ANNEXURE 9

Geotechnical Report

prepared by

Coffey Geosciences

ANNEXURE 9

Manildra Group Pty Ltd

Proposed Packing Facility, Bolong Road, Bomaderry NSW

Geotechnical Investigation and Assessment

23 February 2016

In a
turbulent
world
we provide
clear thinking

Proposed Packing Facility, Bolong Road, Bomaderry NSW

Prepared for
Manildra Group Pty Ltd
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Bomaderry NSW 2541
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23 February 2016

Our ref: GEOTWOLL03845AA-AB rev1

Dear Aaron,

Please find enclosed our revised geotechnical investigation and assessment report for the proposed packing facility within the Manildra plant along Bolong Road, Bomaderry NSW. The revision covers the slope stability analysis for the section of rail siding and access road and associated fill embankment adjacent to the bank of Abernethys Creek..

We draw your attention to the document following the report text entitled ‘Important Information about Your Coffey Report” which should be read in conjunction with this report.

Should you have any questions in relation to this report please contact the undersigned in our Wollongong office.

For and on behalf of Coffey

Dominic Trani
Senior Geotechnical Engineer

Quality information

Revision history

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0	Final	11/01/2016	Dominic Trani	Jon Thompson	Dominic Trani
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1. Introduction

The Manildra Group (Manildra) has proposed modifications to its packing facility within its Bomaderry plant. It is understood that the proposed development in relation to the packing facility comprises:

- Packing warehouse buildings;
- Truck load silos and associated facilities;
- Two car parks to the north and south east of the packing warehouse buildings;
- Internal road network to the buildings;
- Container storage area;
- A rail line extension (spur line off the existing line); and
- A bridge over Bolong Road and associated access to the buildings.

This report presents the results of the geotechnical investigation and assessment undertaken by Coffey Geotechnics Pty Ltd (Coffey) with consideration of the following objectives:

- Assessment of the geotechnical conditions within the site for the proposed packing warehouse buildings, truck loadout silos and associated facilities, and a bridge over Bolong Road. The report also provides advice on bearing capacity for the soils and rock encountered and suitable footing systems for the proposed structures;
- Assessment of the potential effects of the development (specifically the fill embankments or fill platform for the access road and railway, and associated train and truck loads) on the stability of the Abernethy's Creek bank; and
- Geotechnical report discussing the findings of the investigation and recommendations in relation to the above objectives.

2. Scope of work

To address the objectives outlined above, the following scope of work has been completed:

- Review of relevant geotechnical investigation data from a previous investigation of the Packing Facility site by Coffey:
  - Coffey had previously carried out a preliminary environmental assessment and geotechnical investigation at this site in 2008 (refer to Coffey report ENVIUNAN00111AA dated 25 June 2008). The main objective of the 2008 investigation was environmental assessment and about 60% of the boreholes and test pits were excavated for environmental purposes and provided only limited geotechnical information. Some geotechnical investigation and testing were also carried out to provide general recommendations in relation to the proposed facilities within the proposed construction footprints and alignments.
  - Coffey also carried out a geotechnical investigation at this site (refer to Coffey report GEOTWOLL02584AU-AB rev.1, dated 13 July 2012) in relation to the proposed rail spur.
- Geotechnical investigation for the packing warehouse building, including:
  - Drilling of two boreholes CBH508 and CBH509 with a track mounted drilling rig within the footprint of the proposed packing warehouse building, truck load silos and associated facilities. The boreholes were drilled to maximum depths of 15.85m and 18.75m, respectively. The boreholes were drilled to Tungsten Carbide (TC) bit refusal on rock and then continued in rock below this level using diamond coring techniques for a further 5.15m and 3.05m, respectively. Standard Penetration Tests (SPTs) were carried out at an initial depth of 1m and

then at 1.5m intervals to 6m, then at 3m intervals to refusal, to assess soil consistency or relative density. The approximate locations of the boreholes are shown in Figure 1; and

  - Point Load testing of 12 rock core samples to assess rock strength (Point Load Index Strength Tests).
- Geotechnical investigation for the proposed pipe and pedestrian bridge over Bolong Road:
  - Drilling of two boreholes CBH510 and CBH511 with a track mounted drilling rig at the northern and southern abutments, respectively. The boreholes were drilled to maximum depths of 17.9m and 18.9m, respectively. The boreholes were drilled to TC bit refusal on rock and then continued in rock below this level using diamond coring techniques for a further 6.15m and 7.15m, respectively. SPTs were carried out at an initial depth of 1m and then at 1.5m intervals to 6m, then at 3m intervals to refusal, to assess soil consistency or relative density. The approximate locations of the boreholes is shown in Figure 1; and
  - Point Load testing of 12 rock core samples to assess rock strength (Point Load Index Strength Tests).
- Site visit by a senior geotechnical engineer to position the boreholes and assess access for a drilling rig to the test locations;
- A geotechnical engineer from Coffey was onsite full time during fieldwork to log the subsurface conditions;
- The approximate location of the boreholes was recorded based on the existing site features and by use of a handheld GPS to provide eastings and northings;
- Stability assessment of bank of Abernethys Creek:

  Numerical assessment to assess the stability of the bank of Abernethys Creek in relation to proposed adjacent access road and nearby railway. One section at the closest location of the proposed road and railway to the creek bank was selected for analysis; and
- Provision of a report providing the results of the investigation including a summary of the subsurface conditions encountered and advice in accordance with the objectives of the investigation outlined in Section 1.

3. Results of the investigation

3.1. Local geology

Reference to the 1:100,000 Kiama Soil Landscape Series Sheet (9028, First Edition), produced by the Department of Conservation and Land Management NSW (1993) indicates that the site is located on Shoalhaven Soils. These soils are described as moderately deep Prairie Soils on levees, Red Earths and Yellow and Red Podzolic Soils on terraces and Alluvial Soils and Greyed Podzolic Soils on the floodplains.

Reference to the 1:250,000 Wollongong Geological Series Sheet (S1 56-9, First Edition) prepared by the NSW Department of Mines (1952) indicates the site is likely to be underlain by Quaternary alluvium, gravel, swamp deposits and sand dunes. Coffey's extensive experience from investigations within and around the Manildra Plant indicates that alluvial deposits over 20m in depth may occur in this area. These alluvial deposits may include silts and clays, silty sands and sands of variable consistency or density, including some very soft zones.

3.2. Site surface observations

The proposed packing plant is bounded by Bolong Road to the southeast, Abernethys Creek to the east, the Shoalhaven Starches Plant rail line to the southwest, light industrial premises (comprising businesses for smash repairs, auto repairs, sheet metal, glass and mirrors) to the west and the Bomaderry Sewerage Treatment Works to the north.

The site of the proposed packing facility is part of a vacant grass covered area used to keep horses. Some ponding of water was noted at the time of the fieldwork as a result of recent rainfall preceding this time. The ground surface was noted to be spongy and soft under foot. The ground surface appeared to be slightly more elevated towards the west nearer the neighbouring western properties (refer to **Photograph 1**).

The site of the southern abutment for the proposed bridge over Bolong Road has a grass cover and is bounded by Abenethys Creek to the east, a building to the south, and Bolong Road to the north (refer to **Photograph 2**). The site of the northern abutment for the proposed bridge is located on the northern side of Bolong Road. This area partly comprised car parking and a vacant grass covered area noted to be soft and spongy under foot (refer to **Photograph 3**). A sewer pumping station is located just outside the southern part of this area near Bolong Road. This area has a 3m wide easement for a sewer line aligned across the site from Bolong Road to the sewerage treatment plant.

Photograph 1. View of the grass covered area proposed for the packing facility – looking west.

Photograph 2. General location of the southern abutment of the proposed bridge over Bolong Road – looking east.

Photograph 3. View looking north of the potential alignment of the bridge over Bolong Road.

3.3. Subsurface conditions

Table 1 below presents a summary of the subsurface conditions encountered in the boreholes positioned within the proposed footprint of the packing plant warehouse building. **Table 2** below presents a summary of the subsurface conditions encountered at the abutments of the proposed bridge over Bolong Road. The engineering borehole logs with explanatory notes are presented in **Appendix A**.

Table 1. Summary of interpreted subsurface conditions, boreholes CBH508 and CBH509.

Unit	Material / Origin	Depth range to top of unit (m)	Thickness of unit (m)	Description
1	Topsoil	0.0	0.3 to 1	Silty CLAY: low to medium plasticity, dark brown/ dark grey, trace of fine grained sand, trace of organics (rootlets). Soft to firm in consistency.
2a	Alluvial (or estuarine) Clay	0.3 (only in CBH509)	2.3	Silty CLAY: medium plasticity, grey/ dark grey mottle, trace of fine grained sand, trace of organics (rootlets). Soft to firm in consistency.
3	Residual/ Extremely Weathered Material	1 to 2.6	9.7 to 13.1	Silty CLAY/ Silty Sandy CLAY: medium to high plasticity, grey mottled red/orange, fine grained sand, trace of fine to medium grained sub-angular to sub-rounded ironstone/ quartz gravel. Firm to hard in consistency.
4	Sandstone	10.7 to 15.7	Not proven (end oh hole ranges from15.85 to 18.75)	Extremely Weathered (XW) to Fresh SANDSTONE: fine to coarse grained, red brown mottled orange/ pale grey, iron stained, trace of fine to coarse grained sub-rounded to rounded gravel inclusions. Generally medium to high estimated strength with the exception of very low strength seams.

Table 2. Summary of interpreted subsurface conditions, boreholes CBH510 and CBH511.

Unit	Material / Origin	Depth range to top of unit (m)	Thickness of unit (m)	Description
1	Topsoil	0.0	0.8 to 1.2	Silty CLAY/ Silty SAND: low to medium plasticity clay, fine grained sand, dark brown, trace of fine sub-angular to sub-rounded gravel, trace of organics (rootlets/ grass). Firm clay, medium dense sand.
2a	Alluvial (or estuarine) Clay	0.8 to 1.2	1.7 to 2.8	Silty CLAY: medium plasticity, grey/ dark grey/ brown, trace of fine grained sand, trace of organics (rootlets). Soft to stiff in consistency.
2b	Alluvial (or estuarine) Sand	2.5 to 4	0.3 to 0.7	Silty/ Clayey SAND: fine to medium grained, grey/ dark grey/ brown/ mottled grey/ brown, trace of medium plasticity clay, trace of silt. Loose in relative density.
3	Residual/	2.8 to 4.7	7.1 to 8.9	Silty CLAY/ Silty Sandy CLAY: medium to high

Unit	Material / Origin	Depth range to top of unit (m)	Thickness of unit (m)	Description
	Extremely Weathered Material			plasticity, grey mottled red/orange, fine grained sand, trace of fine to medium grained sub-angular to sub-rounded ironstone/ quartz gravel. Soft to hard in consistency.
4	Sandstone	11.75	Not proven (end oh hole ranges from17.90 to 18.9)	Extremely Weathered (XW) to Fresh (FR) SANDSTONE: fine to coarse grained, red brown mottled orange/ pale grey, iron stained, trace of fine to coarse grained sub-rounded to rounded gravel size quartz inclusions, interbedded with thin XW sandstone bands. Generally low to high estimated strength with the exception of very low strength XW bands.

3.3.1. Groundwater

Groundwater inflows were noted on the engineering borehole logs to have been encountered at the following depths:

- CBH508 at 7.5m;
- CBH509 at 0.3m;
- CBH510 at 2.2m; and
- CBH511 at 3.5m.

3.3.2. Point load test results

Point Load Index Tests on rock core samples collected from the boreholes were carried out in a Coffey NATA accredited laboratory. The laboratory test results are shown on the engineering borehole logs presented in **Appendix A**.

4. Discussion and recommendations

4.1. Foundations

Assessment of the geotechnical conditions within the site for the proposed packing warehouse buildings, truck load silos and associated facilities, and a bridge over Bolong Road is summarised in Section 3 above.

At the site of the proposed packing warehouse buildings, truck load silos and associated facilities, a variable subsurface profile is described as follows:

- North-western edge of the proposed footprint: CBH508 and CBH24 (refer to historical borehole in Coffey report ENVIUNAN00111AA-R02) indicate shallow depths to top of stiff to very stiff alluvial or residual clay of 0.3m to 1m from original ground surface;
- South-eastern edge of the proposed footprint: CBH 509 and CBH108 (refer to historical borehole in Coffey report ENVIUNAN00111AA-R02) indicate relatively deep to top of stiff to very stiff residual clay layer of 2.6m to 4m from original ground surface.

Therefore, an earthworks solution is not considered feasible to allow a high level footing system as this would involve a substantial volume of material to be removed and replaced. The selection of the final footing system will depend on the loads to be supported by the building frame and within the floor areas. We recommend the following:

- To support relatively light loads, particularly on the north-western portion of the proposed building footprint, a maximum allowable bearing capacity of 200kPa is estimated at a founding depth of 1.5m to 2m from original ground surface; and
- To support heavier loads from building design elements including high column loads, concentrated or high floor loads from plant or stacking, sensitive machinery, we recommend deep footings (displacement or non-displacement) founded in the underlying highly weathered to slightly weathered sandstone.

4.1.1. Displacement piles

Based on our experience from past investigations and information from the current investigation, treated timber, steel or precast concrete piles driven to effective refusal on or in highly or moderately weathered rock would be suitable. The selection of pile types will depend on the building loads, pile load capacity and availability of piles and a suitable piling contractor. Due to the variation in the degree of weathering of the rock encountered in previous investigations near this site, driven timber piles may not penetrate or even reach the highly weathered rock, and may terminate in the extremely weathered rock (hard clays). Steel piles will more likely achieve a higher penetration into the hard clays.

On the basis of our experience with similar subsurface conditions, it is recommended that final sets for the piles be checked by attempting to re-drive after a delay of *not less than 24 hours*. Specialist geotechnical advice should be sought if piles can be driven further into bedrock at higher penetration rates (mm/blow) than encountered at the initial set. It should be noted that excessive driving must be avoided to limit pile damage.

We note that pile driving can cause vibrations and ground movement which may affect the performance of nearby structures if founded at shallow depth. Further advice should be sought where there are existing structures close to the proposed buildings or bridge.

The importance of geotechnical monitoring during pile driving must be stressed due to the variable nature of the rock. As the depth of piles to achieve a final set at each of the sites is expected to be variable, the driving of trial piles at or near corners of the buildings and pile load testing is recommended. The installation of the piles should be carried out by an experienced piling company with pile load testing facilities.

4.1.2. Non-displacement piles

Grout injected, CFA piles or screw piles may be considered where driven piles are deemed inappropriate (due to ground vibration) or to overcome penetration problems associated with driven piles, particularly where deeper deposits of hard clay materials exist, but where higher end-bearing capacities are not required. A piling contractor experienced with the installation of ground-injected piles, CFA piles or screw piles through deep interbedded clayey and sandy soils, soft soils below the water table and weak rock should be used.

As a guide, bored piles are likely to achieve higher end bearing due to greater penetration depths compared to driven or screw piles.

4.1.3. Pile design parameters

The parameters provided in **Table 3** are the indicative ultimate limit state geotechnical design parameters that can be adopted for the displacement/ non-displacement pile foundation design with pile spacing not less than 5 times pile diameter. For the design of piles, a limit state method must be adopted to comply with the piling code AS2159-2009. The following notations used in the table are defined as follows:

γ_b - Bulk unit weight
E_{sv}' - Young's modulus for axial response
E_{sh}' - Young's modulus for lateral response
f_s - Ultimate skin friction
f_b - Ultimate end bearing capacity for the layer at the tip of the pile
p_y - Ultimate lateral yield pressure

Table 3. Geotechnical foundation design parameters for displacement/ non-displacement piles

Unit	γ_b (kN/m^3)	f_s (kPa)	f_b (MPa)	p_y (MPa)	E_{sv}' (MPa)	E_{sh}' (MPa)
1 – Topsoil	17	25	--	--	4 to 6	3 to 4.5
2a – Alluvial Clay	16	25	0.1	0.05	4 to 6	3 to 4.5
2b – Alluvial Sand	17	10	0.1	0.05	4 to 6	3 to 4.5
3a – Residual	19	30	0.4	0.2	8 to 10	6 to 7.5
3b – XW Material	20	50	0.9	0.9	20 to 38	15 to 28.5
4a – HW to MW Sandstone	22	500	10	5	400 to 500	300 to 375
4b – SW to FR Sandstone	23	750	18	9	900 to 1200	675 to 900

4.1.4. Geotechnical strength reduction factors

For limit state design, a geotechnical reduction factor (ϕ_g) is applied to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in **Table 3** to derive the design ultimate geotechnical pile capacity. In accordance with AS2159-2009, ϕ_g is dependent on assignment of an Average Risk Rating (ARR) which takes into account various geotechnical uncertainties, redundancy of the foundation system, construction supervision, and the quantity and type of pile testing. The assessment of ϕ_g therefore depends on the structural design of the foundation system as well as the design and construction method, and testing (if any) to be employed by the designer and piling contractor.

Where no pile load testing or other verification of soil geotechnical quality and condition is specified a geotechnical strength reduction factor of 0.4 should be adopted. If pile load testing or other soil quality and condition verification is undertaken, it may be possible to adopt a higher ϕ_g value that leads to a more economical design. The final selection of ϕ_g should be reviewed by an appropriately experienced geotechnical engineer at the detailed design stage.

The use of limit state design also requires that serviceability performance of the foundation system be assessed, including pile group interaction effects. Such assessment should be carried out by an experienced geotechnical professional using well-established and soundly based methods. The modulus values given in **Table 3** may be adopted for such assessment, but it should be recognised that the accuracy of settlement prediction is a function of construction methodology as well as the assessed values of material stiffness, both of which can involve considerable uncertainty. Therefore, the accuracy of settlement predictions may be no better than ± 50%. Where foundation settlement is critical to the performance of the structure, serviceability pile load testing should be carried out to confirm the design assumptions and/or assess prediction accuracy.

The final embedment depths for piles will be dependent on the proposed pile dimensions, design loads and the total number of piles.

In view of the significant depths to competent material layers for end bearing and possible variations in depths and quality of the material, we recommend that piles be assessed during construction by an experienced geotechnical engineer who can assess anomalies in the soil type and depths and advise on a course of action.

4.1.5. Aggressivity

The discussion on the assessment of the soils and groundwater within the site had been discussed in the Coffey report ENVIUNAN00111AA-R02 dated 25 June 2008. The assessment of the aggressivity of the soils and the groundwater relative to the structural design elements is in accordance with AS2159-2009.

Based on the test results presented in the previous Coffey report, the following recommendations are provided:

- The exposure classification for concrete piles is assessed as 'non aggressive', however due to the proposed industrial use of the site and the possibility chemical spills, the exposure classification of concrete piles has been increased to 'mild'. Assuming a 50 year design life, the minimum concrete strength (f'_c) should be 32MPa for cast in place concrete piles and 50MPa for precast and prestressed concrete piles. The minimum cover to reinforcement is 60mm for cast in place piles and 20mm for precast and prestressed piles; and
- The exposure classification for steel piles is assessed as 'non aggressive' which requires a uniform corrosion allowance of less than 0.01mm/year. However, due to the close proximity of the site to the Shoalhaven River, and the unknown origin of fill materials, and the possibility of chemical spills we would recommend that a uniform corrosion allowance of 0.01mm/year to 0.02mm/year be adopted.

4.1.6. Negative skin friction

Load carrying capacity of the proposed deep foundation is a combination of end bearing and shaft adhesion. It may be the case that the soft to firm alluvial clay material is subject to long term compression and the shaft adhesion within this material zone will likely be low or become negative as the material settles. Down drag forces (negative skin friction) need to be considered as they may increase the load on the part of the pile that is carrying the load.

4.2. Abernethys Creek stability assessment

The assessment of the stability of the section of Abenethys Creek where it is closest to both the proposed access road and railways alignments provides factors of safety for both short term and long term cases. The slope stability analyses have been conducted using Slope/W 2007 version 7.23 and adopting the General Limit Equilibrium (GLE) method. The GLE method encompasses the key elements of the more commonly used Morgenstern – Price method of limit equilibrium analysis with the advantage of a more numerically stable implementation.

At this stage, the assessment has been completed based on the following assumptions:

1. Thickness of the material unit layers as per Coffey reports GEOTWOLL03845AA-AB (dated 17 December 2015) and GEOTWOLL02584AU-AB rev1 (dated 13 July 2012). The proposed development includes a 1.9m to 2.3m thick general fill (assumed to be imported) layer to be placed over the current profile which comprises a 0.5m to 0.7m thick topsoil layer, underlain by a 0.5m to 1m thick layer of firm estuarine clayey sandy silt, 7m thick soft/firm estuarine silty

clay/clay (reference: boreholes RBH03 and RBH04 from the Coffey report GEOTWOLL02584AU-AB rev1);

2. The placement of future fill material is assumed to be engineered and controlled. The maximum batter slope for the fill is set at 1H:1V- this applies to a compacted well grained granular fill;
3. The general geometry is based on the drawing as provided by Manildra (Drawing No.: MN262-015 Rev P03 dated 20 August 2015) re-attached in this report as Appendix B;
4. The assumed geotechnical properties used in the short term and long term case assessments are as shown in Figures 2 to 9;
5. The maximum load from the vehicles utilising the access road is assumed to be represented with 20kPa surcharge. The loads from the trains on the rail tracks is assumed to be represented with 44.4kPa surcharge for each track (refer to GEOTWOLL03552AA-AB dated 14 October 2013); and
6. The stability criteria are: Factor of safety (FoS) = 1.3 for short term, FoS = 1.5 for long term, and FoS = 1.2 for long term with rapid drawdown post major flooding event.

Table 4. Summary of assessed cases and resulting Factors of Safety (FoS).

Figure Reference	Case Description	FoS	Remarks
Figure 2	Case 1: Short term – construction with no prior ground improvement	1.13	Deep seated failure plane extending under the road and including the railway tracks
Figure 3	Case 2: Short term – construction after installing appropriate sheetpile wall	1.60	Deep seated failure plane but satisfies FoS criterion
Figure 4	Case 3: Long term – construction after installing appropriate sheetpile wall	1.68	Shallow failure plane including the access road but satisfies FoS criterion
Figure 5	Case 4: Long term, rapid drawdown – construction after installing appropriate sheetpile wall	< 1.0	Shallow failure plane including the access road – failure plane does not go through the sheetpile wall
Figure 6	Case 5: Short term – embankment offset increased by 6m, no sheetpile wall	1.31	Deep seated failure plane but satisfies FoS criterion
Figure 7	Case 6: Long term – embankment offset increased by 6m, no sheetpile wall	1.71	Shallow failure plane including the access road but satisfies FoS criterion
Figure 8	Case 7: Long term, rapid drawdown – embankment offset increased by 6m, no sheetpile wall	1.0	Shallow failure plane including the access road
Figure 9	Case 8: Long term, rapid drawdown – embankment batter slope construction at 1V:2H with no load on access road	1.25	Shallow failure plane including the access road but satisfies FoS criterion

Results of the analyses are summarised in **Table 4**. Based on the results shown, we conclude that:

1. The proposed construction of an access road and two rail tracks on a 1.6m to 2.3m high embankment built on a relatively thick layer of soft to firm estuarine clay soil would be significant at risk of failure. The failure would likely occur as a deep seated circular failure plane which would include both the road and the railway tracks (Figure 2). Various options have been considered to reduce the risk of instability in the proximity of the creek bank as follows:

Option 1

We recommend installation of a sheetpile wall near the crest of the Abernethys Creek bank, leaving existing established trees in place where possible. Piles should have an appropriate section and be driven to suitable depth (estimated to be at slow or difficult penetration within the underlying very stiff alluvial clay layer). Assuming a suitable sheet pile wall is provided between the road and the critical section of the Abernethys Creek bank, case analyses based on estimated short term, long term, and long term with rapid drawdown post major flooding event scenarios satisfy required FoS (Figures 3 to 5). Note that Figure 5 only shows shallow failure planes which do not propagate towards the proposed location of the sheetpile wall.

