Form A (version 2)

ADDENDUM TO THE INDIVIDUAL EXPERT REPORT OF DR STEVE PERRENS

COURT DETAILS

Court	Land and Environment Court of New South Wales
Class	1
Case number	2016/159652 (formerly 2015/10898) & 2016/157848 (formerly 2015/10951)

TITLE OF PROCEEDINGS

PROCEEDINGS 2016/159652

Applicant	**Liverpool City Council**
First respondent	**Moorebank Recyclers Pty Ltd**
Second respondent	**Minister for Planning**

PROCEEDINGS 2016/157848

First applicant	**Benedict Industries Pty Limited**
Second applicant	**Tanlane Pty Limited**
First respondent	**Minister for Planning**
Second respondent	**Moorebank Recyclers Pty Limited**

PREPARATION DETAILS

Prepared for	**Moorebank Recyclers Pty Ltd,** First respondent in proceedings 2016/159652 and Second respondent in proceedings 2016/157848
Legal representative	Mark Gerard McDonald, Mark McDonald & Associates Lawyers Pty Ltd
Legal representative reference	MGM 01/246
Contact name and telephone	Mark Gerard McDonald, (02) 9293 2519
Contact email	mgmcdonald@ozemail.com.au

Land and Environment Court: Proceedings 2016/159652 and 2016/157848

Materials Recycling Facility, Moorebank

Addendum to Expert Report:
Sewage Management, Flooding and Stormwater

Dr Steve Perrens

16 September 2016

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1 Introduction

1 This document provides an addendum to my earlier report dated 19 August 2016 (**my earlier report**) which was prepared during overseas travel when I had limited access to internet resources.

2 In particular, this addendum provides further assessment of matters relating to stormwater that are covered in Section 6 of my earlier report:

- The required water quality standard for any stormwater discharge;
- The similarities and differences between the methods adopted by Dr Martens and myself for assessing the effectiveness of stormwater treatment processes; and
- The adequacy of the proposed stormwater treatment system.

3 This addendum also:

- Updates some details of the proposed site landform and surface drainage that have been developed to align with the *Remediation Action Plan* (being prepared by Environmental Resource Management) and geotechnical considerations; and
- Provides further assessment in relation to the potential impacts of the proposed development on flood levels.

2 Discharge Water Quality Requirements

4 I have further reviewed the Liverpool City Council web site in order to ascertain the water quality requirements of the Liverpool DCP 2008 and the standard imposed by Council in its approval of a development application (**DA**).

5 On 15 July 2016 Council approved DA-100/2015 for *the subdivision of one lot into two with demolition of existing structure and construction fourteen multi dwelling units on proposed lot 1 and retention of existing dwelling on proposed lot 2.* Council's notice of Determination includes the following requirement in relation to stormwater:

> *"26. Prior to the issue of a Construction Certificate the Certifying Authority shall ensure that details of the stormwater pre-treatment system have been provided on the stormwater plans and that the design meets the retention criteria in accordance with Council's Development Control Plan."*

6 As noted in Paragraph 116 of my earlier report, Part 1, Section 6.4 of the Liverpool DCP 2008 (Amended 10 June 2016), includes the following controls for stormwater discharge from development sites:

> *"1 The post development water quality shall be reduced to the following targets when compared to pre development water quality:*
> - *45% reduction in the mean annual load of total nitrogen.*
> - *45% reduction in the mean annual load of total phosphorus.*
> - *80% reduction in the mean annual load of total suspended solids."*
>
> *2. In the case of areas were council has adopted a master plan or in Part 2 specifying water quality targets. The requirements of those documents shall be utilised in preference to the targets listed above.*

3. *In the case of green field developments where Council has not adopted a master plan or is not included in Part 2 of the DCP specifying water quality targets the above targets shall be utilised by comparing post development water quality with that of a conventional stormwater drainage design without water quality treatment for an urbanised development.*

7 Sites adjacent to the proposed Development that have locality specific controls specified in Part 2 of the DCP are:

- Subdivision of land and residential development in Georges Fair, Moorebank (Part 2.3, amended 3 September 2014); and
- Development in Moorebank East (Benedict Sands) (Part 2.10, amended 19 February 2014).

