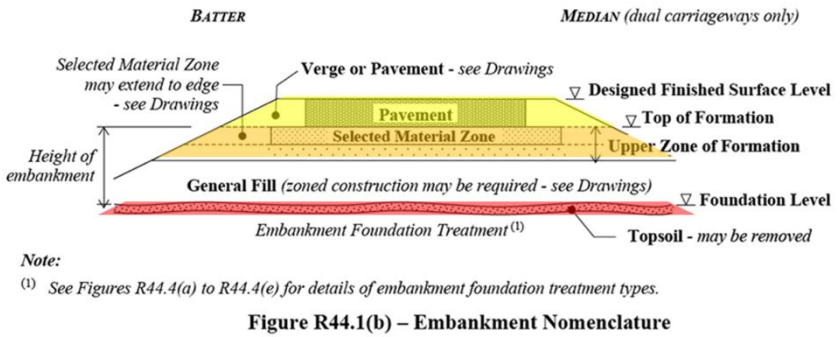


Figure R44.1(b) – Embankment Nomenclature

QA 3211 Cementitious Materials, Binders and Fillers

Fly Ash used as a supplementary cementitious material:

- Long established history of fly ash usage
- Improved long term performance outcomes
- Commercially viable, high value product
- Environmental and sustainability benefits

Photo: Pacific Highway Upgrade, Woolgoolga to Ballina

Cementitious Materials - Challenges and Opportunities

QA 3211 Cementitious Materials, Binders and Fillers

Fly Ash used as a supplementary cementitious material:

- Importance of material characterisation
- Strict criteria for acceptance because this impacts performance
- Air entraining agents are currently used in rigid pavements. They provide rheology and constructability benefits.
- Performance of air entrainers is influenced by many factors, including unburnt carbon, measured by LoI testing.

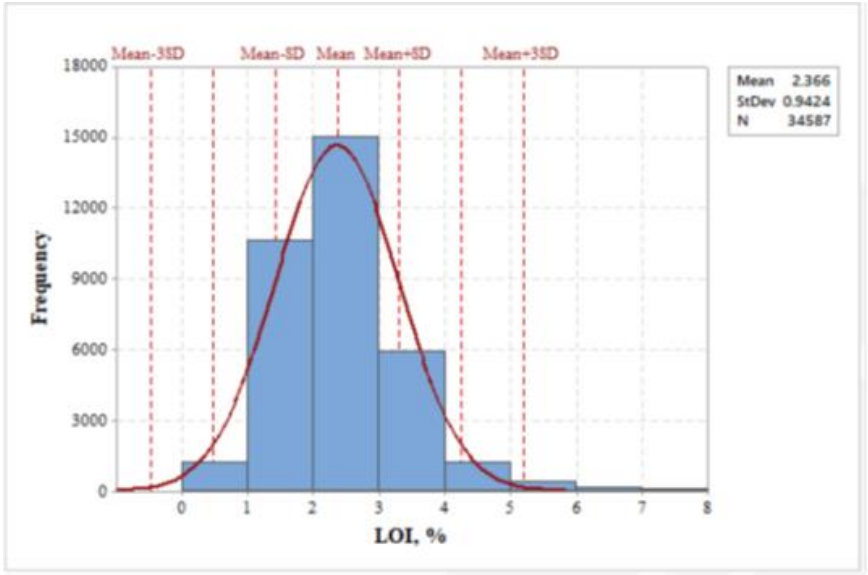


Table 3211.1 – Fly Ash Uniformity Requirements

Property	Formula	Limit
Carbon content (by loss on ignition)	$LoI_{avg} + 3SD$	≤ 4%
Fineness	$Fineness_{avg} + 3SD$	≤ 100%
	$Fineness_{avg} - 3SD$	≥ 75%
	CoV	≤ 3.0%

where:

LoI_{avg} = Mean of the test results

SD = Standard deviation of the test results expressed as a decimal

$Fineness_{avg}$ = Mean of the test results

CoV = Coefficient of variation of the test results = $\frac{SD}{Fineness_{avg}} \times 100\%$

Cementitious Materials - Challenges and Opportunities

QA 3211 Cementitious Materials, Binders and Fillers

Fly Ash used as a supplementary cementitious material:

- Changing Fly Ash acceptance criteria carries risk
- Risk needs to be transferred to those best capable of managing the risk
- Risk must consider contractual arrangements
- The supply chain must have confidence in the changes and the ability to achieve performance, commercial and environmental outcomes

Thank you

Special thanks to:

- **Hossein Asadi** (Senior Manager, Pavements, Infrastructure & Place, TfNSW)
- **Sheena Murugan** (Senior Manager, Materials, Infrastructure & Place, TfNSW)
- **Basil Ben** (Pavements Manager (Rigid Pavements), Infrastructure & Place, TfNSW)
- **James Allen** (Pavements Manager (Flexible Pavements), Infrastructure & Place, TfNSW)
- **Michael Hughes** (Senior Manager Geotechnical Science, Infrastructure & Place, TfNSW)
- **Gary Rigozzi**