Option 2

Where the fill embankment can be offset from the bank of Abernethys Creek by at least a further 6m in addition to the 12m shown in the Manildra Drawing No.: MN262-015 Rev P03, the risk of deep seated failure associated with the creek bank may be significantly reduced. Case analyses based on estimated short term, long term, and long term with rapid drawdown post major flooding event scenarios satisfy required FoS (Figures 6 to 8). Note that Figure 8 only shows shallow failure planes which do not propagate towards the creek;

2. A relatively steep batter slope within the proposed 1.6m to 2.3m thick general fill can be achieved provided slope treatment or ground retention systems are provided. If slope treatment or ground retention systems are not considered, we recommend that the embankment be constructed with a batter slope of 1V:2H (Figure 9); and
3. To provide an adequate retention system supporting the proposed fill material, a separate design and analysis should be undertaken considering the following:
   a. Relatively thick weak zone at the foundation level;
   b. The 1.6m to 2.3m thick general fill layer; and
   c. The lateral loads on the access road and the railway track.
4. Should Option 1 (ie, sheetpile wall option) be considered, a separate design and analysis should be undertaken. Provided that adequate geotechnical information is available, this analysis will also include the extent the sheetpile wall required.

4.3. Site earthworks

The site preparation earthworks within the building footprint is assumed to be part of the general site preparation earthworks that will cover the whole site. The discussion on the preparation of the site in general and pavement subgrade in particular has been presented in the Coffey report GEOTWOLL03845AA-AB. In most areas, the earthworks will require the removal of vegetation comprising mainly thick grass and root zone. The site should be stripped using an excavator with a ‘gummy’ bucket, with other vehicles kept off the stripped area to avoid disturbance to areas underlain by soft soils. The removal of grass, root zone and organic topsoil should be limited to 300mm.The stripped surface should then be assessed by a geotechnical engineer to determine if any additional stripping of unsuitable materials is necessary. In the deep soft soil areas, the vegetation should be slashed and the cut grass removed, leaving the root zone and topsoil, with geogrid and geotextile fabric to be placed over the remaining vegetation, before placing controlled fill.

We also note the potential concern of the condition of the backfill material within the sewer line trench that runs across the site in an approximate southeast-northwest direction (towards the sewer treatment plant). At this stage, there is no available information that could be used to assess the condition of the backfill material. It is likely that during construction works, the backfill material could be encountered and may require additional treatment. We recommend that a contingency be allowed for in this regard.

5. Limitations

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. Under no circumstances can it be considered that these findings represent the actual state of the site at all points. The subsurface conditions may vary significantly in other parts of the site, particularly where no nearby sampling and testing work has been carried out.

Should any site conditions be encountered during construction that vary significantly from those discussed in this report, Coffey should be advised and appropriate action should be taken.

We draw your attention to the document following the report text entitled ‘Important Information about Your Coffey Report” which should be read in conjunction with this report.

Important information about your Coffey Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples.

These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

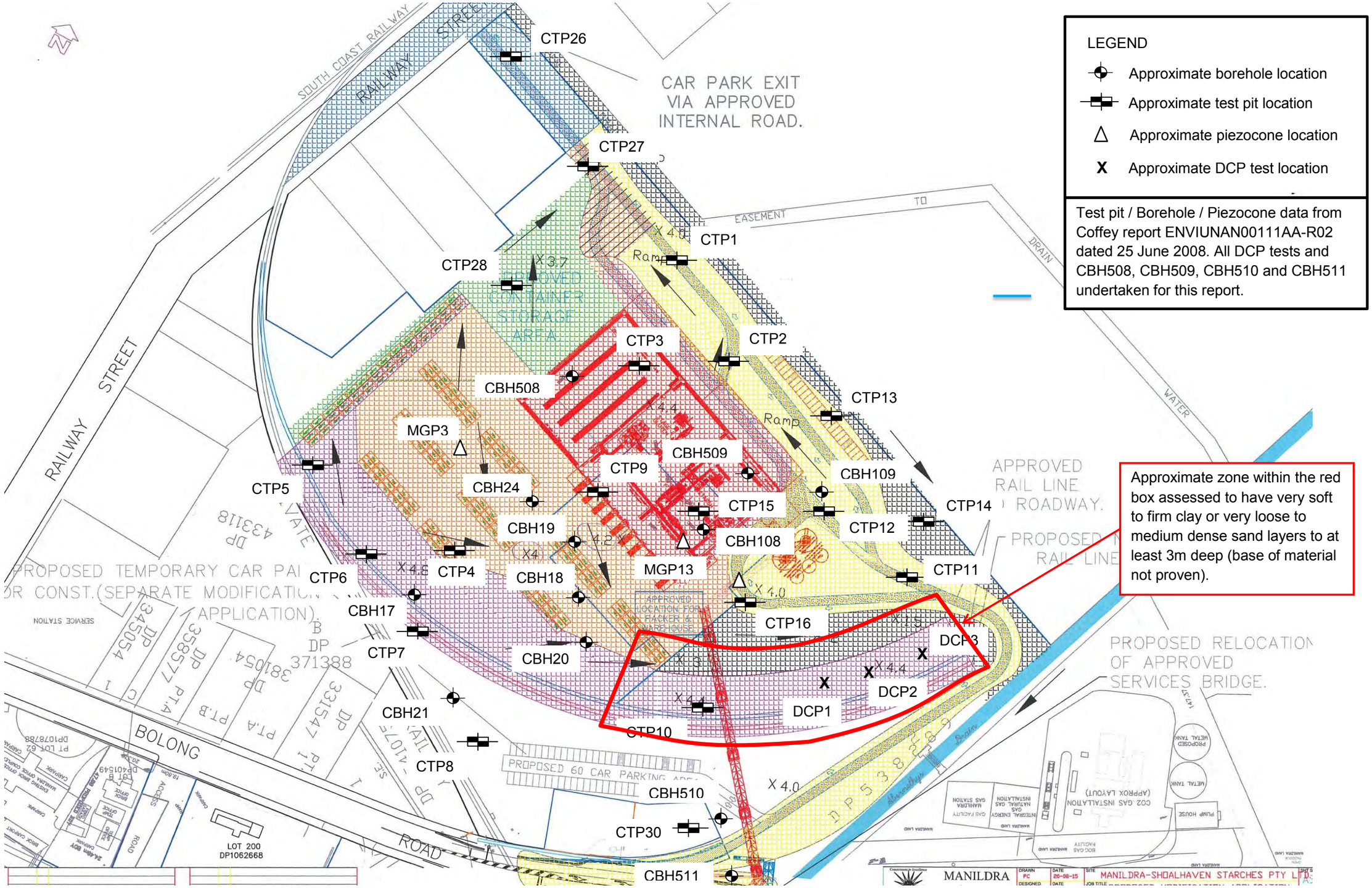
Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures

Appendix A – Engineering Logs and Explanatory Notes



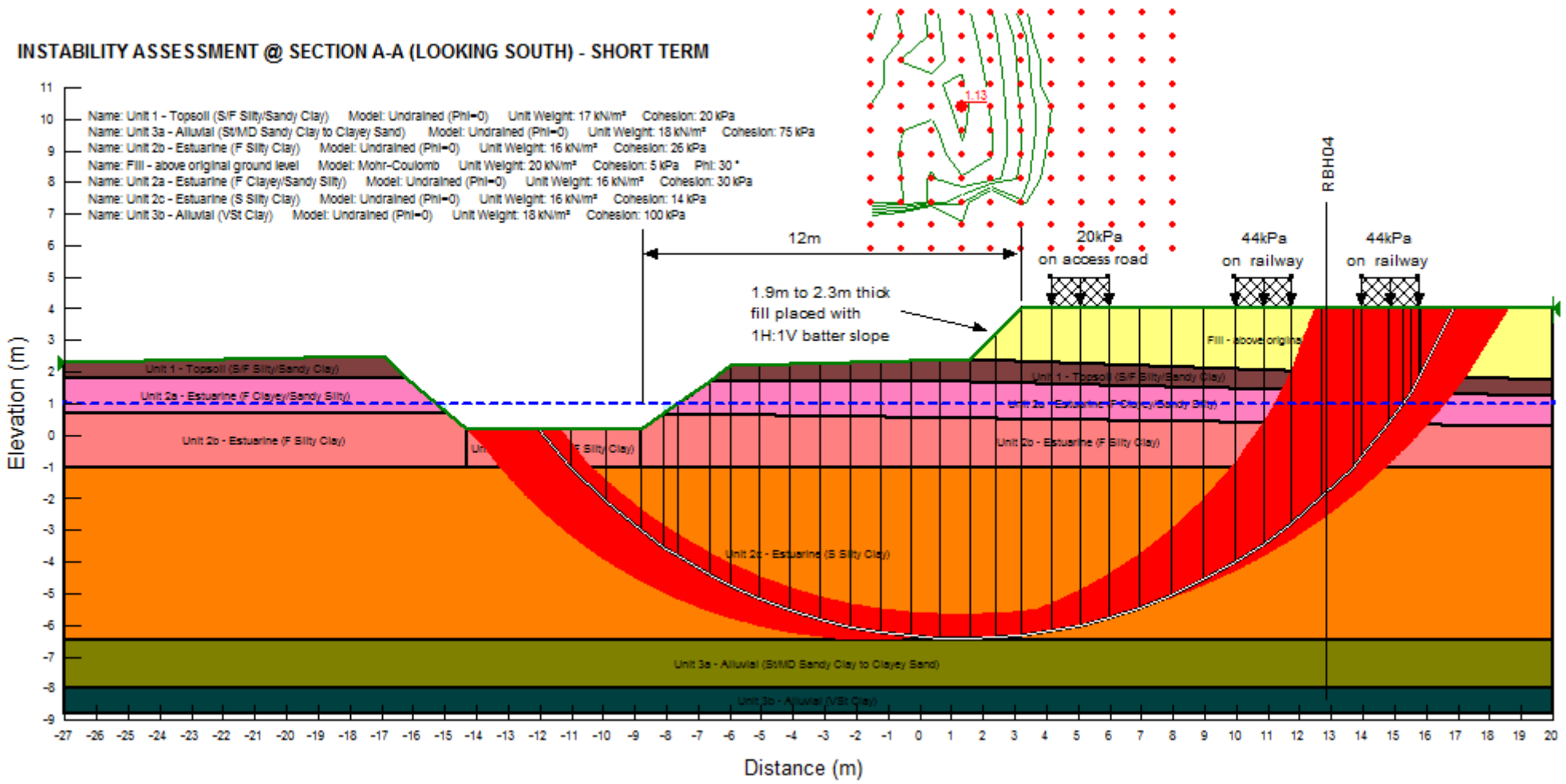
revision	description	drawn	approved	date
	Test location plan	DT	JPT	9/12/215

Drawing Layout Reference:
Packing Facility Levels (Drawing No.: MN262-009, Rev P03, dated 20 August 2015) with areas with final design levels

drawn	**DT**
approved	**JPT**
date	**9/12/2015**
scale	**N.T.S.**
original size	**A3**

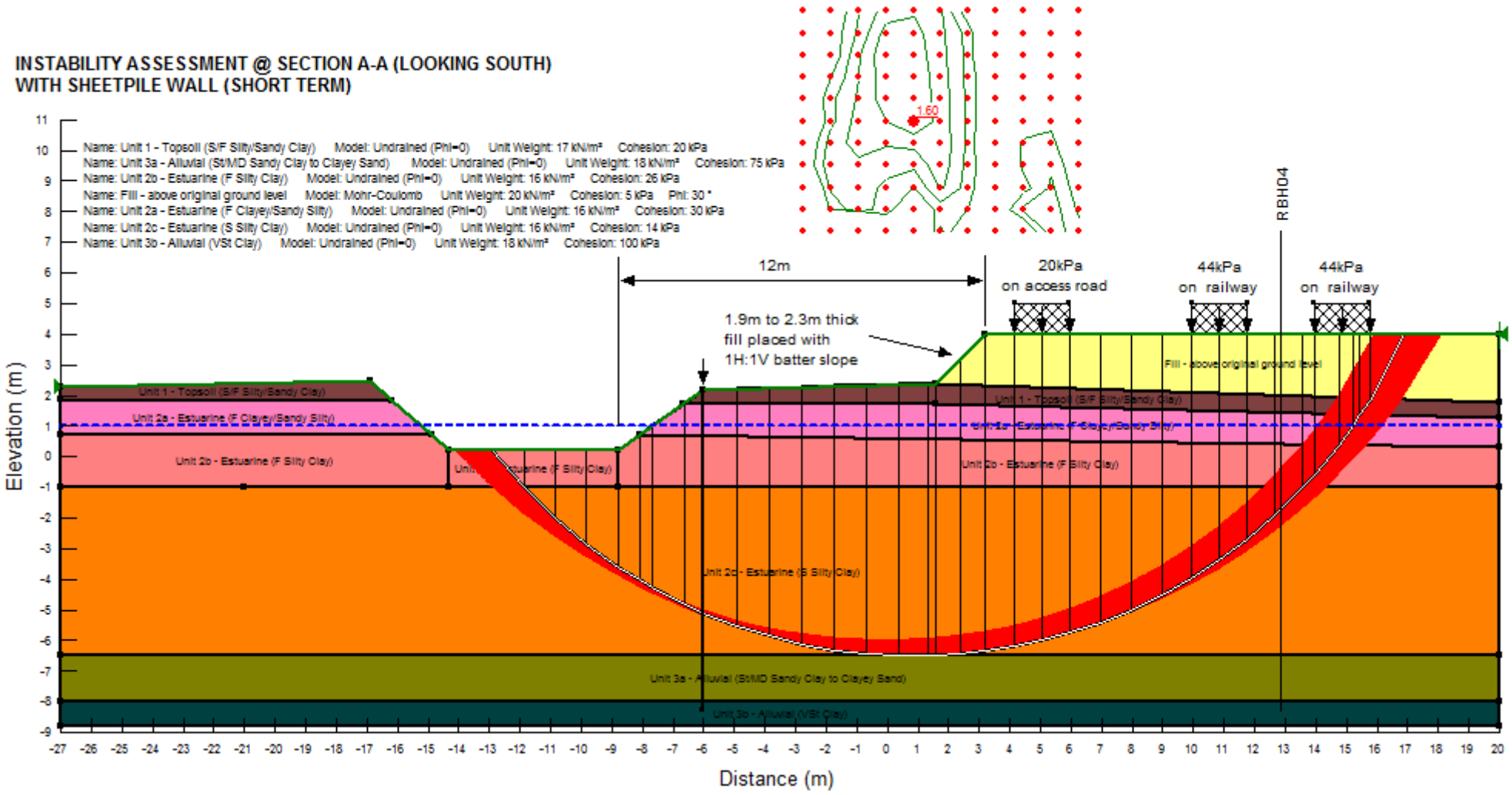
coffey

client:	**Manildra Group Pty Ltd**
project:	**Proposed Packing Plant - Pavement design and proposed boiler ash material assessment Bolong Road, Bomaderry NSW**
title:	**TEST LOCATION PLAN**
project no:GEOTWOLL03845AA-AA	figure no: 1



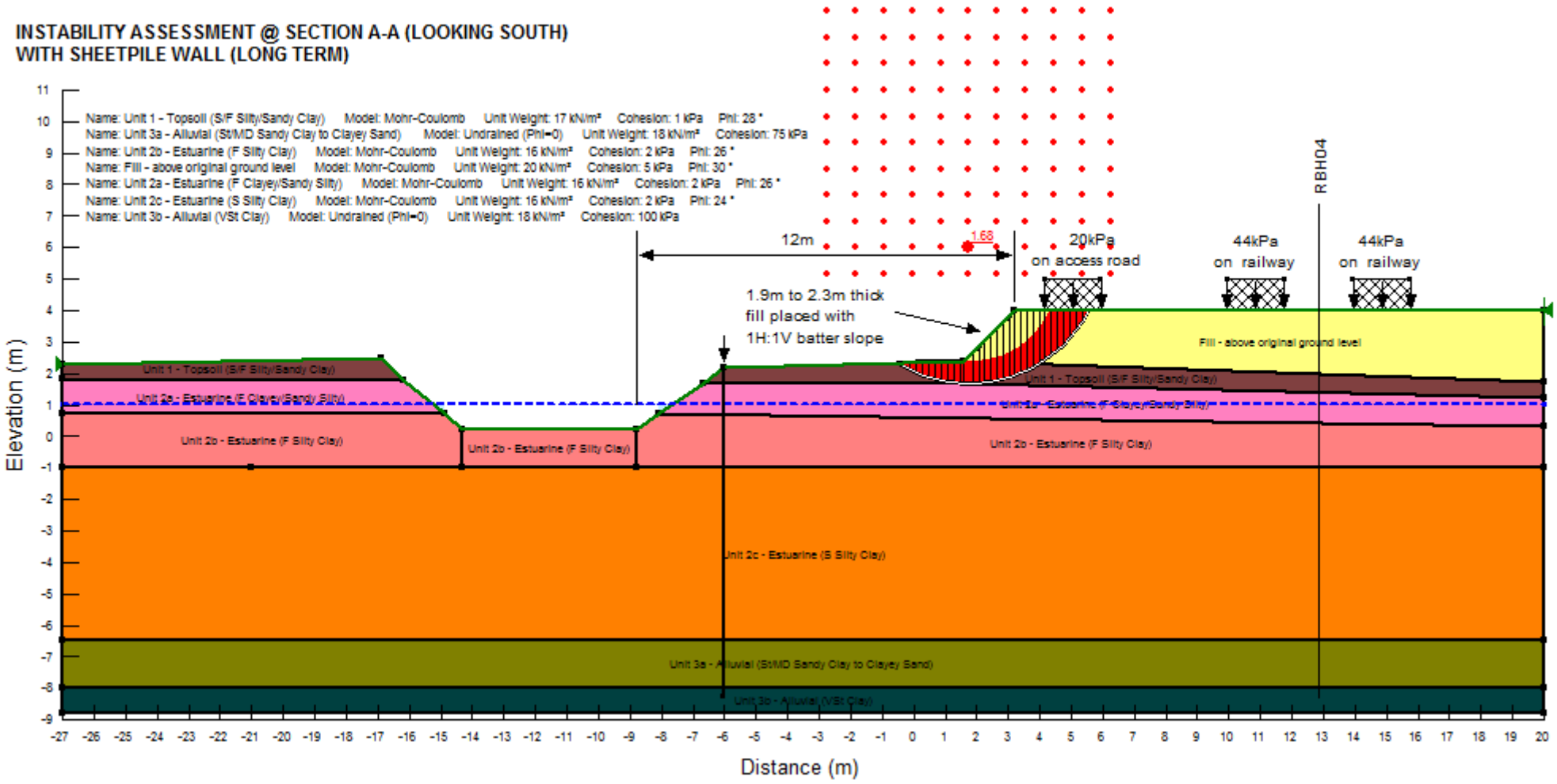
drawn	**DT**	coffey	client:	**Manildra Group Pty Ltd**
approved	**JPT**		title:	**Section A-A closest to Abernethys Creek** **Case 1 – Short term with no ground improvement**
date	**19/02/2016**		project:	**Proposed Packing Facility**
scale	**NTS**		project no: **GEOTWOLL03845AA-AB rev1**	figure no: **2**
original size	**A4**			

INSTABILITY ASSESSMENT @ SECTION A-A (LOOKING SOUTH) WITH SHEETPILE WALL (SHORT TERM)



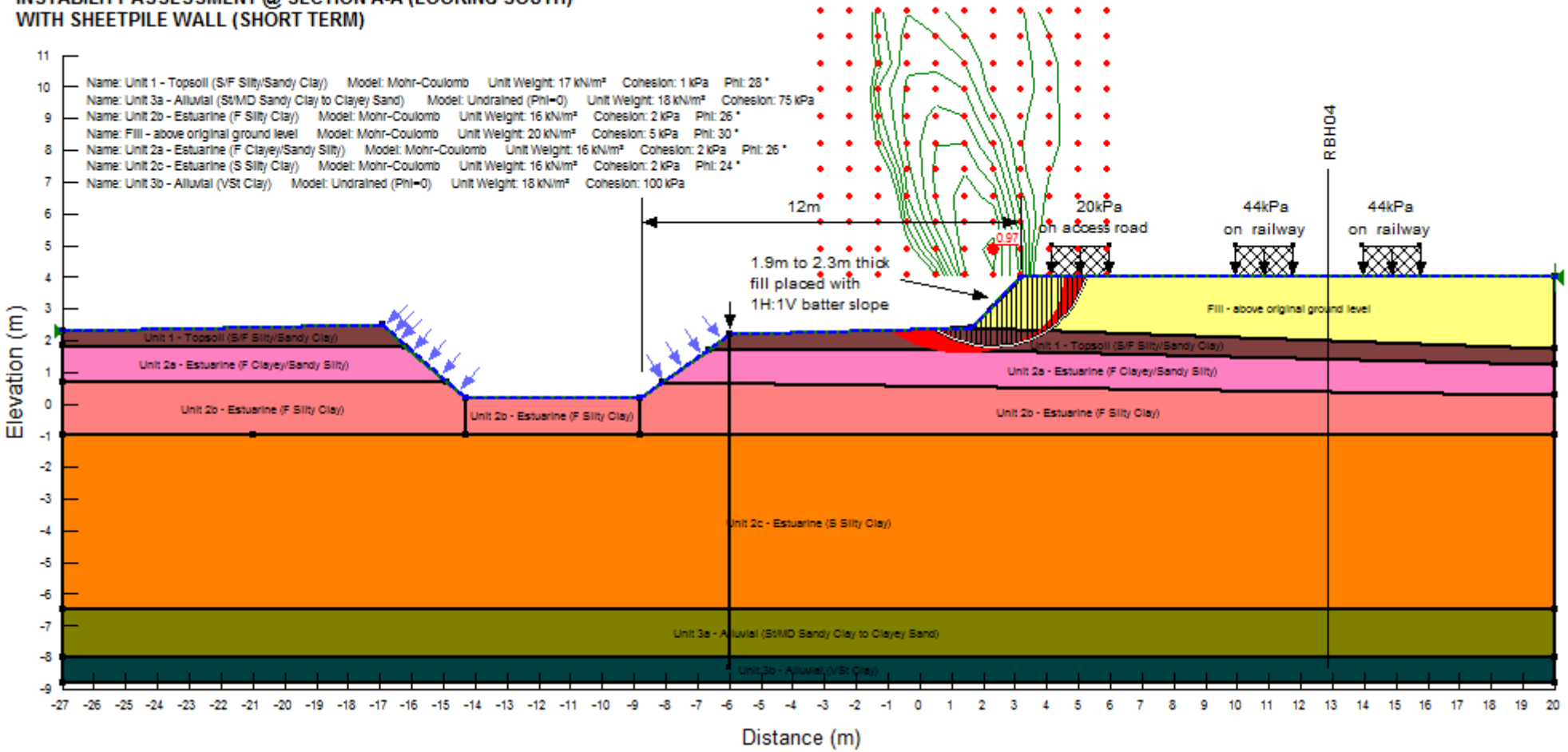
drawn	**DT**		client:	**Manildra Group Pty Ltd**
approved	**JPT**		title:	**Section A-A closest to Abernethys Creek Case 2 – Short term with sheetpile wall**
date	**19/02/2016**		project:	**Proposed Packing Facility**
scale	**NTS**		project no: **GEOTWOLL03845AA-AB rev1**	figure no: **3**
original size	**A4**			

INSTABILITY ASSESSMENT @ SECTION A-A (LOOKING SOUTH) WITH SHEETPILE WALL (LONG TERM)