8 Section 2.5 of Part 2.3: Subdivision of land and residential development in Georges Fair, Moorebank specifies the following stormwater management controls:

"1. Consider the use of bio-retention swales in road verges and maximise runoff flow onto grassed areas where feasible.

2. Use gross pollutant traps and water quality control ponds to remove suspended sediment, nutrients and bacteria. The gross pollutant traps and water quality control ponds are to be located in the areas zoned R3 - Medium Density Residential or before discharging into land zoned E3 - Environmental Management."

9 Section 2.7: of Part 2.10 Moorebank East (Benedict Sands) specifies the following stormwater controls:

"1. The site should be generally drained east toward the Georges River, rather than to the drain on the western side of the site.

2 An onsite detention basin is required to avoid any increase in peak stormwater discharge from the drain on the western boundary of the property.

3. Use gross pollutant traps and water quality control ponds to remove suspended sediment, nutrients and bacteria."

10 Neither of the locality specific controls quoted in Paragraphs 8 and 9 above specify any specific additional controls that would over-ride the requirements of Part 1, Section 6.4 of the Liverpool DCP 2008 quoted in Paragraph 6 above.

11 For consistency with a recent DA approval and Council's DCP, I consider that the requirements for reductions in mean annual pollutant load quoted in Paragraph 6 to be applicable to the proposed development of a recycling facility for demolition and construction waste.

3 Stormwater Quality Modelling

12 Any computer model is only a representation of real world processes based on a conceptualisation of the key processes that need to be considered. While Dr Martens and I have utilised different conceptual models, both models consider the key processes, namely:

- Rainfall onto the surface of the land leading to some loss (by infiltration or evaporation) and resulting in surface runoff;
- Collection of various pollutants from the land surface by the surface runoff;
- Capture and storage of runoff for purposes of dust control;

- Treatment of excess runoff before discharge from the site.

13 The difference in our modelling approaches relates to how the processes listed above are characterised and the assumptions made regarding the associated parameters. However, both approaches are similar in that the model results are expressed as the percentage change or reduction in the average annual pollutant loads themselves, which is consistent with Council's requirement as set out in Paragraph 6 above.

14 Dr Martens has carried out a stormwater pollution assessment using the stormwater modelling system '*Model for Urban Stormwater Improvement Conceptualisation*' (**MUSIC**). MUSIC is primarily used for the conceptual design of urban stormwater systems for new residential and light industrial developments, and the assessment of the effectiveness of different stormwater treatment options.

15 Dr Martens provides relatively few details of the assumptions underlying his model and simply states that, "*I have made a range of assumptions based on accepted engineering principles to enable the MUSIC model to be constructed.*" Based on the outline provided in his report, the system diagram provided in Attachment B of his report and model characteristics set out in '*Draft NSW Music Modelling Guidelines*' (Sydney Metropolitan Catchment Management Authority, 2010) (**the MUSIC Guidelines**), I understand that Dr Martens' model is based on the following:

15.1 The model is structured as:

- three sub-catchments within the operating area each of which drain to a sediment basin which discharges into a grassed swale before draining off-site;
- a sub-catchment within the operating area which drains to a sediment basin which discharges into a bio-retention swale before draining off-site;
- a sealed carpark which drains to the same bio-retention swale as the carpark before draining off-site;
- the access road which drains off-site without treatment.

15.2 Runoff is characterised as:

- 'Unsealed road' for the operational area and access road for which the MUSIC Guidelines only provide a 'runoff threshold' of 1.5 mm but all other runoff characteristics are dependent on soil type (unstated by Dr Martens);
- 'Sealed road' (? text is unclear) for the carpark area for which the MUSIC Guidelines quote a 'runoff threshold' of 1.5 mm and, by implication, assumes that all subsequent rainfall is converted to runoff;

15.3 Dr Martens does not specify the adopted runoff pollutant characteristics. The MUSIC Guidelines specify that pollutant runoff should be modelled by means of an in-built stochastic model that uses mean and standard deviation concentrations expressed as logarithms to base 10. For sealed roads these concentrations are based on data published by Fletcher et al (2004). However, for unsealed roads the MUSIC Guidelines are simply designated as "*Additional surface type not included in Fletcher et al (2004)*", with no additional attribution. Mean concentrations in the Table 1 below are based on the values for storm flow in Table 3.10 of the MUSIC Guidelines which have been transformed back from logarithms to 'natural' numbers.