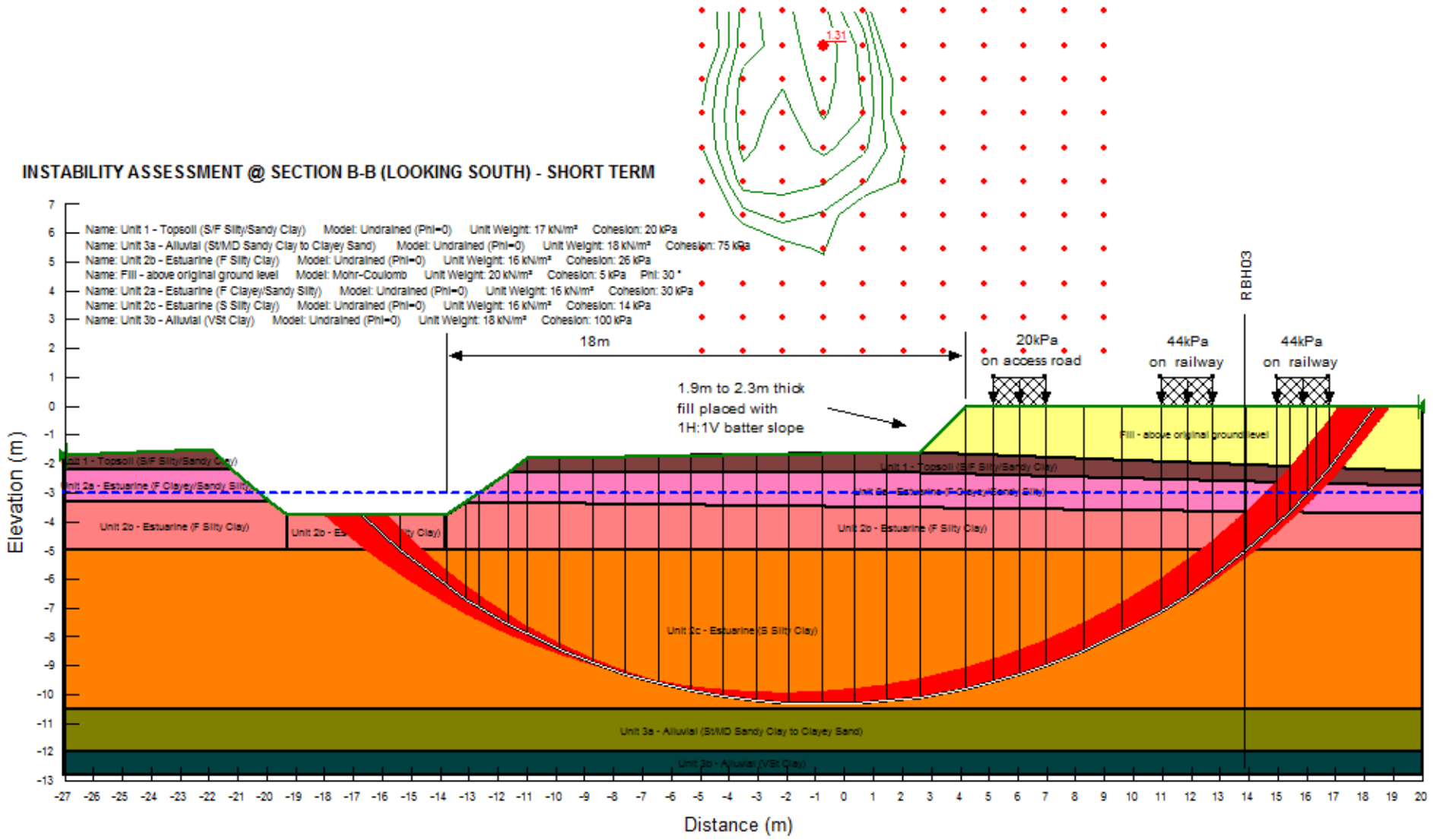


drawn	**DT**	coffey	client:	**Manildra Group Pty Ltd**
approved	**JPT**		title:	**Section A-A closest to Abernethys Creek Case 3 – Long term with sheetpile wall**
date	**19/02/2016**		project:	**Proposed Packing Facility**
scale	**NTS**		project no: **GEOTWOLL03845AA-AB rev1**	figure no: **4**
original size	**A4**			

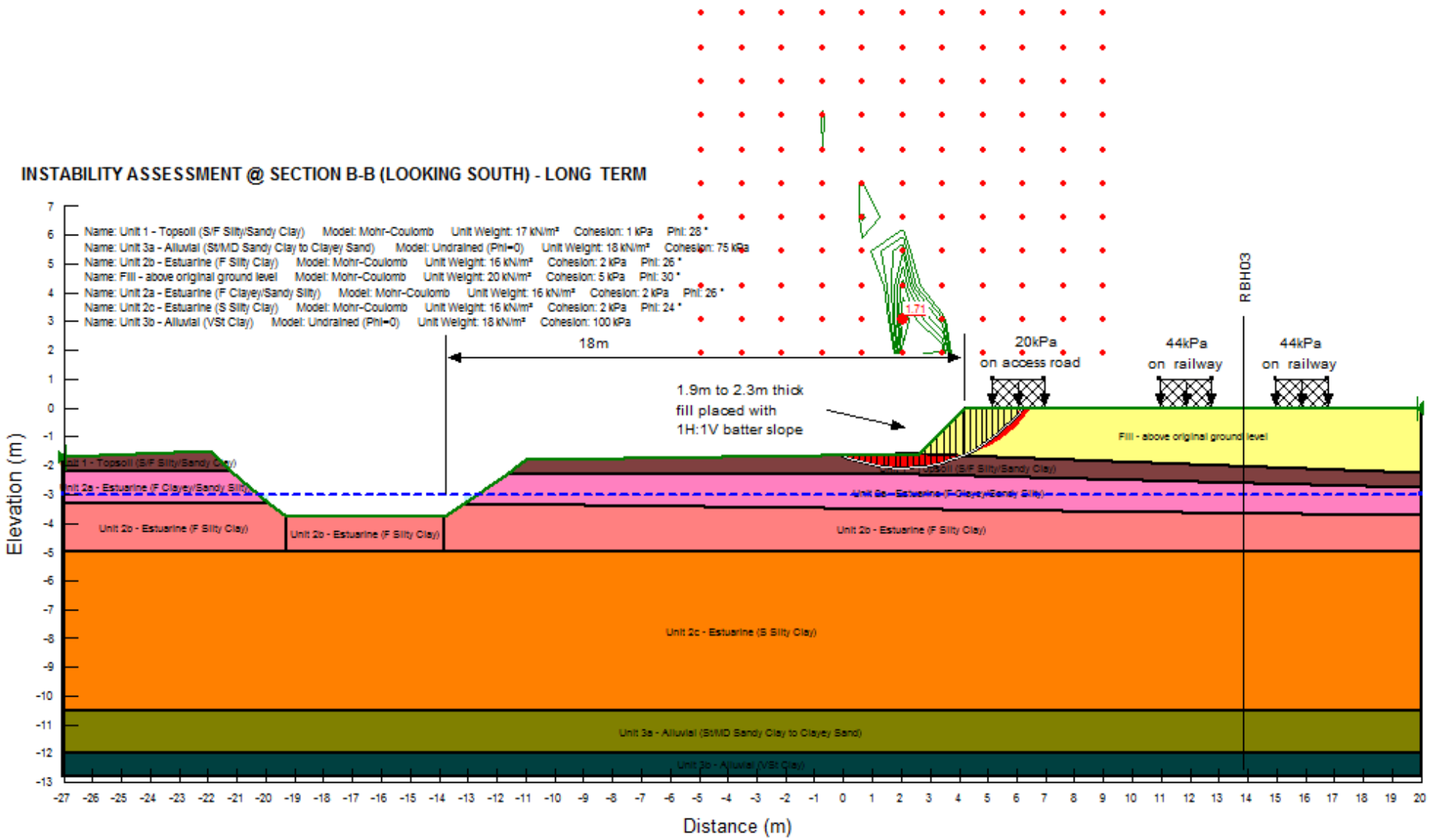
INSTABILITY ASSESSMENT @ SECTION A-A (LOOKING SOUTH) WITH SHEETPILE WALL (SHORT TERM)



drawn	**DT**	coffey	client:	**Manildra Group Pty Ltd**
approved	**JPT**		title:	**Section A-A closest to Abernethys Creek** **Case 4 – Long term, rapid drawdown with sheetpile wall**
date	**19/02/2016**		project:	**Proposed Packing Facility**
scale	**NTS**		project no: **GEOTWOLL03845AA-AB rev1**	figure no: **5**
original size	**A4**			



drawn	**DT**	coffey	client:	**Manildra Group Pty Ltd**
approved	**JPT**		title:	**Section A-A closest to Abernethys Creek Case 5 – Short term with embankment offset increased by 6m, no sheetpile wall**
date	**19/02/2016**		project:	**Proposed Packing Facility**
scale	**NTS**		project no: **GEOTWOLL03845AA-AB rev1**	figure no: **6**
original size	**A4**			



drawn	**DT**
approved	**JPT**
date	**19/02/2016**
scale	**NTS**
original size	**A4**

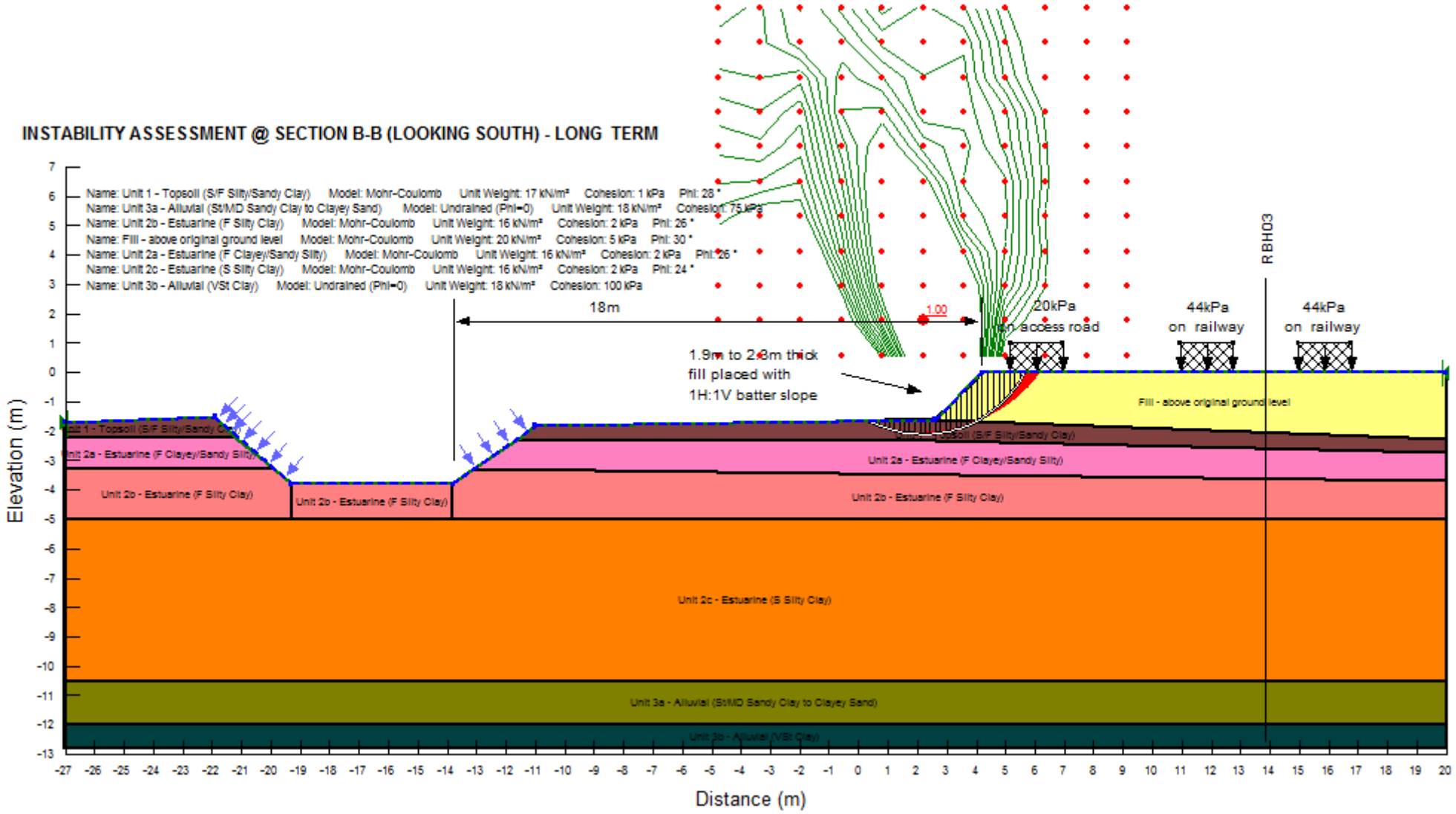
coffey

client: **Manildra Group Pty Ltd**

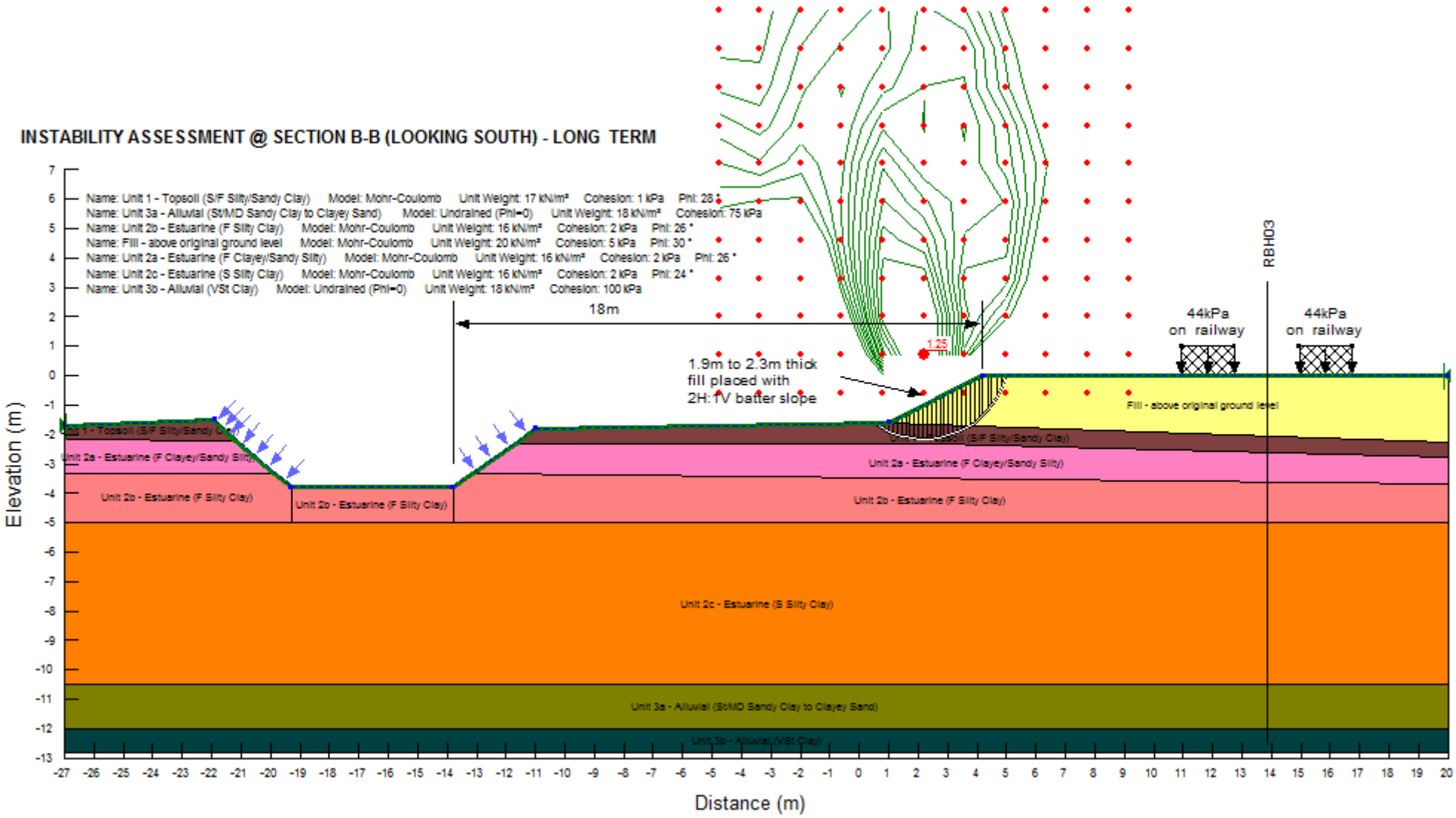
title: **Section A-A closest to Abernethys Creek**
Case 6 – Long term with embankment offset increased by 6m, no sheetpile wall

project: **Proposed Packing Facility**

project no: **GEOTWOLL03845AA-AB rev1** figure no: **7**



drawn	**DT**	coffey	client:	**Manildra Group Pty Ltd**
approved	**JPT**		title:	**Section A-A closest to Abernethys Creek Case 7 – Long term, rapid drawdown with embankment offset increased by 6m, no sheetpile wall**
date	**19/02/2016**		project:	**Proposed Packing Facility**
scale	**NTS**		project no: **GEOTWOLL03845AA-AB rev1**	figure no: **8**
original size	**A4**			



drawn	**DT**
approved	**JPT**
date	**19/02/2016**
scale	**NTS**
original size	**A4**

coffey

client: **Manildra Group Pty Ltd**

title: **Section A-A closest to Abernethys Creek Case 8 – Long term, rapid drawdown with embankment batter slope construction at 1V:2H with no load on access road**

project: **Proposed Packing Facility**

project no: **GEOTWOLL03845AA-AB rev1** figure no: **9**

coffey

Engineering Log - Borehole

Borehole ID.	***CBH508***
sheet:	1 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***24 Nov 2015***
principal:	***-***
date completed:	***24 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281688; N: 6140559 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description **SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T HW casing								**Silty CLAY**: high plasticity, dark grey, trace of organics (rootlets)	>Wp	S		**TOPSOIL**
			SPT 1, 2, 3 N*=5		1.0		CH	**Silty CLAY**: high plasticity, grey mottled red/orange, trace of organics (rootlets), trace of fine grained sand	Wp	St - VSt		**RESIDUAL**
			SPT 6, 10, 12 N*=22		2.0 3.0				<Wp	VSt - H		**RESIDUAL/EXTREMELY WEATHERED MATERIAL**
			SPT 4, 8, 11 N*=19		4.0		CI-CH	**Silty Sandy CLAY**: medium to high plasticity, grey mottled red/orange, fine grained sand, trace of fine to medium grained sub-angular to sub-rounded ironstone gravel		St - VSt		
			SPT 7, 16, 19 N*=35		5.0							
					6.0			trace of fine sub-angular quartz gravel, colour changed to red mottled orange		VSt - H		**EXTREMELY WEATHERED MATERIAL**
					7.0			colour changed to grey/red/orange mottle				

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole ID.	***CBH508***
sheet:	2 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***24 Nov 2015***
principal:	***-***
date completed:	***24 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281688; N: 6140559 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T HW casing		W	SPT 9, 13, 20 N*=33		9.0		CI-CH	**Silty Sandy CLAY**: medium to high plasticity, grey mottled red/orange, fine grained sand, trace of fine to medium grained sub-angular to sub-rounded ironstone gravel *(continued)* changed to fine to coarse grained sand	<Wp	VSt - H		**EXTREMELY WEATHERED MATERIAL**
					10.0			Borehole CBH508 continued as cored hole				
					11.0							
					12.0							
					13.0							
					14.0							
					15.0							

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- * bit shown by suffix
- e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Cored Borehole

Borehole ID.	***CBH508***
sheet:	3 of 3
project no.	***GEOTWOLL03845AA***
client: ***MANILDRA GROUP***	date started: ***24 Nov 2015***
principal: ***-***	date completed: ***24 Nov 2015***
project: ***Proposed Packing Facility***	logged by: ***FF***
location: ***Bolong Road, Bomaderry, NSW***	checked by: ***DT***

position: E: 281688; N: 6140559 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted drilling fluid: casing diameter : HW vane id.:

drilling information				material substance						rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
					start coring at 10.70m						
NMLC			11.0		**SANDSTONE**: fine to coarse grained, red brown mottled orange/pale grey, iron stained distinct colour change at 0 deg to pale grey, trace of fine to coarse grained sub-rounded to rounded gravel inclusions	MW - SW		d=1.02 a=1.34	62%		PT, 0°, PL, SO, VN SM, 10°, PL, Sandy clay, 20 mm PT, 10°, PL, RO, VN JT, 10°, PL, RO, Sandy clay CO JT, 45°, PL, RO, VN SM, 10°, PL, Sandy clay, 10 mm SM, 30°, PL, Sandy clay, 20 mm Drilling Break JT, 10°, PL, RO, VN JT, 20°, PL, RO, VN Drilling Break Drilling Break JT, 30°, PL, RO, VN SM, 45°, PL, Sandy clay, 20 mm JT, 30°, PL, RO, VN Drilling Break Drilling Break Drilling Break
			12.0		distinct colour change at 20 deg to orange brown						
					NO CORE: 0.13 m						
			13.0		**SANDSTONE**	MW - SW		d=0.98 a=0.93	80%		SM, 60°, PL, Sandy clay, 30 mm PT, 0°, PL, RO, VN JT, 20°, PL, RO, Sandy clay CO, 5 mm Drilling Break Drilling Break PT, 0 - 5°, CU, RO, SN JT, 10°, PL, RO, Sandy clay CO, 10 mm PT, 0°, PL, SO, SN JT, 10°, PL, RO, Sandy clay CO, 2 mm JT, 20°, PL, RO, Sandy clay CO, 3 mm JT, 20°, PL, RO, SN JT, 0 - 20°, UN, RO, SN Drilling Break JT, 20°, PL, RO, VN Drilling Break Drilling Break PT, 0°, UN, RO, VN JT, 60 - 90°, UN, RO, SN PT, 0°, UN, RO, SN PT, 0°, PL, RO, SN JT, 60 - 90°, UN, RO, VN JT, 20°, PL, RO, VN Drilling Break
			14.0			FR		d=2.13 a=1.11			
			15.0								
			16.0		Borehole CBH508 terminated at 15.85 m Target depth						
			17.0								
			18.0								

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method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

water
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

core run & RQD
- barrel withdrawn
- RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

coating
- CN clean
- SN stain
- VN veneer
- CO coating

PointID : CBH508 Depth Range: 10.70 - 14.50 m

drawn	FF
approved	DT
date	12/12/2015
scale	N.T.S.
original size	A4

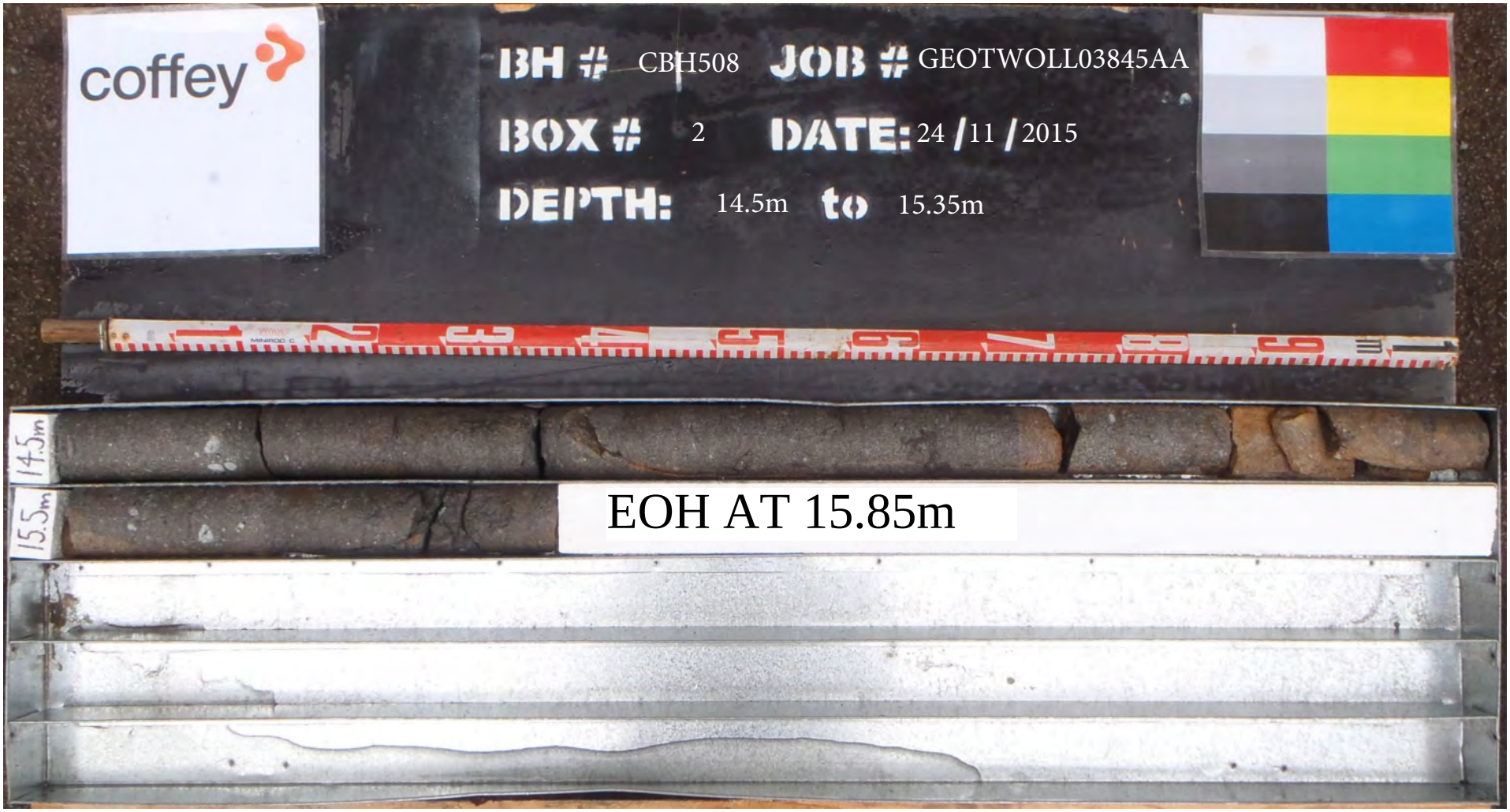
coffey

client: MANILDRA GROUP

project: Proposed Packing Facility
Bolong Road, Bomaderry, NSW

title: **CORE PHOTOGRAPH**
CBH508

project no: GEOTWOLL03845AA | fig no: | rev:



PointID : CBH0508 Depth Range: 14.50 - 15.35 m

drawn	FF
approved	DT
date	12/12/2015
scale	N.T.S.
original size	A4

coffey

client: MANILDRA GROUP

project: Proposed Packing Facility
Bolong Road, Bomaderry, NSW

title: **CORE PHOTOGRAPH**
CBH508

project no: GEOTWOLL03845AA | fig no: | rev:

coffey

Engineering Log - Borehole

Borehole ID.	***CBH509***
sheet:	1 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***24 Nov 2015***
principal:	***-***
date completed:	***24 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281805; N: 6140552 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T		▶			0.0			**Silty CLAY**: low to medium plasticity, dark brown, trace of fine grained sand, trace of organics (rootlets)	<Wp	F		**TOPSOIL**
							CI	**Silty CLAY**: medium plasticity, grey/dark grey mottle, trace of fine grained sand, trace of organics (rootlets)	>Wl - ~Wl	S - F		**ALLUVIAL**
			SPT 0, 0, 0 N*=0		1.0			no sand present, changed to medium plasticity to high plasticity				
			SPT 0, 1, 3 N*=4		2.0							showing slight structure
HW casing					3.0		CH	**Silty CLAY**: high plasticity, grey mottled yellow/orange/brown, trace of fine grained sand, trace of organics (fine rootlets)	=Wp - >Wp	F - St		**RESIDUAL**
			SPT 3, 5, 7 N*=12		4.0			changed colour to grey mottled orange/red	>Wp			
W			SPT 3, 4, 6 N*=10		5.0							
					6.0			changed colour to grey/red/orange mottle, trace of fine grained sub-angular to sub-rounded gravel (ironstone)		St		drill head dropped (material got stiffer)
					7.0							

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method

AD	auger drilling*
AS	auger screwing*
HA	hand auger
W	washbore
*	bit shown by suffix
e.g.	AD/T
B	blank bit
T	TC bit
V	V bit

support

M	mud
C	casing
N	nil

penetration 1 2 3 — no resistance ranging to refusal

water

▽	10-Oct-12 water level on date shown
▶	water inflow
◀	water outflow

samples & field tests

B	bulk disturbed sample
D	disturbed sample
E	environmental sample
SS	split spoon sample
U##	undisturbed sample ##mm diameter
HP	hand penetrometer (kPa)
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
VS	vane shear; peak/remouded (kPa)
R	refusal
HB	hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
Wl	liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole ID.	***CBH509***
sheet:	2 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***24 Nov 2015***
principal:	***-***
date completed:	***24 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281805; N: 6140552 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
W			SPT 2, 2, 5 N*=7				CI	**Silty Sandy CLAY**: medium plasticity, grey/red/orange mottle, fine grained sand	<Wp	F - St		drill head loosened (material got softer) **RESIDUAL**
					9.0			trace of fine to medium grained sub-angular to sub-rounded ironestone gravel				**RESIDUAL/EXTREMELY WEATHERED MATERIAL**
					10.0					St - VSt		drill head dropped
			SPT 7, 13, 16 N*=29		11.0					VSt - H		
					12.0			changed to fine to coarse grained sand (containing quartz)				**EXTREMELY WEATHERED MATERIAL INTERBEDDED WITH HIGHLY WEATHERED MATERIAL**
			SPT 7, 14, 19 N=33		13.0							
					14.0							
					15.0					H		no sample recovered (fell out of SPT spoon) drill head dropped
								Borehole CBH509 continued as cored hole				

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- * bit shown by suffix
- e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration (1 2 3) no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Cored Borehole

Borehole ID.	***CBH509***
sheet:	3 of 3
project no.	***GEOTWOLL03845AA***
client: ***MANILDRA GROUP***	date started: ***24 Nov 2015***
principal: ***-***	date completed: ***24 Nov 2015***
project: ***Proposed Packing Facility***	logged by: ***FF***
location: ***Bolong Road, Bomaderry, NSW***	checked by: ***DT***

position: E: 281805; N: 6140552 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted drilling fluid: casing diameter : HW vane id.:

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
					start coring at 15.70m						
NMLC			16.0		**NO CORE:** 0.05 m	HW - MW					JT, 70°, PL, RO, SN JT, 80 - 90°, CU, RO, SN JT, 30°, PL, RO, VN PT, 0°, PL, RO, SN JT, 30°, PL, RO, SN SM, 0°, PL, Sandy clay, 40 mm PT, 0 - 10°, CU, RO, SN Drilling Break
					SANDSTONE: fine to coarse grained, grey/red/orange mottle, fine grained sub-angular to sub-rounded gravel inclusions (quartz)	XW SW		a=1.32 d=1.65			
					SANDSTONE: fine to coarse grained, grey, fine to coarse grained sub-rounded to rounded gravel inclusions	FR		a=1.14 d=1.75	82%		Drilling Break PT, 0°, PL, RO, CN Drilling Break
			17.0								
			18.0					d=2.16 a=1.44			Drilling Break Drilling Break
					Borehole CBH509 terminated at 18.75 m Target depth						
			19.0								
			20.0								
			21.0								
			22.0								
			23.0								

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
DW distinctly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SZ shear zone
SS shear surface
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

coating
CN clean
SN stain
VN veneer
CO coating

PointID : CBH509 Depth Range: 15.70 - 18.75 m

drawn	FF
approved	DT
date	12/12/2015
scale	N.T.S.
original size	A4

coffey

client: MANILDRA GROUP

project: Proposed Packing Facility
Bolong Road, Bomaderry, NSW

title: **CORE PHOTOGRAPH**
CBH509

project no: GEOTWOLL03845AA | fig no: | rev:

coffey

Engineering Log - Borehole

Borehole ID.	***CBH510***
sheet:	1 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***23 Nov 2015***
principal:	***-***
date completed:	***23 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281845; N: 6140432 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T								**Silty CLAY**: low to medium plasticity, dark brown, trace of fine grained sand/ trace of organics (rootlets/grass)	<Wp	F		**TOPSOIL**
AD/T			SPT 2, 1, 3 N*=4		1.0		CI	**Silty CLAY**: medium plasticity, dark grey, trace of fine sand, trace of organics (rootlets)	~Wp - <Wp	S - F		**ALLUVIAL**
AD/T					2.0				>Wl			
AD/T HW casing			SPT 0, 0, 0 N*=0				SC	**Clayey SAND**: fine grained, dark grey , mottled grey/brown, medium plasticity clay, trace of silt	W	L		
AD/T HW casing					3.0		CH	**Silty CLAY**: high plasticity, grey mottled orange, trace of fine grained sand, trace of organics (rootlets)	>Wp	S		**ALLUVIAL/RESIDUAL**
AD/T HW casing								colour changed to grey mottled red brown/orange				
AD/T HW casing			SPT 0, 3, 5 N*=8		4.0				Wp	F - St		**RESIDUAL**
AD/T HW casing W					5.0					St		
AD/T HW casing W			SPT 5, 8, 10 N*=18							St - VSt		
AD/T HW casing W					6.0							
AD/T HW casing W							CH	**Silty Sandy CLAY**: high plasticity, red/grey/orange mottle, fine to medium grained sand, trace of fine grained sub-angular to sub-rounded gravel fragments (containing quartz)		VSt		**RESIDUAL/EXTREMELY WEATHERED MATERIAL**
AD/T HW casing W					7.0							

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- * bit shown by suffix
- e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
- 1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole ID.	***CBH510***
sheet:	2 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***23 Nov 2015***
principal:	***-***
date completed:	***23 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281845; N: 6140432 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
W			SPT 14, 17, 19 N*=36		9.0		CH	**Silty Sandy CLAY**: high plasticity, red/grey/orange mottle, fine to medium grained sand, trace of fine grained sub-angular to sub-rounded gravel fragments (containing quartz) *(continued)* changed to trace of fine to medium grained sub-angular to angular gravel fragments (ironstone)	Wp	VSt - H	X-X	**EXTREMELY WEATHERED MATERIAL TO HIGHLY WEATHERED MATERIAL**
			SPT 16, 20/100mm N*=R		11.0		CH	**Silty CLAY**: high plasticity, red/purple/pale grey/orange mottle, trace of fine to coarse grained sand, with some fine to medium grained sub-angular to angular ironstone gravel	<Wp	H		**HIGHLY WEATHERED MATERIAL**
					12.0			Borehole CBH510 continued as cored hole				
					13.0							
					14.0							
					15.0							

CDF_0_9_06_LIBRARY.GLB rev:AA Log COF BOREHOLE: NON CORED GW03845AA-AA_DATABASE.GPJ <<DrawingFile>> 22/12/2015 15:43

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remoulded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Cored Borehole

Borehole ID.	***CBH510***
sheet:	3 of 3
project no.	***GEOTWOLL03845AA***
client: ***MANILDRA GROUP***	date started: ***23 Nov 2015***
principal: ***-***	date completed: ***23 Nov 2015***
project: ***Proposed Packing Facility***	logged by: ***FF***
location: ***Bolong Road, Bomaderry, NSW***	checked by: ***DT***

position: E: 281845; N: 6140432 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted drilling fluid: casing diameter : HW vane id.:

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
					start coring at 11.75m						
NMLC			12.0		**NO CORE:** 0.35 m						
					SANDSTONE: fine to coarse grained, red/purple/grey/orange bands, distinctly laminated at 20 deg, fine to medium grained sub-angular to sub-rounded gravel sized quartz fragments throughout, iron staining, interbedded with thin extremely weathered sandstone bands	HW	O	d=0.79	64%		Drilling Break Drilling Break Drilling Break Drilling Break Drilling Break Drilling Break SM, 0°, PL, Sandy clay, 100 mm
						XW					
			13.0			HW	X	a=0.39			SM, 0°, PL, Sandy clay, 20 mm Drilling Break Drilling Break Drilling Break Drilling Break Drilling Break
						MW - SW					
			14.0						99%		
						XW					Drilling Break Drilling Break SM, 0°, PL, Sandy clay, 10 mm Drilling Break Drilling Break
						MW - SW	O X	d=0.11 a=0.15			
			15.0			XW					SM, 0°, PL, Sandy clay, 350 mm
						HW					Drilling Break Drilling Break
						XW			65%		SM, 0°, PL, Sandy clay, 60 mm
						HW					Drilling Break Drilling Break Drilling Break Drilling Break Drilling Break Drilling Break PT, 5°, PL, RO, CN PT, 5°, PL, RO, SN, iron stained
			16.0			MW - SW					
							X O	d=1.21 a=0.60			Drilling Break JT, 0 - 5°, CU, RO, CN JT, 5°, PL, RO, SN, iron stained
			17.0						86%		
											Drilling Break Drilling Break Drilling Break Drilling Break Drilling Break SM, 0°, PL, Sandy clay, 20 mm
			18.0		**SANDSTONE**: fine to coarse grained, grey Borehole CBH510 terminated at 17.90 m Target depth	XW SW					
			19.0								

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method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

water
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

core run & RQD
- barrel withdrawn
- RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

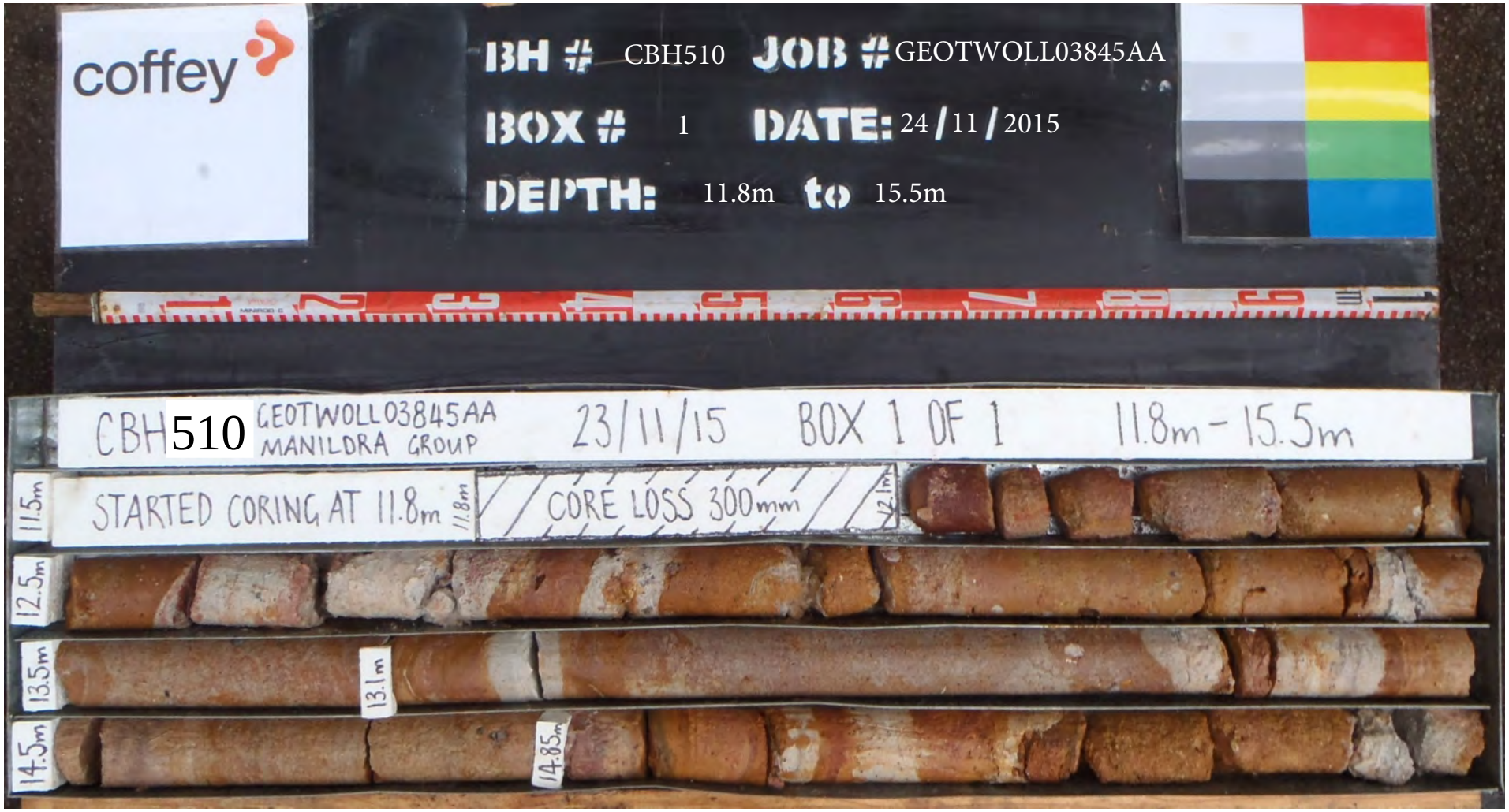
strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

coating
- CN clean
- SN stain
- VN veneer
- CO coating



PointID : CBH510 Depth Range: 11.80 - 15.50 m

drawn	FF
approved	DT
date	12/12/2015
scale	N.T.S.
original size	A4

coffey

client: MANILDRA GROUP

project: Proposed Packing Facility
Bolong Road, Bomaderry, NSW

title: **CORE PHOTOGRAPH**
CBH510

project no: GEOTWOLL03845AA | fig no: | rev:

PointID : CBH510 Depth Range: 15.50 - 17.90 m

drawn	FF
approved	DT
date	12/12/2015
scale	N.T.S.
original size	A4

client: MANILDRA GROUP

project: Proposed Packing Facility
Bolong Road, Bomaderry, NSW

title: **CORE PHOTOGRAPH**
CBH510

project no: GEOTWOLL03845AA | fig no: | rev:

coffey

Engineering Log - Borehole

Borehole ID.	***CBH511***
sheet:	1 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***25 Nov 2015***
principal:	***-***
date completed:	***25 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281841; N: 6140386 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T					0.0			**Silty SAND**: fine grained, dark brown, trace of medium plasticity clay, trace of fine sub-angular to sub-rounded gravel, trace of organics (rootlets)	M	MD		**TOPSOIL**
HW casing			SPT 3, 3, 4 N*=7		1.0		CI	**Silty CLAY**: medium plasticity, dark brown grey/brown, trace of grained sand, trace of organics	<Wp	F		**ALLUVIAL**
					2.0		CI	**Silty CLAY**: medium plasticity, grey, trace of fine grained sand, trace of organics (rootlets)		F - St		
			SPT 3, 3, 4 N*=7		3.0			colour changed to dark grey/grey/brown mottle			×	
		▶						colour changed to grey	>Wl	S - F		
			SPT 0, 0, 0 N*=0		4.0		SM	**Silty SAND**: fine to medium grained, grey/brown, trace of medium plasticity clay	W	L		
							CH	**Silty CLAY**: high plasticity, grey mottled red/orange, trace of fine grained sand, trace of fine sub-angular to sub-rounded ironstone gravel	Wp	St		drill head dropped **RESIDUAL**
W			SPT 6, 8, 8 N*=16		5.0						×	
					6.0			colour changed to red mottled grey/orange		St - VSt		drill head dropped
					7.0							

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Borehole

Borehole ID.	***CBH511***
sheet:	2 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***25 Nov 2015***
principal:	***-***
date completed:	***25 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281841; N: 6140386 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted casing diameter : HW

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
W							CH	**Silty CLAY**: high plasticity, grey mottled red/orange, trace of fine grained sand, trace of fine sub-angular to sub-rounded ironstone gravel *(continued)*	Wp	St - VSt		**RESIDUAL**
			SPT 10, 20/120mm N*=R		9.0		CI	**Silty Sandy CLAY**: medium plasticity, grey mottled red/orange, fine to coarse grained sand	<Wp	VSt - H		**EXTREMELY WEATHERED MATERIAL INTERBEDDED WITH HIGHLY WEATHERED MATERIAL**
					10.0							
					11.0							
			SPT 17, 20/100mm N*=R				CI	**Silty CLAY**: medium plasticity, grey mottled red/orange, trace of fine grained sand				
					12.0			Borehole CBH511 continued as cored hole				
					13.0							
					14.0							
					15.0							

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- * bit shown by suffix
- e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey

Engineering Log - Cored Borehole

Borehole ID.	***CBH511***
sheet:	3 of 3
project no.	***GEOTWOLL03845AA***
client:	***MANILDRA GROUP***
date started:	***25 Nov 2015***
principal:	***-***
date completed:	***25 Nov 2015***
project:	***Proposed Packing Facility***
logged by:	***FF***
location:	***Bolong Road, Bomaderry, NSW***
checked by:	***DT***

position: E: 281841; N: 6140386 (MGA94 Zone 56) surface elevation: Not Specified angle from horizontal: 90°

drill model: Hanjin 109, Track mounted drilling fluid: casing diameter : HW vane id.:

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
					start coring at 11.75m						
NMLC			12.0		Silty CLAY: medium plasticity, grey mottled red/orange, trace of fine grained sand, trace of fine to medium grained sub-angular gravel	XW	O	d=0.05			Extremely weathered material interbedded with thin highly weathered material.
					SANDSTONE: fine to coarse grained, orange/red mottle, fine grained sub-angular to angular gravel inclusions	HW - MW			29%		JT, 20°, PL, RO, SN SM, 10 - 20°, PL, Sandy clay, 50 mm
						MW	X	a=0.41			JT, 30°, PL, RO, VN JT, 70 - 80°, PL, RO, VN PT, 0°, UN, RO, VN
			13.0		colour changed to red/orange/grey mottle						JT, 20°, PL, RO, Clay CO, 3 mm SM, 0°, PL, Sandy clay, 120 mm
					NO CORE: 0.05 m	XW - HW					Drilling Break
						MW					Drilling Break JT, 80 - 90°, CU, RO, VN Drilling Break
			14.0			XW - HW			88%		SM, 60°, PL, Sandy clay, 40 mm SM, 0°, PL, Sandy clay, 20 mm SM, 0°, PL, Sandy clay, 30 mm
						MW					JT, 70 - 90°, UN, RO, Clay CO, 5 mm
					NO CORE: 0.25 m						
			15.0			XW - HW	X O	d=0.83 a=0.04			XW-HW Material SM
						XW					
					colour changed to orange brown	HW			39%		
			16.0								JT, 20°, PL, RO, VN JT, 30°, PL, RO, CN JT, 20°, PL, RO, CN, 50 mm JT, 80°, PL, RO, SN JT, 10°, PL, RO, VN
						MW					Drilling Break
					colour changed to grey/red/orange mottle	MW - HW					Drilling Break
			17.0								Drilling Break
					colour changed to grey						Drilling Break
					colour changed to orange brown						JT, 20°, PL, RO, VN, 20 mm
									89%		JT, 10°, PL, RO, SN
			18.0		colour changed to grey/red/orange mottle	SW - FR	X	d=0.50 a=0.38			JT, 10°, PL, RO, SN, 40 mm
											Drilling Break
			19.0		Borehole CBH511 terminated at 18.90 m Target depth						Drilling Break

CDF_0_9_06_LIBRARY.GLB rev:AA Log COF BOREHOLE: CORED GW03845AA-AA_DATABASE.GPJ <<DrawingFile>> 22/12/2015 16:08

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
SPT standard penetration test

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
DW distinctly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