Table 1: Mean Concentrations of Pollutants for Sealed and Unsealed Roads

Land Use	Mean Concentration (mg/L)		
	Total Suspended Solids	Total Phosphorus	Total Nitrogen
Sealed Roads	269	0.50	2.19
Unsealed Roads	1,000	0.50	2.19

(Source: Table 3-10. Draft NSW MUSIC Modelling Guidelines)

15.4 As noted in paragraph 15.1, each sub-catchment within the operating area drains to a sediment basin. Dr Martens does not provide any details of the capacity or how these basins are assumed to operate. The MUSIC Guidelines state that "*The basin sizing is typically based on a specific design event and should be undertaken applying the approaches outlined in the current version of Managing Urban Stormwater Soils and Construction – Volumes 1 and 2 (the 'Blue Book').*" I note that these are the same publications that have been used to determine the volume and pump transfer rates for the stormwater collection sumps in my model.

15.5 Dr Martens states that he has estimated the length of swales from "*information provided in the 2013 Water Report, and measurements made using the Six Maps viewer system provided by the NSW Government*". No details are provided as to which measurements were made using the Six Maps viewer or how the modelled lengths differ from details provided in the *2013 Water Management Report*. Dr Martens' report infers that the standard MUSIC model pollutant reduction characteristics of the vegetated and bio-reduction swales have been adopted.

15.6 For his 'Scenario 1' Dr Martens assumes that water re-use (for dust suppression) is a uniform 43.3 kL/day (or one third of the peak rate quoted in the *2013 Water Management Report*). It is unclear whether this water is sourced from the sediment basins individually or some other source and what storage volume is used to provide the supply. As noted in Paragraph 140 of my earlier report, the use of a constant daily water re-use value misrepresents the variation of water use for dust suppression that would occur in practice. This is a key limitation of a MUSIC model for characterising water use for operations such as those proposed at the site, where dust suppression is an important aspect of site management. I have further explained the basis for my view in Paragraph 141 of my earlier report.

15.7 Dr Martens provides no details of the rainfall data used for his modelling.

16 The *2013 Water Management Report* provides details of the stormwater analysis developed specifically to characterise the main stormwater pollution reduction mechanism for the project; namely the capture and storage of runoff for use in dust suppression. The reuse of stormwater in this manner represents an efficient use of water resources by minimising the volume of potable water that would otherwise be required for dust suppression. The analysis in the *2013 Water Management Report* consist of a water balance model for the assessment of the capture, storage and reuse of stormwater and the use of a published graphical method (DECC, 2008) to assess the pollutant load reduction achievable using vegetated swales and or bio-retention swales to treat overflow discharge. Features of the analysis that are similar to, or different from, Dr Martens' analysis are outlined below.

16.1 The model has been developed to specifically determine:

- the proportion of water that is required for dust suppression which can be provided by stormwater runoff;
- the percentage reduction in average annual pollutant loads (as required by Council's DCP – see Paragraph 6 above).

Because water for dust suppression can be drawn from any of the storage tanks, the model treats the operational area as a single unit. The model assumes that any overflow discharge from the four outlets would occur in proportion to the contributing sub-catchment area.

16.2 Runoff is separately characterised for each of the different surfaces within the operating area (roofs, stockpiles, roadways and parking, grass and landscaping, and other operating areas) as set out in Table 6 of the *2013 Water Management Report*. The relevant runoff characteristics are based on published data, MUSIC modelling of runoff from a hardstand surface and my experience on quarry and landfill sites.