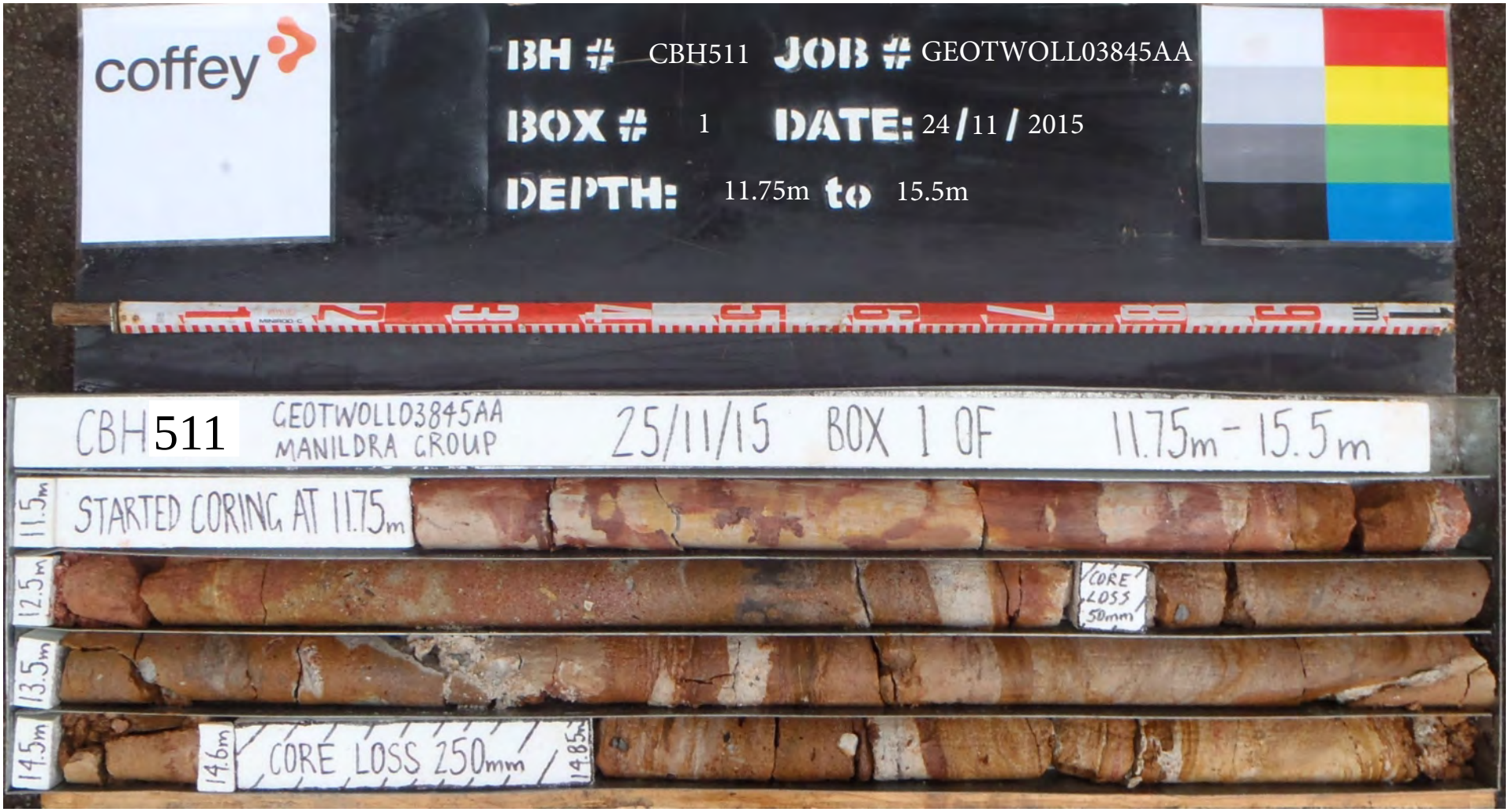
strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SZ shear zone
SS shear surface
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
SL slickensided
POL polished
SO smooth
RO rough
VR very rough

coating
CN clean
SN stain
VN veneer
CO coating



PointID : CBH511 Depth Range: 11.75 - 15.50 m

drawn	FF
approved	DT
date	12/12/2015
scale	N.T.S.
original size	A4

coffey

client: MANILDRA GROUP

project: Proposed Packing Facility
Bolong Road, Bomaderry, NSW

title: **CORE PHOTOGRAPH**
CBH511

project no: GEOTWOLL03845AA | fig no: | rev:

PointID : CBH511 Depth Range: 15.50 - 18.90 m

drawn	FF
approved	DT
date	12/12/2015
scale	N.T.S.
original size	A4

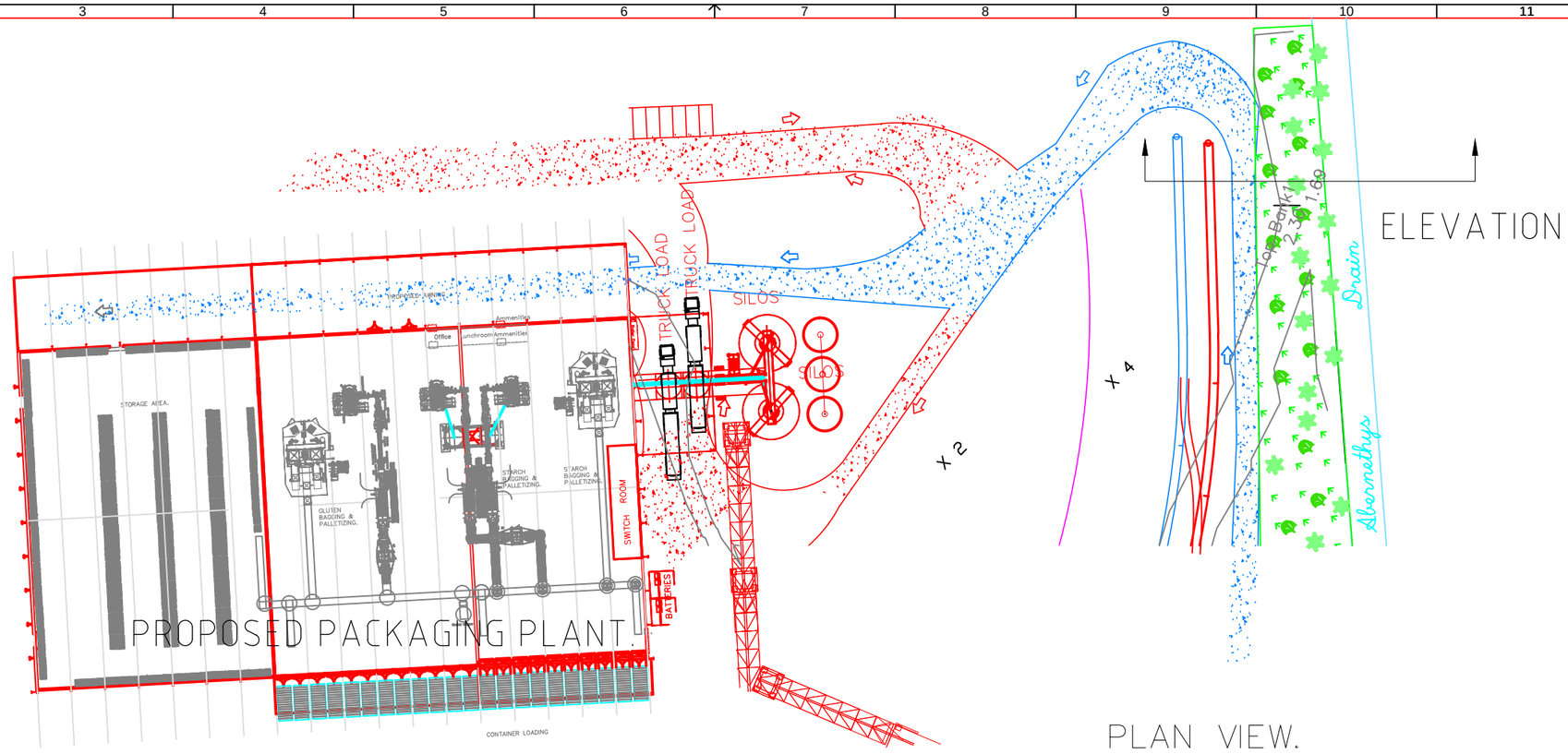
coffey

client: MANILDRA GROUP

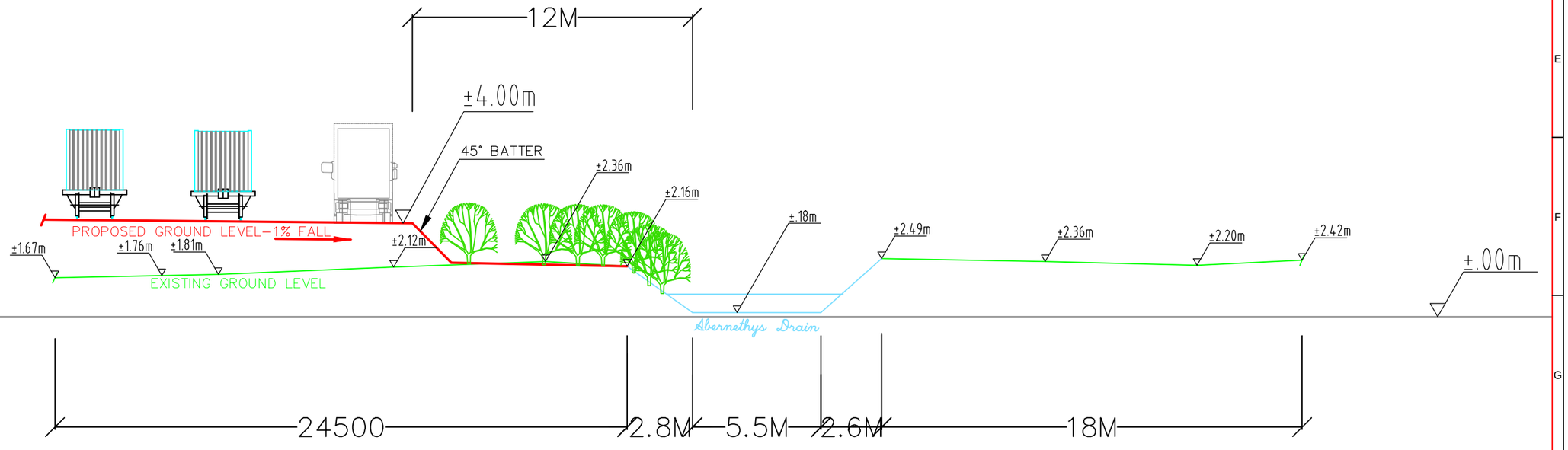
project: Proposed Packing Facility
Bolong Road, Bomaderry, NSW

title: **CORE PHOTOGRAPH**
CBH511

project no: GEOTWOLL03845AA | fig no: | rev:



PLAN VIEW.
SCALE 1:1000(A3)



ELEVATION THROUGH CREEK
AT NORTH EASTERN CORNER
SCALE 1:200(A3)

DRAWN PC	DATE 20-08-15	SITE MANILDRA-SHOALHAVEN STARCHES PTY LTD	SHT SIZE A3
DESIGNED. PC	DATE	JOB TITLE PROPOSED MODIFICATION APPLICATION	SHEET
CHKD GM	DATE	DWG TITLE PACKING FACILITY. SITE ELEVATION THROUGH CREEK.	OF
APPD A.T.	DATE 20-08-15		REV. P03
	SCALE 1:200/1:1000	PROJECT No. 5767	DWG No. MN262-015

ANNEXURE 10

Traffic Impact Assessment

prepared by

ARC Traffic and Transport

ANNEXURE 10

Shoalhaven Starches, Bomaderry

Proposed Packing Plant Modification

Traffic Impact Assessment

December 2015

prepared for

Manildra Shoalhaven Starches

prepared by

ARC Traffic + Transport

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Introduction

Manildra Shoalhaven Starches (Manildra) proposes a Modification to Project Approval MP06_0228 (the Shoalhaven Starches Expansion Project – SSEP Approval) in regard to the Shoalhaven Starches Packing Plant, approved on Lot 16 DP 1121337 and Lot 2 DP 538289, Bolong Road and Railway Street, Bomaderry (the PP Site).

The Modification provides for the retention of the approved Packing Plant in the general location as originally approved on the PP Site, but would modify the size and siting of the Packing Plant. The Modification also provides for an additional rail spur line on the PP Site to that which as originally approved (to a total of 2 rail spurs); an additional weighbridge; and minor revisions to the location and alignment of the approved Bolong Road pedestrian bridge crossing that will also contain pipe infrastructure linking the PP Site and broader Shoalhaven Starches Site (SS Site) south of Bolong Road.

While the Modification provides for a greater Packing Plant floor-area than provided in the SSEP Approval, this increase relates to engineering design requirements, and maximising the efficiency of future operations; significantly, the Modification does not provide for any increase in production output (or raw material requirements) above those limits provided for in the SSEP Approval. Similarly, the Modification would not result in increases in vehicle trips or rail movements above those limits provided for in the SSEP Approval.

As such, the only potential impacts associated with the Modification (above those previously assessed and approved per the SSEP Approval) relate to the period of the construction works, estimated at some 12 months.

ARC Traffic + Transport (ARC) has been commissioned to examine the access, traffic and parking issues associated with the Modification. This Traffic Impact Assessment specifically references reports prepared by ARC in regard to vehicle access modifications to/from Bolong Road further to recent Shoalhaven Starches approvals; specifically, ARC has referenced the following reports: -

- Shoalhaven Starches Dryer Modification Traffic Impact Assessment October 2015 (Dryer TIA)
- Shoalhaven Starches Demolition Modification Traffic Impact Assessment October 2015 (Dryer TIA)
- Dairy Farmers Site Reuse Proposal - Meat Processing Plant Traffic Impact Assessment March 2014 (Meat TIA)
- Shoalhaven Starches Access Review March 2014 (Access Review)
- Shoalhaven Starches Interim Packing Plant Traffic Impact Assessment March 2011 (IPP TIA)
- Shoalhaven Starches Ethanol Upgrade & Packaging Plant Traffic Impact Assessment May 2008 (SSEP TIA)

ARC has also referenced the Department of Planning & Environment (DP&E) Secretary's Environmental Assessment Requirements (6th October 2015) which provide the following in regard to traffic: -

Traffic (road and rail) - Assessment of road and rail traffic impacts including type and number of movements compared with existing and approved development. Details of how the modification meets the requirements of the Rail Safety National Law (NSW), including accreditation for the scope of works and development of appropriate safety interfaces if required.

Details relating to the Modification – including confirmation of construction staff and heavy vehicle numbers - have been provided to ARC by Manildra.

1 Background

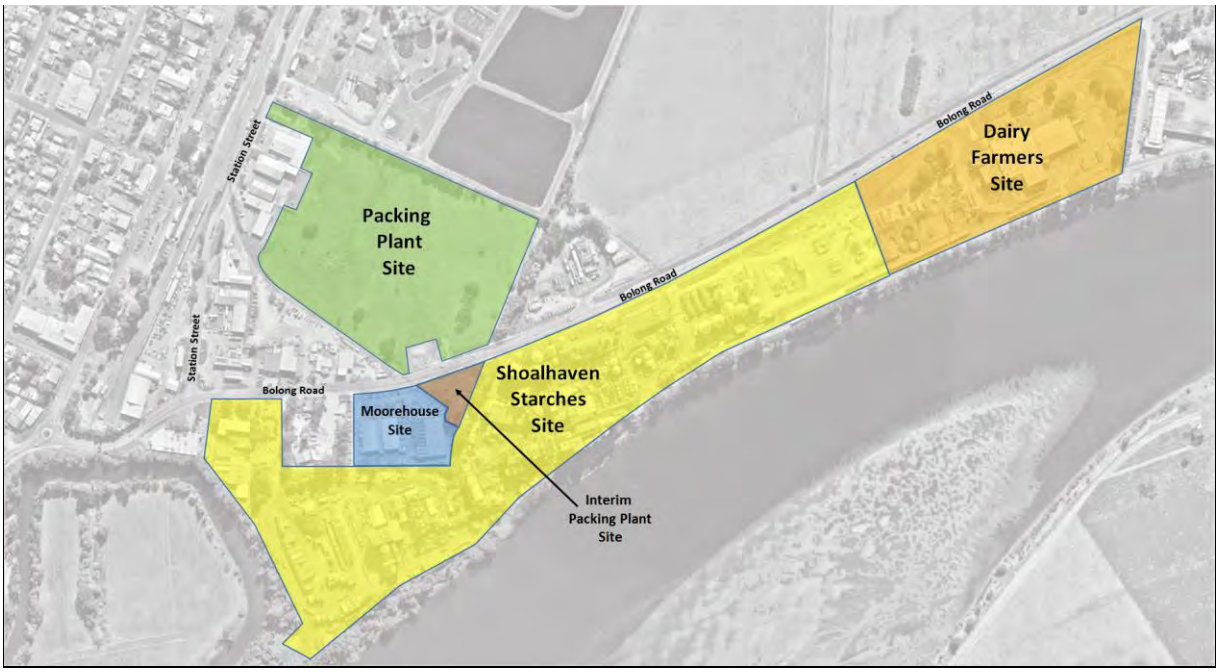
1.1 Manildra Shoalhaven Starches

Manildra's Shoalhaven Starches operations occupy a number of distinct 'sites' in Bomaderry; while operations are integrated across all sites, they are differentiated in this assessment for ease of reference.

The primary SS Site and immediately adjacent Dairy Farmers Site (DF Site) are located south of Bolong Road, Bomaderry, while the approved PP Site is located directly opposite the SS Site on the northern side of Bolong Road. Within the broader SS Site, the Moorehouse Site lies south of Bolong Road, immediately west of the railway line, while the IPP Site lies south of Bolong Road immediately east of the railway line.

These sites are shown in their local context in Figure 1.1.

Figure 1.1 Manildra Shoalhaven Starches, Bolong Road Bomaderry



1.2 Previous Site Approvals

1.2.1 Shoalhaven Starches Expansion Project Approval MP06-0228

The SSEP Approval was granted by the Minister for Planning on the 28th January 2009. This approval also encapsulated previous approvals into one overall approval. The SSEP is a 'transitional Part 3A Project' for the purposes of Schedule 6A of the Environmental Planning & Assessment Act.

The SSEP provides for an increase in ethanol production at Shoalhaven Starches in a staged manner from 126 million litres per year to 300 million litres per year. To accomplish the increase in ethanol production, the SSEP required a series of plant upgrades and increases in throughput of raw materials, principally flour and grain. The SSEP included the following alterations and additions: -

- The provision of an additional product dryer;
- Additional equipment and storage vessels for the ethanol plant including additional fermenters, additional cooling towers and molecular sieves;
- Upgrades to the Stillage Recovery Plant, including additional DDGS Dryers, Decanters, chemical storage and evaporators. This proposal also included the installation of a DDGS Pellet Plant; and
- The establishment of a new Packing Plant, container loading area and rail spur line on the northern side of Bolong road.

Following the SSEP Approval, Manildra acquired the DF Site, and commenced investigations into relocating the Packing Plant from the approved PP Site north of Bolong Road to the DF Site; as an interim measure during these investigations, approval was provided in 2012 for interim Packing Plant operations at the IPP Site.

At this time (October 2015) the PP Site remains broadly unused, though a Bolong Road driveway crossover per the SSEP Approval has been constructed connecting to a short access road servicing a small number of informal parking spaces immediately north of Bolong Road. Two recent Modification submissions provided to the DP&E – the Demolition Modification and Dryer Modification – propose the use of this existing access road and a (to be constructed per the Demolition Modification) temporary car park during demolition and construction works at the Moorehouse Site relating to the proposed Starch Dryer No.5. It is noted that the potential exists for the use of this temporary car park (for Dryer construction staff) through the initial stages of the Packing Plant construction (see also Section 1.3.4).

In addition, a condition of the SSEP Approval required the provision of additional staff parking (across the broader SS Site). The DF Site was identified as an appropriate location for this parking, and subsequently a new staff car park on the DF Site – accompanied by significant additional infrastructure at the intersection of Bolong Road and the DF Site access road (DF 1) – was approved. It is noted that while much of this intersection and internal infrastructure is now in place at the DF Site, the car park itself has not been constructed.

With regard to key access, traffic and parking issues, this generally summarises all Shoalhaven Starches proposals/approvals relating to the SS Site, DF Site, PP Site and IPP Site to date.

1.2.2 DF Site Meat Processing Plant & SS Site Access Review

In 2014, a Meat Processing Plant (the Meat Plant) at the DF Site, which utilises the existing on-site buildings generally occupying the eastern portion of the DF Site, was approved by Council. It is noted that the background traffic analysis of the Meat Plant identified a number of access issues relating to the broader SSEP Approval at the DF Site, and specifically the fact that a number of the required infrastructure upgrades (under the SSEP Approval) had not been completed.

This was largely as a result of the fact that the approved staff car park had not be built, and as such the infrastructure required to support the additional movements to/from the staff car park at the intersection of Bolong Road & DF 1 were not [at that time] warranted.

Notwithstanding – and further also to a review of general access at the adjacent SS Site Eastern Access Point (SS AP 1) in consultation with Council – ARC prepared an Access Review as a general supplement to the DF Meat TIA, detailing the infrastructure and management measures required to provide compliance with the SSEP Approval, and subsequently to appropriately accommodate the traffic demands of the Meat Plant proposal at the intersection of Bolong Road & DF1, and DF Site internal movements. As stated above, the infrastructure works recommended in the Access Review and the DF Meat TIA – and moreover conditioned upgrades required under the earlier DF Site approvals - have either been completed, or have been approved by Council [based on final engineering/design plans] to construction.

ARC notes that the Meat Plant has been approved, and is currently operational.

1.3 Access

The Modification will provide for the construction of the two PP Site access points in accordance with the SSEP Approval, which would provide for Packing Plant construction trips during the construction period; and for a redistribution of existing interim Packing Plant staff and heavy vehicles trips from existing SS Site access points once operational.

ARC notes that the 'Access Point' reference numbers provided below are based on past assessments, and have been retained for ease of reference.

1.3.1 Bolong Road & SS Site Western Access Point (AP 3)

The intersection of Bolong Road & AP 3 currently provides two-way access for light and heavy vehicle traffic generated in the western and southern parts of the SS Site.

At present (and as detailed in the IPP TIA) heavy vehicles are required to transport product and consumable materials from within the broader SS Site to the IPP Site for rail transport; this results in daily heavy vehicle trips being generated on a 'loop' between AP 3 and the IPP Site. The product carrying heavy vehicle trips will be eliminated once the Packing Plant is operational, while a small number of movements will continue to transport consumable items (paper bags, bulk bags, cardboard liners etc) from AP 3 to the PP Site.

1.3.2 Bolong Road & Moorehouse Site Access Point (AP 4)

The intersection of Bolong Road & AP 4 currently provides two-way access to a designated staff car park for some 118 vehicles. Further to the Packing Plant becoming operational, IPP Site staff currently using the Moorehouse Site for parking would be relocated to the PP Site.

1.3.3 Bolong Road & Interim Packing Plant Access Point (IPP 1)

The intersection of Bolong Road & IPP 1 provides separate entry and departure driveways (joined by a small internal access road). Further to the Packing Plant becoming operational, heavy vehicle trips generated by the IPP Site would be relocated to the PP Site (noting again the removal altogether of 'looping' product trips). As importantly, it is noted that the light vehicle trips previously surveyed at the IPP Site – constituting previously required contractor and maintenance vehicle trips – are no longer generated.

A future use for the IPP Site (i.e. further to operations moving to the Packing Plant) has not been determined at this time, but any future use would necessarily require appropriate approvals.

1.3.4 PP Site Access Points

The SSEP Approval provides for two access points to the PP Site, both of which will be constructed as part of this Modification to the specifications provided in the SSEP Approval.

The initial construction task will include the construction of the approved two-way access point to Railway Street (PP 2) and on-site driveways to the staff car park and to the construction site. During the later stages of construction, an internal access road will be constructed to the existing driveway crossover at Bolong Road (PP 1). Once the Packing Plant becomes operational, both access points would be available for use in accordance with the distribution profile provided for in the SSEP Approval.

As discussed in Section 1.2.1, the Demolition Modification and Dryer Modification provide for the retention of the existing Bolong Road crossover (designed with reference to the SSEP Approval – PP 1) and a (minor) access road (which it is acknowledged is not in accordance with the SSEP Approval, providing a different alignment and for two-way movements).