16.3 The analysis provides an assessment of the percentage reduction in pollutant loads achieved by:

- Capture and re-use of stormwater for dust suppression purposes (assessed by means of a daily water balance model as described in Section 3.5 of the *2013 Water Management Report*). This aspect of the model provides for pumping of water captured in stormwater sumps to storage tanks and the removal of water for dust suppression as determined by an algorithm that links water demand to daily climate variation. The model assumes that any shortfall of supply for dust suppression is provided from the mains water supply;
- Treatment of overflow by means of vegetated swales or bio-retention swales using published performance graphs for sediment, as set out in Annexure E of the *2013 Water Management Report*. Although not considered at the time, the same graphs also provide a means of assessing the pollutant load reduction for nitrogen and phosphorus (see Section 4 below).

16.4 As noted in Paragraph 107 of my earlier report, the capture and re-use of stormwater runoff is fundamental to the proposed water management system. Realistic representation of water re-use is a key factor which governs the proportion of site runoff that can be retained for re-use. For the water balance analysis presented in the *2013 Water Management Report* the day-to-day variation in water required for dust suppression was modelled using an algorithm based on the work of Thompson and Visser (2002) that demonstrated a robust relationship between water requirements for dust suppression and the potential evaporation on the day, while taking into account any incident rainfall.

16.5 For purposes of water balance modelling, a 33 year historic daily rainfall record from Bankstown Airport was adopted.

17 The comparisons in Paragraphs 15 and 16 above show that the different approaches each have strengths and limitations. However, I consider the different approaches to be complementary rather than contradictory. Further evidence for this view is provided on Section 4 below.

4 Results of Stormwater Modelling

18 In Paragraph 100 of my earlier report I acknowledge that the stormwater analysis in the *2013 Water Management Report* focussed primarily on measures to retain and treat sediment and oil. Nevertheless I contend that the proposed stormwater 'treatment train' would also significantly reduce any nitrogen or phosphorus loads originating from the Development. I also consider that the stormwater modelling undertaken for the Operational Area is appropriate for the specific conditions on the site.

19 As set out in the *2013 Water Management Report*, the proposed stormwater 'treatment train' involves a number of different pollution control processes:

- Capture of stormwater runoff for re-use within the Site (which accounts for over 70% of the runoff);
- Stormwater collection sumps that provide for sediment settlement and retention of any hydrocarbons prior to discharge of any overflow; and
- Overflow conveyance through a bio-retention swale or natural vegetated swales for further removal of sediment, nitrogen and phosphorus before discharge towards the Georges River.

20 I concede that in 2013 I initially formed the view that nitrogen and phosphorus were unlikely to be of significant concern. Recent monitoring data quoted in Paragraphs 97 and 98 of my earlier report indicate that my initial view was incorrect. Notwithstanding, the proposed stormwater 'treatment train' is capable of treating both nitrogen and phosphorus as well as sediment and hydrocarbons. Table 2 below provides an analysis of the reduction in average annual pollutant loads using the methodology outlined in Paragraph 16.3 above.

Table 2: Stormwater Pollutant Reduction for Proposed Stormwater Management System

Treatment Process	Reduction in Average Annual Pollutant Load (%)			
	Hydrocarbons, Litter	Sediment	Nitrogen	Phosphorus
Retention and reuse of stormwater runoff for dust suppression (from the water balance model)	-	71%	71%	71%
Overflow cap on overflow outlet	100%	-	-	-
Vegetated swales (from Annexure E of the *2013 Water Management Report)*	-	20%	2%	10%
Total pollutant load reduction	100%	91%	73%	81%
Council requirement (Section 6.4 of the Liverpool DCP 2008)		80%	45%	45%

21 Clause 3 of Part 1, Section 6.4 of the Liverpool DCP 2008 (quoted in Paragraph 6 above) requires that for a green field development where Council has not adopted a master plan or is not included in Part 2 of the DCP specifying water quality targets, target reductions in average annual pollutant load shall be assessed by comparing post development water quality with that of a conventional stormwater drainage design without water quality treatment for an urbanised development.

22 In the case of the proposed Development, a conventional stormwater drainage design without water quality treatment would simply involve directing stormwater off-site in a manner which did not cause erosion of the batters of the landfill.

23 Accordingly, the percentage reductions quoted in Table 2 are consistent with Council's requirements in terms of both assessment methodology and annual load reductions.