Further to the Demolition Modification, it is proposed that this existing access road would be widened and extended along its current alignment to provide access to a temporary car park on the PP Site to accommodate SS Site staff relocated from the Moorehouse Site during the demolition and construction periods associated with these Modifications respectively. Full details of these access and traffic characteristics of these proposals are provided in the Demolition TIA and Dryer TIA.

The potential exists for some part of the Dryer construction period to overlap with the Packing Plant construction period. During this period, all access to the Packing Plant construction areas would be exclusively via PP 2, while access to the temporary car park (for SS Sit staff relocated from the Moorehouse Site, and for Dryer construction staff) would be exclusively via PP 1.

Once the Dryer construction is completed, the temporary car park will be removed, allowing for the retrofitting of PP 1 and construction of the PP 1 as a left turn in access road only (i.e. arrival only) and aligned and constructed to provide compliance with the SSEP Approval.

1.3.6 Other SS Site Access Points

Three other SS Site access points are provided to Bolong Road, including the Central Access Point (AP 2); Eastern Access Point (AP 1); and the Dairy Farmers Access Point (DF 1). However, the Modification proposal would not generate any additional movements to these intersections over previously approved flows.

1.4 Assessment Traffic Flows

1.4.1 Existing Traffic Flows

Further to the commission of traffic surveys over many years, and in consultation with Council, ARC has over time developed base peak period traffic flows for the key intersections along Bolong Road that reflect 120th Highest Hour (or 'recreational peak') conditions. 2014 recreational peak flows were most recently reported in the Meat Plant TIA, and have been adapted for this assessment, and include: -

- 2016 recreational peak through flows in Bolong Road
- All approved/proposed access and intersection infrastructure to October 2015
- All approved/proposed flows to the SS Site and DF Site to October 2015
- A minor trip assignment to reflect the occasional parking accessed via PP 1

1.4.2 Princes Highway Upgrade

The upgrade of the Princes Highway between Gerringong and Bomaderry has developed as three consecutive RMS projects – the Gerringong Bypass Project; the Foxground & Berry Bypass Project; and the Berry to Bomaderry Upgrade Project.

As these projects have developed, the RMS estimate of the number of trips that will transfer from the "Sandtrack" (currently approximately 45% of through trips between Bomaderry and Gerringong and vice versa) to the Princes Highway (currently approximately 55% of through trips between Bomaderry and Gerringong and vice versa) has also developed.

The most recent RMS modelling concludes that the transfer from the Sandtrack to the upgraded Princes Highway will be very significant. Further to our discussions with the RMS (Mr Nick Boyd, Senior Project Manager), ARC has confirmed that further to the completion of the (currently under construction) Foxground & Berry Bypass, that with or without the construction of the Berry to Bomaderry Upgrade (in planning by the RMS) the RMS estimates the Princes Highway attracting some 80% of through trips, and the Sandtrack only 20% of through trips.

Taking into account other factors (such as general background traffic growth) the future traffic flows to the Princes Highway and to the Sandtrack (and indeed specifically to Bolong Road at Meroo Road, i.e. immediately west of the SS Site) are provided in Table 1.4.2 below.

Table 1.4.2 Princes Highway Upgrade Future Flow Estimates

Ref.	Route | Direction	Location	AADT											
			2013			2019			2029			2039		
			Base Year			Construction | Opening			Opening +10			Design - Do Something		
			Light	Heavy	Total	Light	Heavy	Total	Light	Heavy	Total	Light	Heavy	Total
Princes Highway														
A	south of Berry	southbound	5,139	1,019	6,158	8,187	1,212	9,399	11,386	1,614	13,000	14,254	2,020	16,274
B		northbound	5,449	950	6,399	9,039	1,130	10,168	12,571	1,504	14,075	15,737	1,883	17,620
-		two-way	10,588	1,970	12,557	17,225	2,342	19,568	23,958	3,118	27,076	29,990	3,903	33,893
C	north of Meroo Rd	southbound	5,378	1,052	6,430	8,904	1,248	10,152	12,629	1,649	14,278	15,778	2,054	17,832
D		northbound	5,686	961	6,647	9,772	1,140	10,912	13,871	1,506	15,377	17,334	1,876	19,210
-		two-way	11,065	2,013	13,077	18,676	2,388	21,064	26,501	3,155	29,655	33,112	3,930	37,042
E	south of Abernethys Lane	southbound	4,897	926	5,823	8,345	1,102	9,447	11,941	1,469	13,410	14,960	1,841	16,801
F		northbound	5,207	840	6,047	9,215	1,000	10,215	13,185	1,333	14,518	16,519	1,669	18,189
-		two-way	10,104	1,766	11,870	17,560	2,102	19,662	25,126	2,802	27,928	31,479	3,510	34,990
S10	Meroo Road Interchange	southbound off ramp	599	155	754	695	180	876	857	222	1,079	1,018	264	1,282
N10		northbound on ramp	598	151	749	694	176	870	855	216	1,072	1,016	257	1,273
S11		southbound on ramp	117	30	147	136	34	171	168	42	210	199	50	250
N11		northbound off ramp	119	30	148	138	35	172	170	43	212	201	51	252
Local Roads														
G	Meroo Road - south of Princes Highway	southbound	718	186	903	834	216	1,049	1,027	266	1,293	1,220	316	1,536
H		northbound	715	181	896	831	210	1,041	1,023	259	1,282	1,216	307	1,523
-		two-way	1,433	367	1,799	1,664	426	2,090	2,050	525	2,575	2,436	623	3,059
I	Sandtrack - north of Meroo Road	southbound	4,544	467	5,011	2,304	551	2,855	2,688	724	3,412	3,339	899	4,238
J		northbound	4,404	386	4,790	2,432	455	2,887	2,837	599	3,435	3,524	744	4,267
-		two-way	8,948	853	9,801	4,736	1,006	5,742	5,525	1,323	6,848	6,862	1,643	8,505

Source: Princes Highway Upgrade – Berry to Bomaderry Technical paper: Traffic and Transport 2013 AECOM Australia

In real terms, these figures indicate that following the completion of the Princes Highway bypass projects, the 2019 AADT in Bolong Road (immediately west of the SS Site) will represent less than 60% of the 2013 AADT, reducing from a 2013 AADT of some 9,800 vehicle trips per day (vtpd) to a 2019 AADT of only 5,742 vtpd. Even with background growth continuing after 2019, the 2029 AADT is estimated to represent only 70% of the 2013 AADT; and the 2039 AADT some 87% of 2013 AADT.

The opening of the Gerringong Bypass in August 2015 will see this transfer from the Sandtrack to Princes Highway commence, but with construction of the additional stages still ongoing or in planning, the Sandtrack is still expected to attract moderate flows in the short term (to 2018), i.e. the significant reduction would not be achieved until the opening of the Foxground and Berry Bypass. It is estimated that in this period (2015 – 2018) Bolong Road flows would be reduced by approximately 15% - 20% (from pre-opening levels).

1.4.3 Dryer Modification Traffic Flows

As discussed in Section 1.3.4, the potential exists for the Packing Plant construction to coincide for a time with the Dryer construction. As detailed in the Dryer TIA, during the Dryer construction the temporary car park on the PP Site would be used by SS Site relocated from the Moorehouse Site, and by Dryer construction staff. Local network traffic flows associated with the Dryer construction are detailed in the Dryer TIA.

1.4.4 Assessment 'Base' Flows

Further to the sections above, two base flow scenarios are provided for the assessment. These are: -

- **Scenario 1 2016 Base Flows + Dryer Construction**

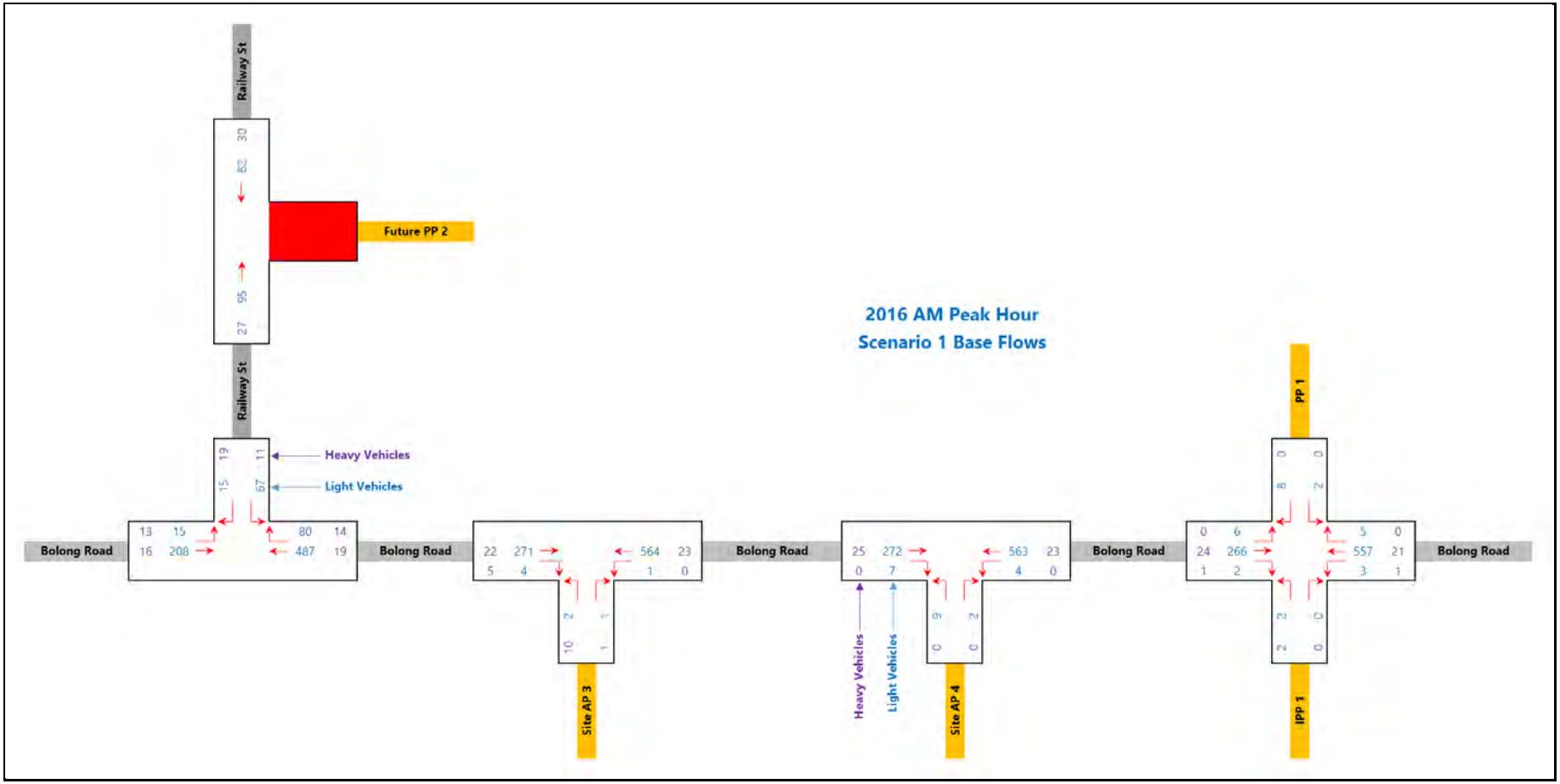
  This scenario provides the base network/flows for the assessment of the period where Packing Plant construction and Dryer construction coincide.

- **Scenario 2 2016 Base Flows**

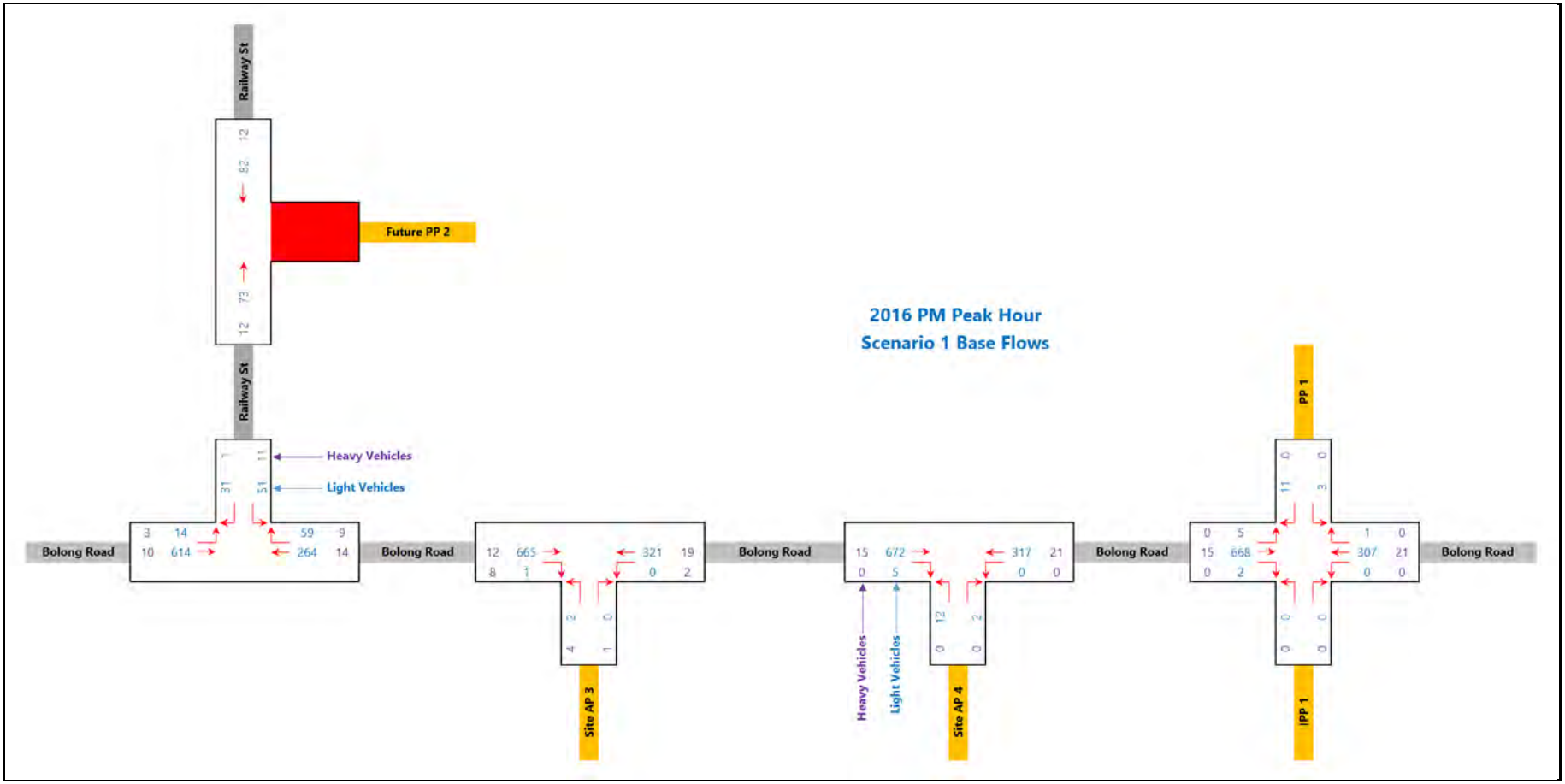
  This scenario provides the base network/flows for the assessment of the period where Packing Plant construction only is occurring (with all access via PP 2 only) and then for the operational Packing Plant (with access available via both PP 1 and PP 2).

With reference to sections above, and to the Dryer TIA, peak hour traffic flows for these two base scenarios are provided in the figures below. It is noted that after 2016 flows in Bolong Road are expected to further reduce, such that 2016 remains (what will be for many years) a 'peak flow' year in Bolong Road, and therefore an appropriate base for the assessment of both the Packing Plant construction and operational traffic flows.

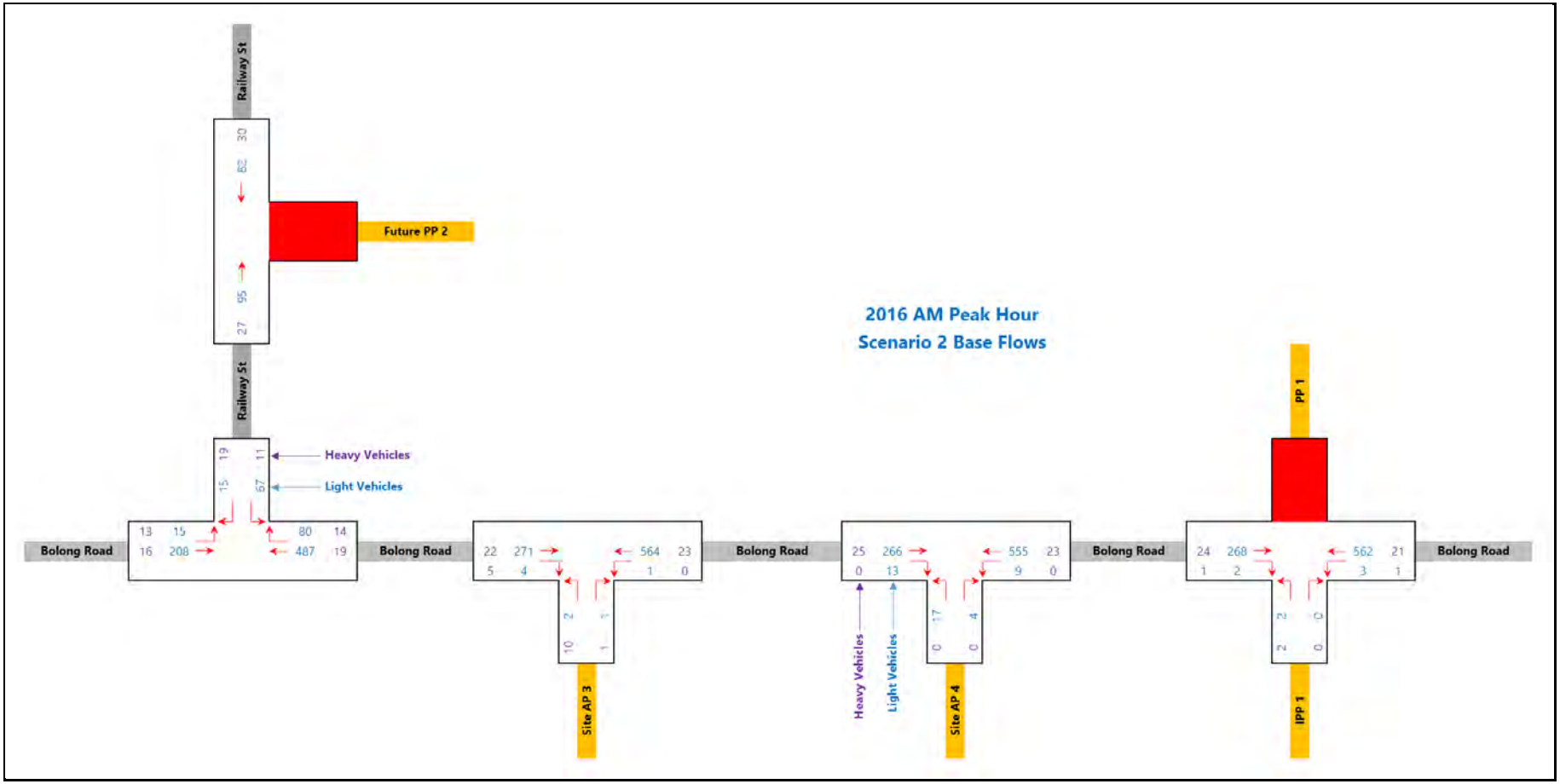
1.4.4.1 Scenario 1 AM Peak Hour Base Network



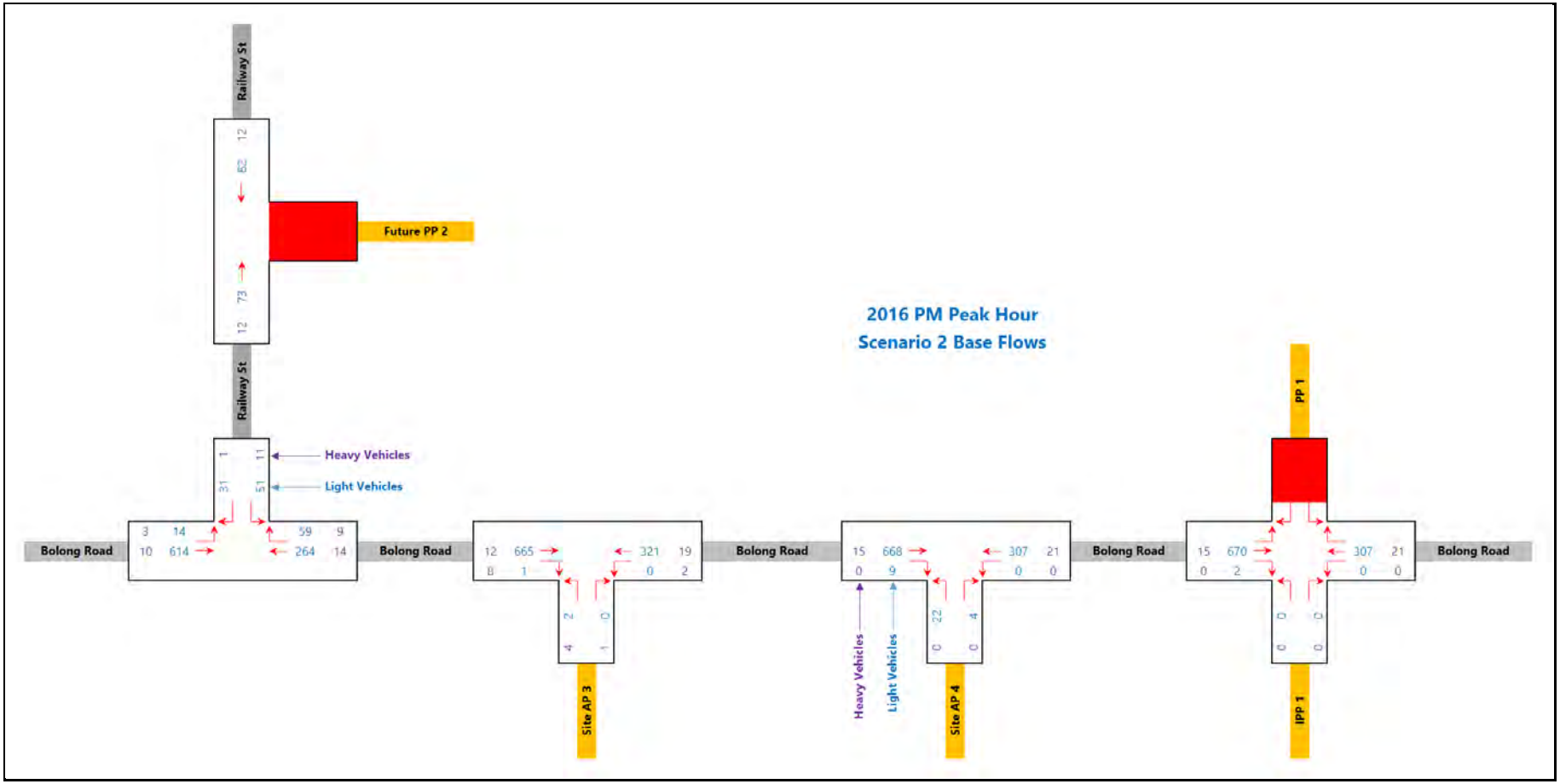
1.4.4.2 Scenario 1 PM Peak Hour Base Network



1.4.4.3 Scenario 2 AM Peak Hour Base Network



1.4.4.4 Scenario 2 PM Peak Hour Base Network



1.4.5 Intersection Performance Assessment

In order to determine the performance of the key intersections as detailed in Section 1.3, as well as the local intersection Bolong Road & Railway Street, the RMS approved SIDRA (Version 6.1) intersection model been utilised to determine current intersection operations. The SIDRA inputs includes peak hour traffic flows and speed profiles, intersection geometry and operational controls, and in turn SIDRA reports the following key performance measures: -

- **Level of Service**

  Level of service is a basic performance indicator assigned to an intersection based on average delay. For signalised and roundabout intersections, level of service is based on the average delay to all vehicles, while at priority controlled intersections level of service is based on the worst approach delay. The RMS Level of service criteria, which have been used in the assessment, are provided below: -

Level of Service (RMS)	Control delay per vehicle in seconds (d) (including geometric delay)		
	Signals and Roundabouts	Rating	Stop and Give Way / Yield Signs
A	d < 14.5	Good	d < 14.5
B	14.5 < d < 28.5	Good with acceptable delay	14.5 < d < 28.5
C	28.5 < d < 42.5	Satisfactory	28.5 < d < 42.5
D	42.5 < d < 56.5	Near capacity	42.5 < d < 56.5
E	56.5 < d < 70.5	At capacity	56.5 < d < 70.5
F	70.5 < d	Over capacity	70.5 < d

- **Delay**

  Delay represents the difference between interrupted and uninterrupted travel times through an intersection, and is measured in seconds per vehicle in this assessment. Delays include queued vehicles accelerating and decelerating from/to the intersection stop, as well as general delays to all vehicles travelling through the intersection. With reference to the LoS criteria above, the average intersection delay for signals and roundabouts represents an average of delays to all vehicles on all approaches, while for priority intersections the average delay for the worst approach is used.