24 The data in Table 2 demonstrates that the proposed stormwater management system would achieve a level of pollutant reduction significantly in excess of Council's requirements as set out in Paragraph 6.

25 Table 1 in Dr Martens' report (reproduced as Table 3 below) summarises the results of his MUSIC modelling for 'Scenario 1' which represents that case in which a daily average of 43.3 kL of water is used for dust suppression.

Table 3: MUSIC Stormwater Modelling Results for Scenario 1

Parameter	Existing Conditions	Developed Conditions	Change %
Annual site discharge (ML/year)	15.1	16.5	+9
Suspended Solids (kg/year)	2,250	1,940	-14
Total Phosphorus (kg/year)	3.6	2.8	-22
Total Nitrogen (kg/year)	29.4	28.5	-3

Source: Table 1, Drainage and Flooding Expert report prepared by Dr Martens (5 August 2016),

26 Notwithstanding my concerns about shortcomings of Dr Martens' MUSIC model, particularly the way that water re-use is modelled, the results in Table 3 indicate that the proposed stormwater system would achieve a net reduction in annual pollutant loads discharged from the site. I consider that, in practice, a significantly greater reduction in pollutant loads could be achieved because a higher proportion of runoff could be collected for reuse than represented in Dr Martens' modelling. Table 2 in his report shows that without any reuse of water for dust suppression, the discharge for developed conditions would be 27.4 ML, whereas with water reuse the site discharge would be 16.5 ML (from Dr Martens' Table 1). This implies that the water use for dust suppression in Scenario 1 would be 10.9 ML (27.4 – 16.5). The use of 10.9 ML for dust suppression equates to 29.9 kL/day (not 43.3 kL/day as stated earlier in Dr Martens' report). In turn, 29.9 kL/day is only about 43% of the water use represented in my water balance model (25.4 ML/year or 69.6 ML/day).

27 Table 2 in Dr Martens' report (Scenario 2) shows that without any reuse of water for dust suppression, the discharge for developed conditions would increase pollutant loads. This is hardly surprising because the capture and reuse of stormwater runoff is a key aspect of the proposed water management system for the Development. Accordingly, Scenario 2 does not represent a realistic scenario.

5 Conclusions Relating Stormwater Quality

28 In relation to Council's contention No 9 relating to stormwater quality, I consider that:

28.1 The stormwater quality analysis, based on an appropriate stormwater quality model that is specific to the features of the site (particularly stormwater reuse) demonstrates

that the treatment achieved by the proposed stormwater management system would be consistent with Council's requirements for reduction in average annual load (see Table 2 above).

28.2 I acknowledge that nitrogen and phosphorus were not specifically modelled in the analysis presented in the *2013 Water Management Report*. However, the analysis in Table 2 demonstrates the proposed stormwater treatment train would achieve reductions in average annual nitrogen and phosphorus loads in excess of Council's requirements.

28.3 Whilst I disagree with some details of Dr Marten's MUSIC model, his Scenario 1 demonstrates that the proposed treatment train is capable of achieving a reduction in average annual pollutant loads compared to existing conditions.

28.2 However, I consider that Dr Martens' Scenario 1 underestimates the volume of water that would be required for dust suppression by a factor of about two. Consequently, I consider that Dr Martens has underestimated the pollutant load reduction achievable.

6 Final Landform and Surface Drainage

29 The final surface levels within Areas 1 and 2 will depend on a number of factors:

- The volume of waste (if any) to be relocated into Areas 1 and 2;
- The effectiveness of heavy compaction following lowering of the level of leachate within the waste;
- The thickness of any additional material required to supplement the existing capping.

30 The principles that will govern the final levels include:

- Construction of a landfill cap that complies with the Remedial Action
- Creation of a landform with typical grading of 2% or greater for surface drainage.

31 Figure A1 (next page) shows the indicative regraded landform following the completion of the implementation of the actions proposed under the *Remediation Action Plan* and re-construction of the landfill cap in accordance with the principles set out in Paragraphs 29 and 30 above. This figure supersedes Figure 1 in my earlier report.

32 Figure A2 is an updated version of Figure 4 in my earlier report. This figure reflects further geotechnical advice.

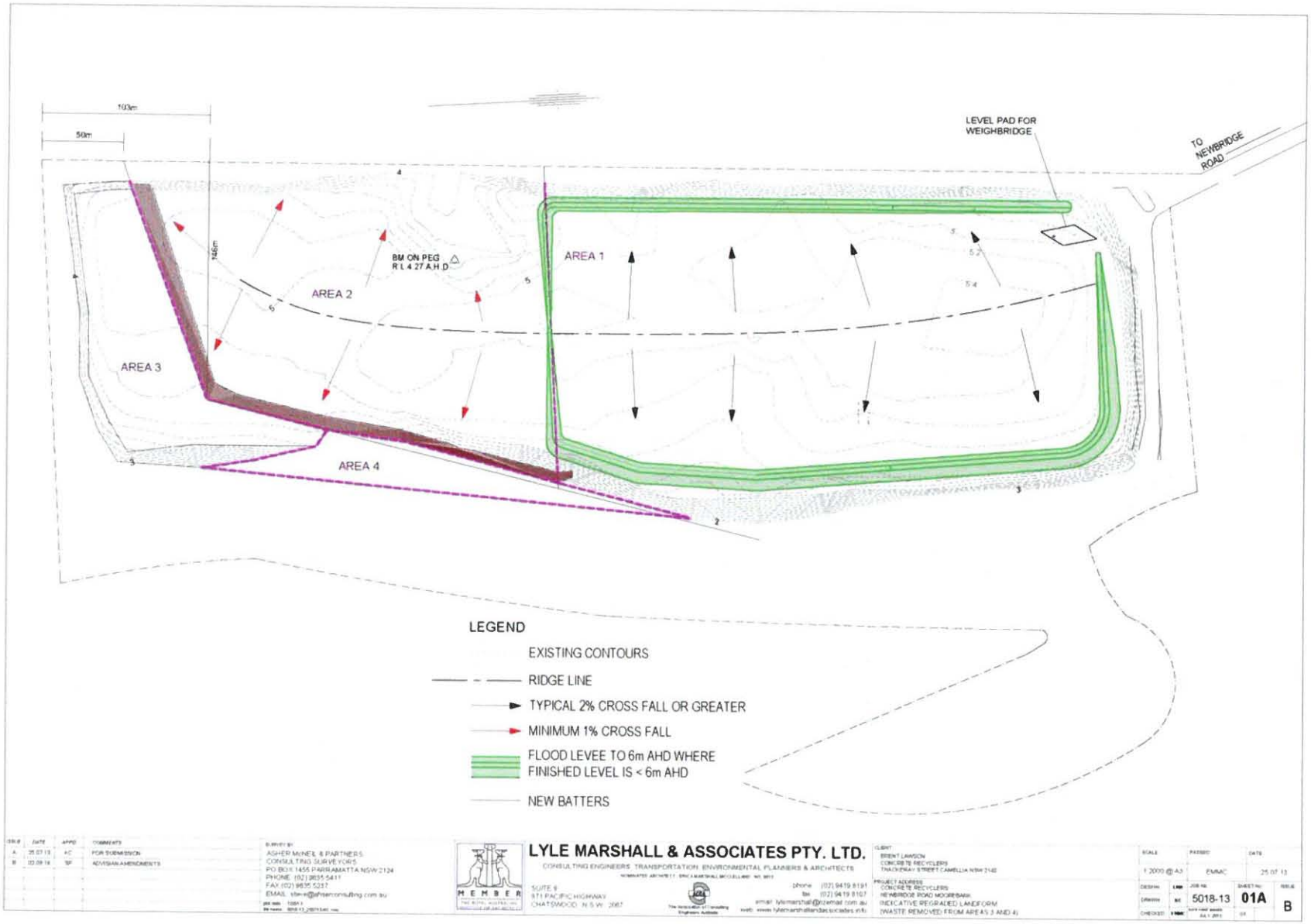

Figure A1: Indicative Regraded Landform

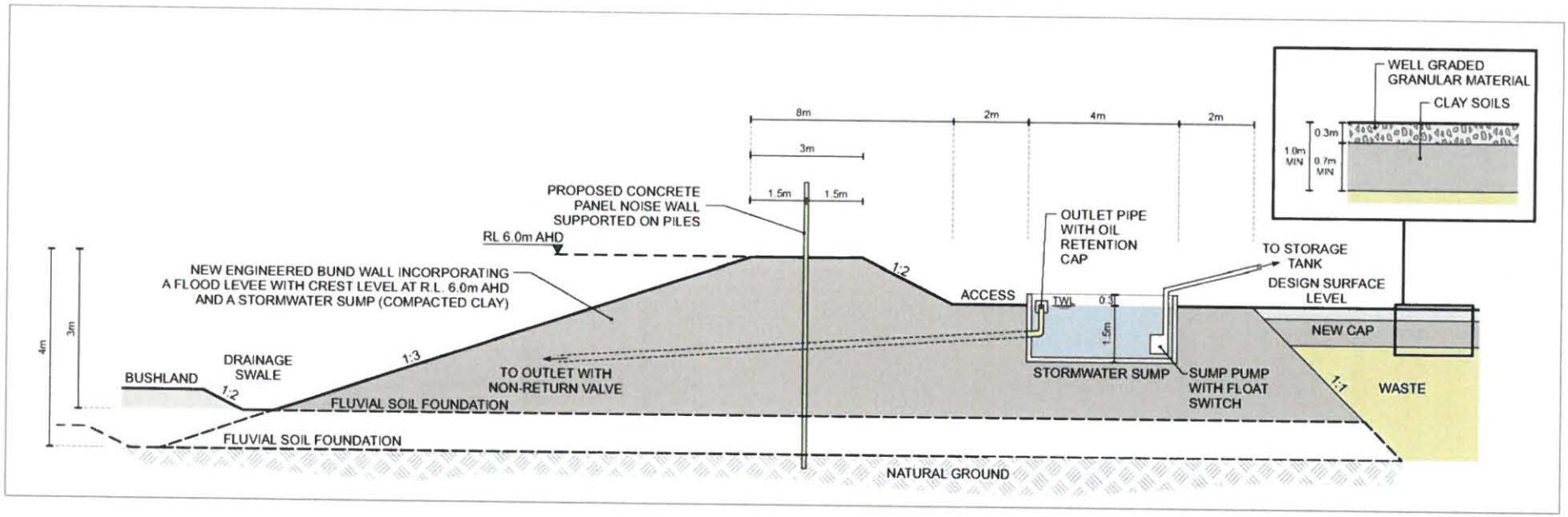

Figure A2: Indicative Arrangement for the Southern Stormwater Sump and Flood Levee Adjacent to the Eastern Leachate Bund

7 Flooding

33 In Paragraph 39.3 of my earlier report dated 19 August, I noted that Scenario B (that was examined as part of the flood assessment report prepared by WMAwater [August 2016]) assessed the flood effects of removal of waste from Areas 3 and 4 (as designated on Figure A1 above). As noted in Paragraphs 41.3 of my earlier report, the analysis indicated that the removal of waste from this area "*provides no benefit in terms of flood levels*". Accordingly, from a flooding perspective, there is no benefit to be gained from carrying out this aspect of the earthworks approved by Liverpool City Council in 2006.

8 Reference Documents

34 Documents referenced in this addendum are listed below.

Department of Environment and Climate Change, (2008), *Managing Urban Stormwater: Treatment Techniques, Consultation Draft*, DECC, Sydney

Environmental Resource Management (September 216), *Materials Recycling Facility, Moorebank - Remediation Action Plan*

Fletcher T, et al, (2004), *Stormwater Flow and Quality and the Effectiveness of Non-Proprietary Stormwater Treatment Measures – A Review and Gap Analysis*, Technical Report 04/8, CRC for Catchment Hydrology, Melbourne

Sydney Metropolitan Catchment Management Authority (2010), *Draft NSW Music Modelling Guidelines*, report prepared by BMT WBM

Thompson and Visser (2002), *Benchmarking and management of fugitive dust emissions from surface mine haul roads*, Trans. Inst. Min. Metal. V110, SA, A28 –A34.