- **Degree of Saturation**

  Degree of saturation is defined as the ratio of demand (arrival) flow to capacity. A degree of saturation above 1.0 represent over-saturated conditions (demand flows exceed capacity) and degrees of saturation below 1.0 represent under-saturated conditions (demand flows are below capacity). The capacity of the movement with the highest degree of saturation is reported.

The performance of key intersections under base conditions is reported in the tables below.

Table 1.4.5.1 Scenario 1 Base Intersection Performance

Scenario 1 Base Flows Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	1.9	1.9	0.345	0.334	7.5	7.8
Bolong Road & Access Point 3	A	A	0.4	0.3	0.309	0.304	1.6	1.4
Bolong Road & Access Point 4	A	A	0.2	0.1	0.310	0.301	0.7	0.4
Bolong Road & IPP 1 & PP 1	A	B	0.3	0.3	0.310	0.358	0.9	1.4

Table 1.4.5.2 Existing Intersection Performance

Scenario 2 Base Flows Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	1.9	1.9	0.343	0.332	7.4	7.7
Bolong Road & Access Point 3	A	A	0.4	0.3	0.309	0.303	1.5	1.4
Bolong Road & Access Point 4	A	A	0.4	0.2	0.309	0.301	1.1	0.8
Bolong Road & IPP 1	A	A	0.1	0.1	0.308	0.357	0.3	0.1

With reference to the tables above, all site access intersections, and the intersection of Bolong Road & Railway Street, operate at a good level of service under 'base' conditions, with minimal average delays and significant spare capacity.

Finally, it is also noted that further to the opening of upgraded sections of the Princes Highway, a percentage of the arrival and departure trips from/to the east reported at the SS Site access points are expected to be redistributed to the Princes Highway (i.e. to/from the west) in the same way as general sub-regional trips are redistributed. However, this is not expected to have a significant impact on the operation of these access intersections.

1.5 Rail Operations

Shoalhaven Starches uses rail for the majority of transport operations, including incoming raw materials and outgoing product. This is has very significant benefits in reducing vehicle trip generation, and specifically heavy vehicle trip generation; it is estimated that existing rail movements equate to the generation of some 100 heavy vehicle trips per day.

All trains are currently required to use the Railway Street and Bolong Road level crossing to/from the southern side of Bolong Road.

1.5.1 Container Trains

An average of 4 (export material) container trains operate weekly, carrying a total of approximately 280 containers per week. Two types of train configuration are used, being a 40 wagon train (generally used three time a week) and a 20 wagon train (generally used once a week). The majority of these container train services will be relocated to the proposed rail spurs on the PP Site, with a commensurate reduction in crossings to/from the southern side of Bolong Road.

1.5.2 Grain Trains

An average of 4 grain trains operate weekly, comprising 31 wagons and carrying an average weekly volume of approximately 7,200 tonnes. These train services will marginally increase in line with the SSEP Approval, and continue to use the existing sidings on the southern side of Bolong Road.

1.5.3 Flour Trains

An average of 6 flour trains operate weekly, carrying an average weekly volume of approximately 11,500 tonnes. Three types of train configuration are generally used, being a 35 wagon train, a 27 wagon train and a 23 wagon train. These train services will be marginally reduced in line with the SSEP Approval, and continue to use the existing sidings on the southern side of Bolong Road.

1.5.4 Railway Crossings

With reference to sections above, an average of 14 trains service the SS Site each week, and are expressly scheduled (to the extent possible) so as to be spread across each week, i.e. to average 2 trains per day.

Importantly, these 14 'single' trains then generate additional movements at both the Railway Street and Bolong Road level crossings as a result of the available line capacity (length) between the two crossings (i.e. on the PP Site); and as a result of the location of loading/unloading facilities along the existing rail sidings on the southern side of Bolong Road. At Railway Street, this results in minor shunting demands given the availability of the Bomaderry railyard (and across the PP Site). However, at Bolong Road this results in numerous shunting movements by longer trains (and specifically by container trains). As such, the average 14 trains per week can generate over 50 movements at the Bolong Road level crossing.

The provision of new PP Site rail sidings per this Modification will allow container trains – which have the highest number of shunting movements – to be contained on the PP Site, thereby significantly reducing Bolong Road crossing demands. In addition, a future Modification (currently in preliminary planning by Manildra) will provide additional siding capacity on the southern side of Bolong Road, thereby reducing shunting requirements (see also Section 2.6).

1.5.5 Railway Operations Accreditation

Manildra Group is rail safety accredited as the Rail Infrastructure Manager (RIM) for the SS Site. This accreditation requires Manildra Group to have all systems in place to manage the requirements of the RIM for day to day rail operations through a Safety Management System (SMS) which must conform to the Rail Safety National Law (NSW) to which Manildra Group has been subject to ongoing and successful audits.

2 The Modification Proposal

2.1 The Proposal

As stated, Manildra proposes a Modification to the SSEP Approval in regard to the approved Packing Plant, which would provide for revisions to the size and siting of the Packing Plant; the provision of an additional rail spur; the provision of an additional weighbridge; and revisions to the location and alignment of the approved Bolong Road bridge crossing.

Importantly from an access, traffic and parking perspective, once operational the Modification would not result in any increase in production from the broader SS Site/PP Site over that which has been the subject of past approvals, nor as a result an increase in either vehicle traffic or rail movements/duration of train crossings at the Bolong Road and Railway Street rail crossing over previous (approved) forecasts.

The only potential for short term traffic impacts arising from the Modification relate to the 12 month Packing Plant construction period, after which broader Shoalhaven Starches traffic flows would essentially comprise flows as determined in the SSEP TIA. With regard to rail movements, the Modification will allow for a significant reduction in rail movements at Bolong Road.

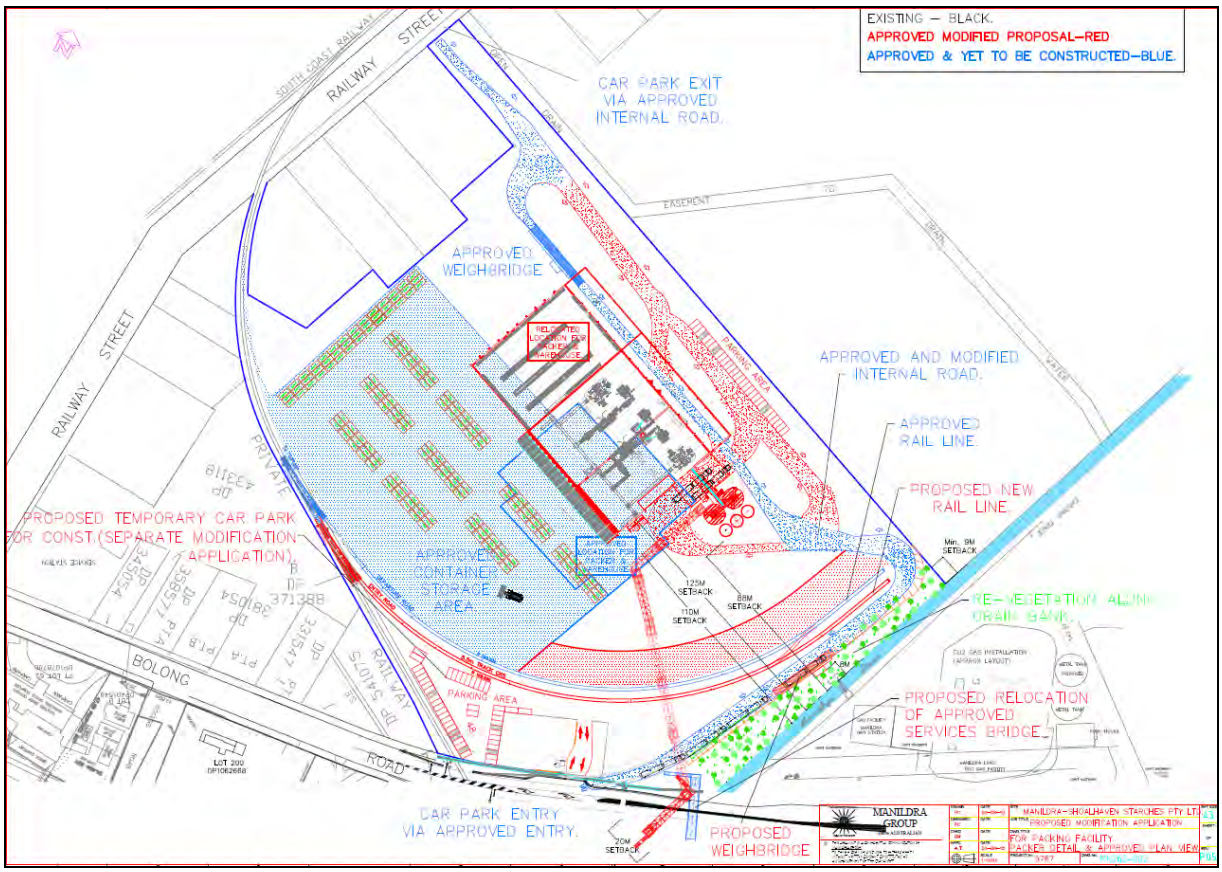
The assessment provided in sections below examines the traffic and transport characteristics of the following: -

- Packing Plant construction works coinciding with the final stage of Dryer construction works
- Packing Plant construction works only
- Packing Plant operations
- Rail operations (once the Packing Plant is operational)

As discussed, the traffic characteristics of the Dryer construction works are detailed in the recent Dryer TIA, and are referenced below without further detail.

Figure 2.1 provides an overview of the Modification, while detailed plans of the proposed Modification components are provided elsewhere within the submission which this TIA accompanies.

Figure 2.1 The Modification



2.2 Packing Plant Construction

2.2.1 Access

Work will commence with the construction of the approved industrial access point (PP 2) to Railway Street, and internal roads to the construction works area and staff car park, which will also be constructed as part of initial works. This access point and all internal access roads will be designed with reference to AS 2890.2.

All Packing Plant construction staff and heavy vehicle trips will utilise PP 2 throughout the construction process; while the construction of the internal access road to PP 1 will be completed in the later stages of the construction process, it is proposed that this access point would only be used once the Packing Plant is operational.

2.2.2 Construction Trip Generation

2.2.2.1 Heavy Vehicle Trips

It is estimated that the Packing Plant construction will throughout generate no more than 10 heavy vehicles (or 20 heavy vehicle trips) per day carrying materials and plant. It is estimated that no more than 2 heavy vehicle trips would be generated during the (commuter) peak hours.

2.2.2.2 Construction Staff Vehicle Trips

It is estimated that the Packing Plant construction will employ up to 27 construction staff per day, including an on-site supervisor and occasional specialists. As with previous projects, a core group of construction staff (11) are expected to arrive in group transport (i.e. shuttle buses) from Wollongong, while other construction staff would generate a mix of shared and individual private vehicle trips. Given that shift times are expected to fall outside of (commuter) peak periods, and the expectation of only minor driver only trips, it is estimated that no more than 4 staff vehicle trips would be generated during the (commuter) peak hours.

2.2.3 Packing Plant Construction Period Traffic Flows

As discussed, the Packing Plant construction could potentially coincide with the Dryer construction for a short period (estimated at 2 – 3 months), after which trips associated with the Dryer construction would no longer be generated. It is again important to note that during the Dryer construction period all trips to the temporary car park would be via PP 1, with no connectivity between PP 2 and the temporary car park.

The Packing Plant construction trips detailed above have been assigned to the two base flow scenarios outlined in Section 1.4 for assessment, with the resulting total flows shown in the following figures: -

- Figure 2.2.3.1 AM Peak Hour Packing Plant Construction + Dryer Construction
- Figure 2.2.3.3 PM Peak Hour Packing Plant Construction + Dryer Construction
- Figure 2.2.3.3 AM Peak Hour Packing Plant Construction only
- Figure 2.2.3.4 PM Peak Hour Packing Plant Construction only

Figure 2.2.3.1 AM Peak Hour Packing Plant Construction + Dryer Construction

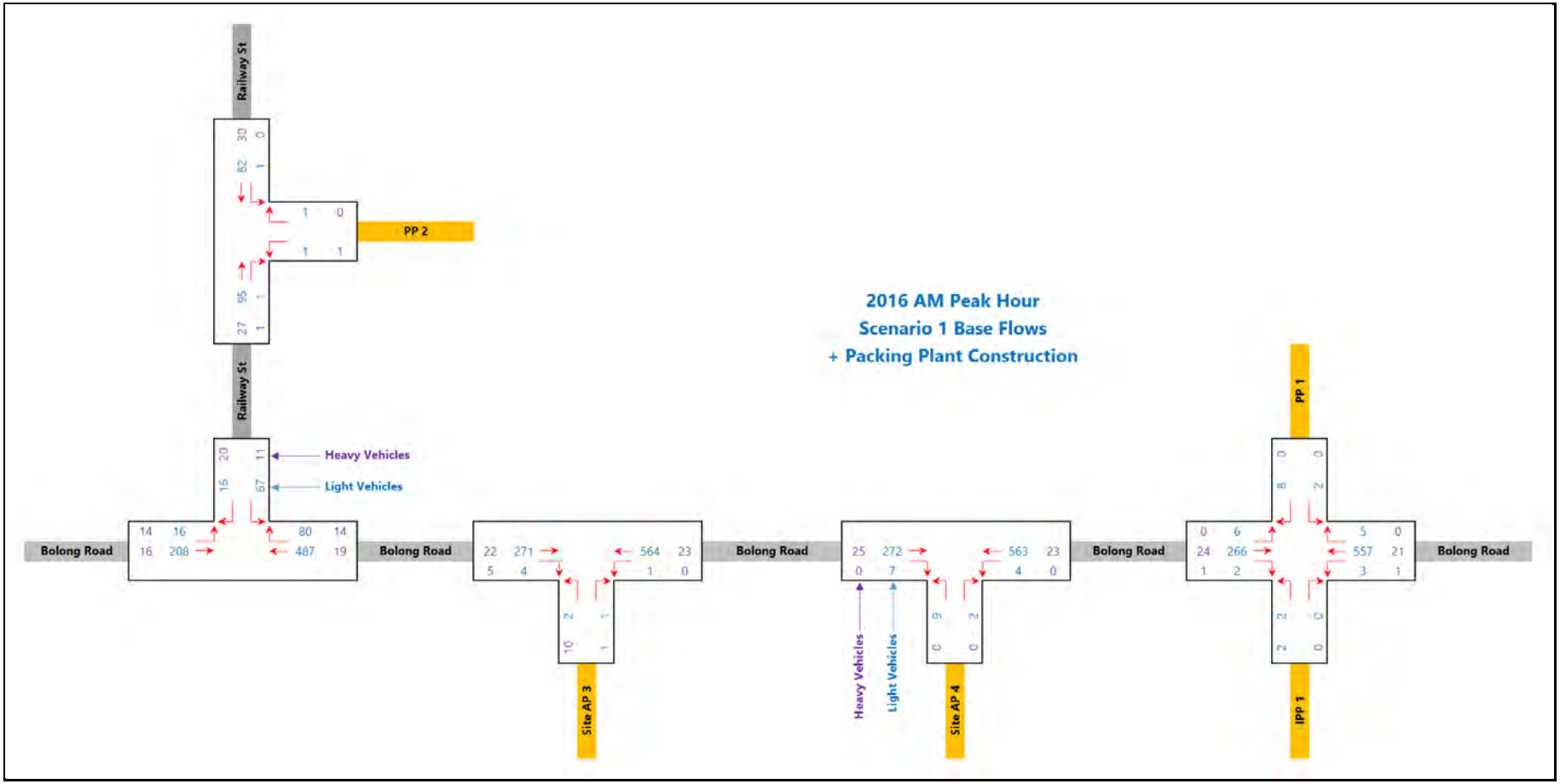


Figure 2.2.3.2 PM Peak Hour Packing Plant Construction + Dryer Construction

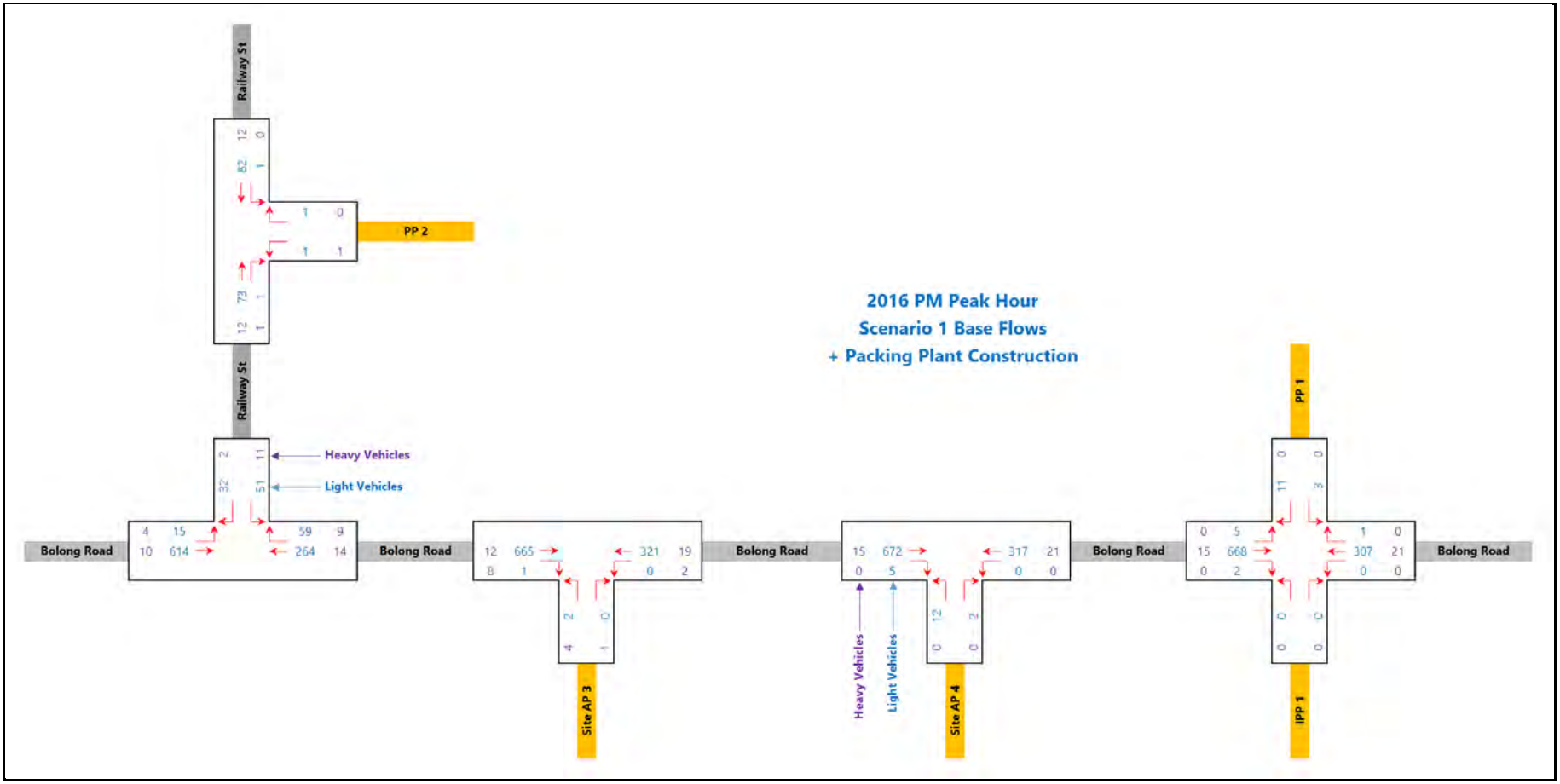


Figure 2.2.3.3 AM Peak Hour Packing Plant Construction

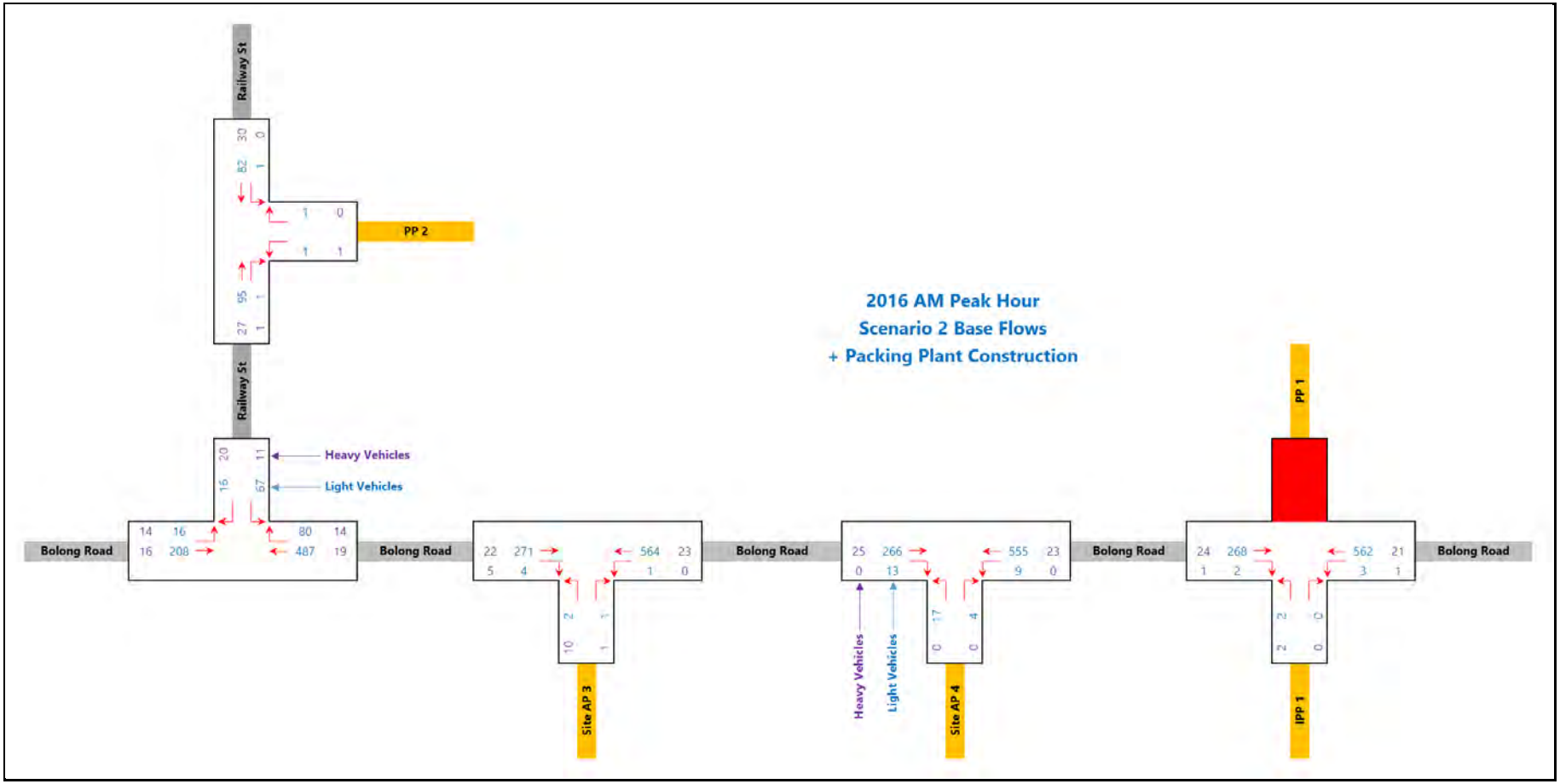
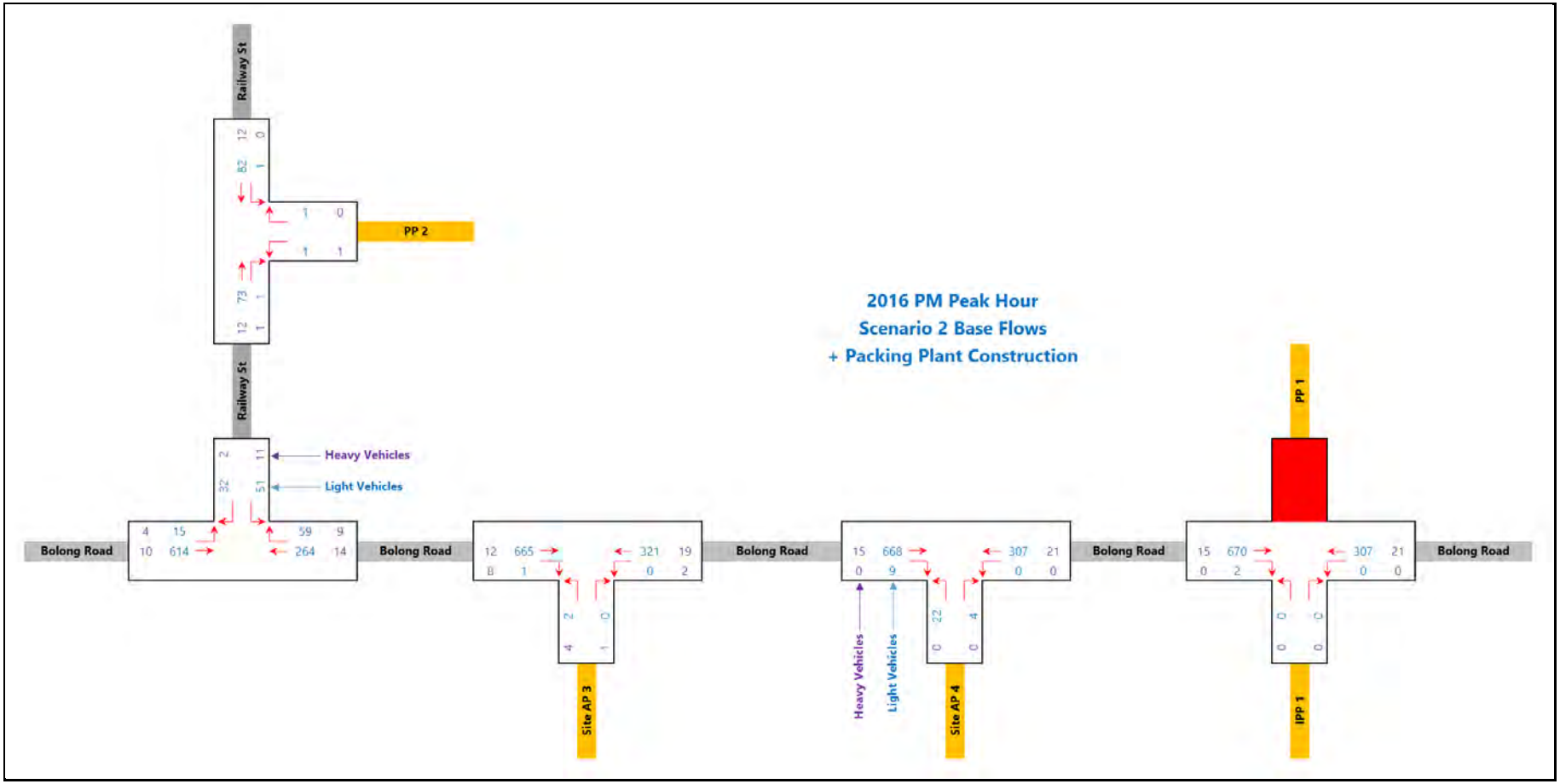


Figure 2.2.3.4 PM Peak Hour Packing Plant Construction



2.3 Packing Plant Operations

2.3.1 Access

Once operational, access to the Packing Plant will be available via both PP 1 at Bolong Road, and PP 2 at Railway Street. PP 1 will provide for heavy vehicle arrival trips only as per the SSEP Approval, with PP 2 providing for heavy vehicle departure trips, as well as all staff arrival and departure trips. It is noted that the provision of an additional weighbridge of Bolong Road will remove the need for heavy vehicles to be looping on-site, and that the queue length provided between the weighbridge and Bolong Road would more than appropriately accommodate what are very minimal peak heavy vehicle flows (see also Section 2.3.2.1 below).

2.3.2 Operational Trip Generation

2.3.2.1 Heavy Vehicle Trips

Once operational, the Packing Plant is estimated to generate only a small number of heavy vehicle trips, associated with the limited demand for road transported product (i.e. trips to and from the regional road network); and heavy vehicles delivering consumable materials from within the SS Site (south of Bolong Road) to the PP Site.

In this regard, and as detailed in the SSEP TIA, it is estimated that no more than 15 heavy vehicles (or 30 heavy vehicle trips) would be generated by the Packing Plant operations per day, approximately 75% of which would be to/from the regional road network, and 25% of which would be to/from the SS Site south of Bolong Road. It is estimated that no more than 4 heavy vehicle trips would be generated in the (commuter) peak hours.

It is important to again note that the interim Packing Plant currently generates a higher number of heavy vehicle trips as a result of product needing to be transported (by heavy vehicle) from production areas within the broader SS Site to the IPP Site for transport by rail. As discussed in the IPP TIA, this has resulted in the generation of 'looping' trips between AP 3 and the IPP Site, i.e. departing the SS Site via AP 3 with product, unloading product at the IPP Site (for rail transport) and then returning to the SS Site via AP 3.

Further to the provision of the pipe infrastructure contained within the Bolong Road pedestrian bridge, these product carrying heavy vehicle trips will no longer be generated.

2.3.2.2 Operational Staff Vehicle Trips

Similarly, Packing Plant staff trips will not be additional trips generated to the local network, but trips redistributed from existing parking on the Moorehouse Site to the PP Site.

A total of 12 staff currently working at the IPP Site will be relocated to the PP Site, with a resulting reduction in trip generation to/from, and parking demand at, the Moorehouse Site. Based on current shift structures, it is estimated that up to 4 (commuter) peak hour staff vehicle trips would be redistributed from the Moorehouse Site to the PP Site (via PP 2).

2.3.3 Operational Traffic Flows

With reference to sections above, total traffic flows further to the Packing Plant becoming operational are shown in the following figures:-

- Figure 2.3.3.1 AM Peak Hour Packing Plant Operational
- Figure 2.3.3.2 PM Peak Hour Packing Plant Operational

Figure 2.3.3.1 AM Peak Hour Packing Plant Operational

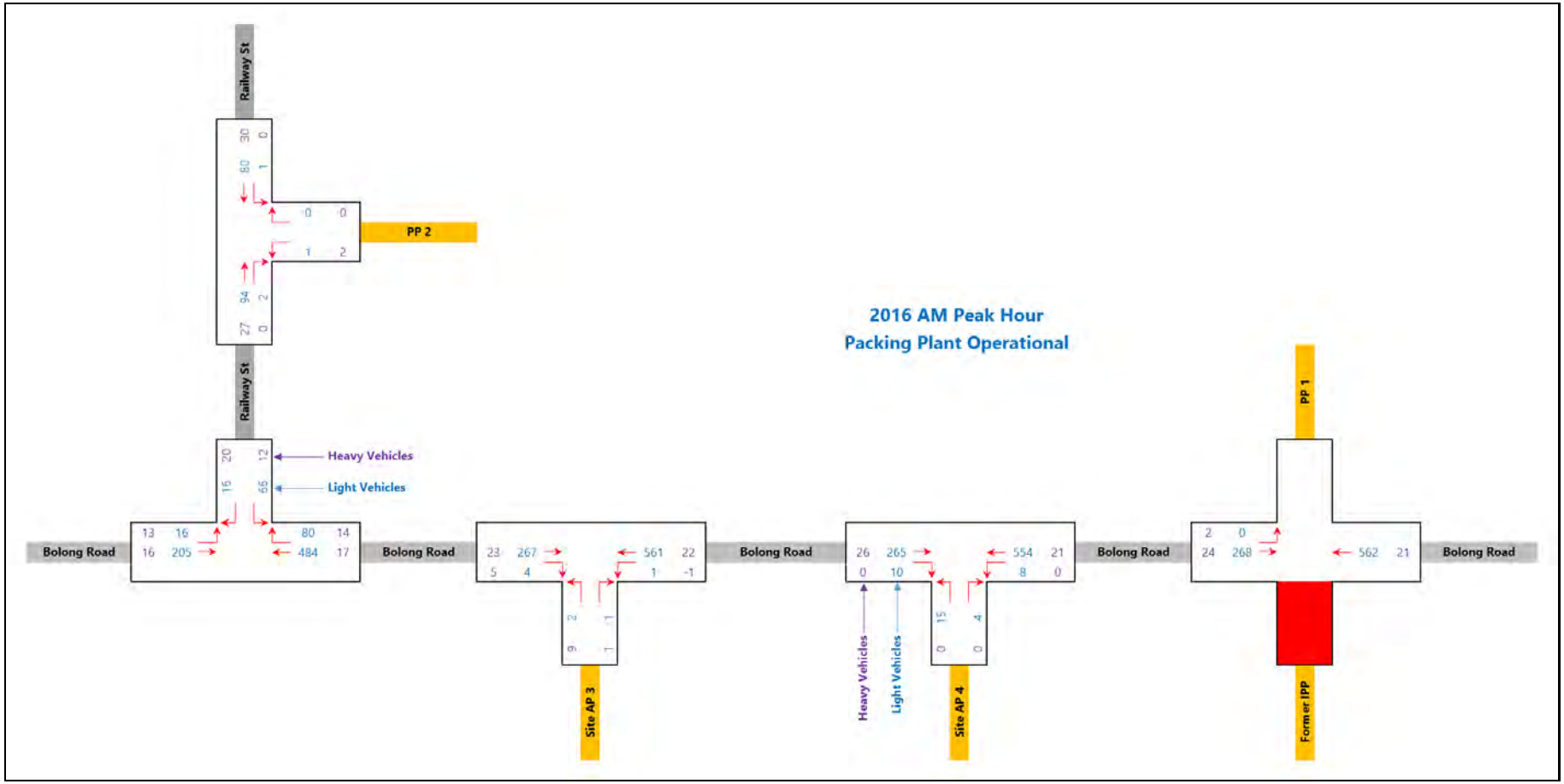
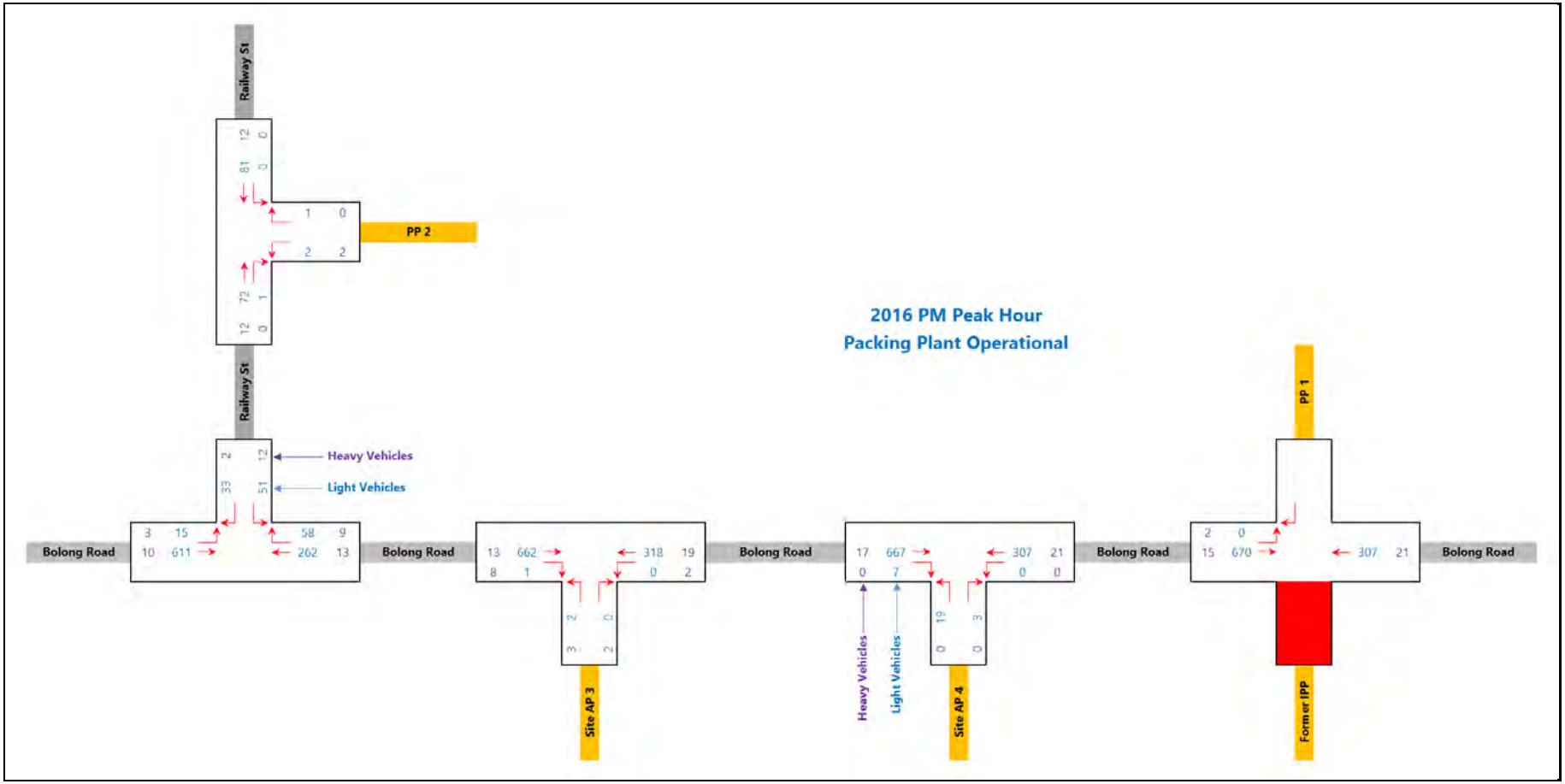


Figure 2.3.3.2 PM Peak Hour Packing Plant Operational



2.4 Traffic Impacts

The performance of the key intersections identified in Section 1.4 have been assessed using SIDRA based on the total traffic flows under Packing Plant construction and operational conditions. The results of the assessment are provided below.

Table 2.4.1 Packing Plant & Dryer Construction Intersection Performance

Packing Plant + Dryer Construction Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	2	2	0.345	0.335	7.5	7.9
Bolong Road & Access Point 3	A	A	0.5	0.3	0.309	0.305	1.6	1.6
Bolong Road & Access Point 4	A	A	0.2	0.2	0.31	0.301	0.7	0.4
Bolong Road & IPP 1 + PP 1	A	A	0.3	0.3	0.309	0.358	0.8	1.4
Railway Street + PP 2	A	A	0.2	0.2	0.073	0.053	0.2	0.1

Table 2.4.2 Packing Plant Construction Intersection Performance

Packing Plant Construction Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	2.0	2	0.345	0.335	7.5	7.9
Bolong Road & Access Point 3	A	A	0.5	0.3	0.309	0.305	1.6	1.6
Bolong Road & Access Point 4	A	A	0.4	0.2	0.306	0.295	1.2	0.8
Bolong Road & IPP 1	A	A	0.1	0.1	0.308	0.356	0.3	0.1
Railway Street + PP 2	A	A	0.2	0.2	0.073	0.053	0.2	0.1

Table 2.3.2 Packing Plant Operation Intersection Performance

Packing Plant Operation Intersection Performance	Level of Service		Average Delay (s)		Degree of Saturation		Queue Length (m)	
	AM	PM	AM	PM	AM	PM	AM	PM
Bolong Road & Railway Street	B	A	2.0	2	0.341	0.333	7.4	7.6
Bolong Road & Access Point 3	A	A	0.4	0.2	0.305	0.303	1.6	1.4
Bolong Road & Access Point 4	A	A	0.4	0.2	0.306	0.301	0.9	0.6
Bolong Road & IPP 1	A	A	0.1	0.0	0.306	0.358	0	0
Railway Street + PP 2	A	A	0.4	0.3	0.073	0.052	0.2	0.1

Reference to the tables above – and indeed to the very minor additional and redistributed flows detailed in Section 2.2 and Section 2.3 respectively - clearly indicates that traffic conditions under both construction and operational conditions would have no significant impact on the operation of the local traffic network, with no significant changes in average delay, reductions in capacity, or increases in queue lengths at any of the key intersections. Indeed, conditions will be significantly improved from those forecast (and approved) in the original SSEP traffic assessments further to traffic reduction in Bolong Road based on the upgrades to the Princes Highway.

2.4 Parking

With reference to the SSEP Approval (*Specific Environmental Condition 31*), 30 staff parking spaces will be provided on the PP Site; this allocation of spaces provides for additional demands generated at shift changeover and for visitor parking. In summary, the proposed car park will appropriate accommodate all PP Site parking demands such that there would be no off-site parking requirement.

The car park will be designed in accordance with AS 2890.1 with regard to aisle widths and space dimensions, and it is recommended that one space be designed as an accessible with reference to AS 2890.6.

During the construction period, construction staff would utilise informal parking adjacent to the construction areas in the northern part of the PP Site, until such time as the formal Packing Plant car is completed. It is again noted that Packing Plant construction staff would not use the (Dryer Modification proposed) temporary car park in the southern part of the PP Site, nor would any access be available between PP 2 and the temporary car park.

2.5 Pedestrian Access

The Modification provides for the construction of a pedestrian footbridge crossing of Bolong Road, providing pedestrian access between the PP Site and the broader SS Site south of Bolong Road. The location and alignment of the bridge has been revised, such as that on the southern side of Bolong Road it links to the existing pedestrian path west of Abernathy's Creek (rather than the previously proposed landing to the east of Abernathy's Creek).

This modification has been provided to provide more efficient connections to key facilities serviced by the pipework contained within the bridge (for example the relocated Dryer on the Moorehouse Site) and would in our opinion have no impact on pedestrian movement efficiency or safety.

2.6 Rail Operations

The Modification provides for two rail spurs to the PP Site. The provision of these spurs is designed to maximise the efficiency of rail handling, allowing for simultaneous loading and unloading of containers, and minimising crossings of Bolong Road.

2.6.1 Container Trains

In line with the SSEP Approval, an average of 5 container trains will be required each week, each of which would provide a formation of up to 700m (comprised of up to 35 longer wagons than currently used).

All container trains will utilise the PP Site rail spurs, though it is noted that a portion of some trains may cross to the southern side of Bolong Road to access existing DDG loading facilities. However, this would entail a single arrival and single departure crossing, i.e. it would not require shunting.

The use of the PP Site rail spurs is expected to reduce container train movements at Bolong Road by more than 20 movements per week. At Railway Street, the capacity provided by the PP Site rail spurs is also expected to reduce shunting (from the Bomaderry rail yards) such that even with the additional train service, total container train movements at Railway Street would be generally unchanged from existing movements.

2.6.2 Grain & Flour Trains

Grain and flour trains will continue to use the existing sidings on the southern side of Bolong Road.

With regard to grain trains, 4 services weekly would continue to be generated, though the length of trains would increase to an average 40 wagon service. Flour trains will reduce to 5 services per week, though train are expected to accommodate larger capacity wagons and be of a slightly longer length than existing.

The longer grain and flour trains will require additional shunting movements, but these are expected to be partially off-set by the reduced number of flour trains, and moreover by the very significant reduction in movements further to the use of the PP Site rail spurs by container trains.

2.6.3 Future Railway Crossings

With reference to sections above, railway crossings of Railway Street are expected to remain largely unchanged. At Bolong Road, the minor increase in grain and flour train movements would be more than off-set by the removal of [the majority of] container train movements, such that Bolong Road rail crossing movements are estimated to be reduced by approximately 20 movements per week from current levels.

Finally, it is important to acknowledge that the SSEP Approval includes an upgrade of the existing rail sidings on the southern side of Bolong Road, specifically to remove shunting requirements at Bolong Road. Manildra is currently investigating these upgrades, which are expected to form a future Modification application; once this upgrade is completed, crossing of Bolong Road would be even further to reduced.

2.6.4 Railway Design and Operations Accreditation

As discussed, Manildra is rail safety accredited as the RIM for the SS Site; this accreditation requires Manildra to have all systems in place to manage the requirements of the RIM for the day to day operation through a SMS which conforms to the RSNL (NSW).

An integral requirement in proving the new rail infrastructure is compliance with the RSNL (NSW), which requires in turn that any new proposed construction activity is to be notified to the Office of National Rail Safety Regulation (ONRSR) through a Management of Change process. The Management of Change process includes formal documentation to be submitted to the ONRSR and also requires that Manildra keep the ONRSR informed of the process commencing with design through to construction and commissioning of any new sidings, inclusive of rail safety risk assessment documentation.

Manildra will necessarily comply fully with these procedures, noting that the process commences only further to an Approval (of the Modification). At this time, detailed track design components have yet to be finalised, and as discussed above there will be a requirement to conduct and finalise the risk assessment for the design and construction/commissioning stages; and then another operational risk assessment prior to any new or change in operation.

Manildra has an existing Safety Interface Agreement in place with Sydney Trains (Transport for NSW) which caters for the existing interface connection, which will not be affected by the Modification given that the new works will be within the Manildra owned land. In addition, Manildra has an Interface Agreement in place with Shoalhaven Council for both the Railway Street and Bolong Road rail level crossings.

Finally, it is important to note that the Bolong Road railway crossing was upgraded in accordance with the SSEP Approval to provide compliance with the Australian Level Crossing Assessment Model (ALCAM) standards. Manildra's National Rail Management section has determined (with reference to ALCCAM) that the Modification would not require any additional upgrades of the existing crossing infrastructure at either Bolong Road or Railway Street, (nor is such required per the SSEP Approval).

3 Conclusions

Following a detailed and independent assessment of the access, traffic and parking conditions associated with the Modification, ARC has concluded that the Modification – and specifically the construction works associated with the Modification - would have no significant impacts on the local or on-site traffic environments. In summary: -

- While the Modification provides for an increased floor-area for the Packing Plant, once operational the Modification would not result in any increase in production from the broader Shoalhaven Starches over that which has been the subject of past approvals, nor as a result an increase in either vehicle traffic or rail movements at the Bolong Road and Railway Street rail crossing over previous (approved) forecasts.

- The Modification provides for the construction of the two approved PP Site access points; a 30 space car park; and a pedestrian bridge across Bolong Road in accordance with the SSEP Approval.

- During the Packing Plant construction period (including the period of potential overlap with the Dryer construction period) and once the Packing Plant is operational, the local road network would continue to operate at a high level of efficiency.

- The staff car park will be designed with reference to the appropriate Australian Standards.

- The minor realignment of the pedestrian bridge provided for by the Modification would have no impact on the efficiency or safety of pedestrian movements between the PP Site and the broader SS Site south of Bolong Road.

- Rail movements would not increase above those limits established in the SSEP Approval, and indeed are expected to be further reduced in regard to crossings of Railway Street and Bolong Road given the capacity provided by the additional PP Site rail spur.