APPENDIX 6. GROUNDWATER, SURFACE WATER AND PFAS

Preliminary Documentation

Cabbage Tree Road Sand Quarry - (EPBC 2016-7852)

The following background documents are included in this Appendix:

1. Umwelt, November 2015. Groundwater Impact Assessment.
2. Umwelt, October 2016. Potential for Sand Extraction to Increase Flooding Impacts in Surrounding Area.
3. RCA, June 2016. Groundwater Assessment.
4. Umwelt, November 2016. Response to Hydro Simulation Peer Review 1.
5. Umwelt, January 2017. Response to Hydro Simulation Peer Review 2.
6. Kleinfelder, February 2017. Soil Sampling Assessment.
7. Kleinfelder, June 2017. Water Sampling Assessment.
8. Kleinfelder, June 2017. Contingency Management Plan for Potential PFAS Disturbance during Construction Activities.
9. Contamination Water Working Group Comments on the EIS; and Correspondence with Hunter Water Corporation: consultation to develop specific controls and management practices for the site operations.
10. Williamtown Contamination Expert Panel Letter.

APPENDIX 6. FLOODING AND GROUNDWATER RESPONSES

RESPONSE TO SUBMISSIONS
CABBAGE TREE ROAD SAND QUARRY (SSD 13_6125)

Williamtown Sand Syndicate Pty Ltd

CABBAGE TREE ROAD QUARRY

Potential for Sand Extraction to Increase Flooding Impacts in Surrounding Area

FINAL

October 2016

Williamtown Sand Syndicate Pty Ltd

CABBAGE TREE ROAD QUARRY

Potential for Sand Extraction to Increase Flooding Impacts in Surrounding Area

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Williamtown Sand Syndicate Pty Ltd

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Report No.	3251/R10/FINAL
Date:	October 2016

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1.0 Introduction

During consultation with the Cabbage Tree Road community, concern has been raised that the proposed quarry on the northern side of Cabbage Tree Road will worsen existing flooding and water logging in low-lying areas adjoining the quarry. It is understood that the concern is that the removal of sand will reduce the ability of the dunes to hold water during significant rainfall events. The concern is that this will result in greater runoff and greater volumes of water moving to the south and impacting on low-lying areas adjoining the quarry during wet periods.

Flooding and water logging in this area is predominantly due to groundwater levels being close to the surface and the low-lying nature of the area. There is very limited ability for infiltration of rainfall into the underlying sandy stratum and as a result water ponds on the surface. Proximity of groundwater to the surface in this location is also driven by a change in slope in topography coinciding with the transition in the landform from elevated sand dunes to the north of Cabbage Tree Road to low-lying floodplain adjoining the quarry. The relatively flat nature of the landform provides limited capacity for water ponded on the surface to drain away and this is further exacerbated by the low relief between this area and Fullerton Cove (see **Figure 1**).

The former Drainage Union historically constructed a series of open drains across the area between Cabbage Tree Road and Fullerton Cove to assist with the drainage in this area and help reduce the extent and duration of flooding and water logging in this area.

In addition, the elevation of this landform in low-lying areas adjoining the quarry is typically less 2 mAHD and is subject to flooding from the Fullerton Cove/Hunter River system. Williamtown Salt Ash Flood Study (WBM 2005) indicates that the 1 in 100 Average Recurrence Interval (ARI) year flood level adjacent to the site is approximately 1.96 mAHD with the Probable Maximum Flood level being approximately 4.65 mAHD.

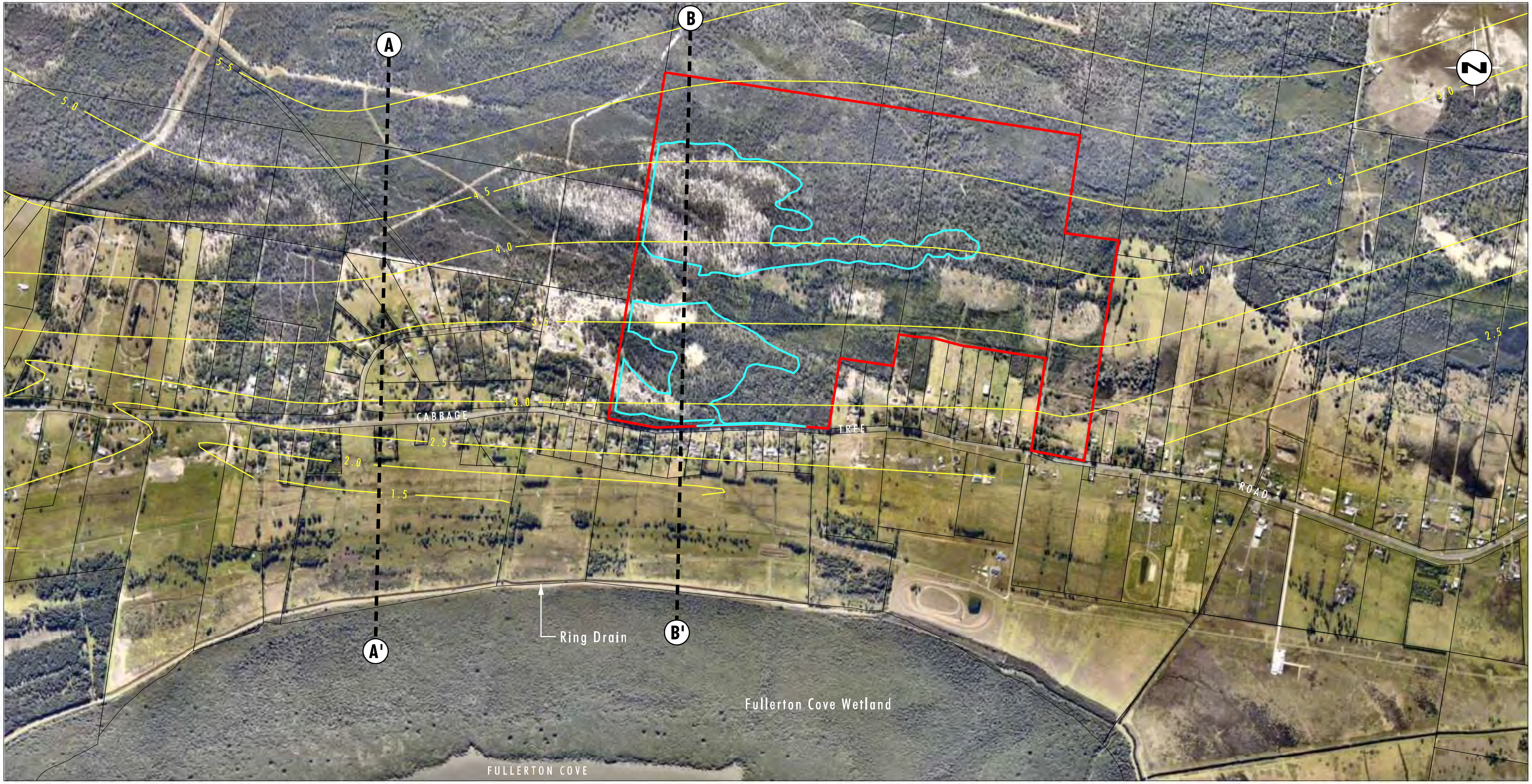


Image Source: Williamtown Sand Syndicate
Data Source: Williamtown Sand Syndicate (2015-2016), LPI (2009)
Note: Contour interval 0.5m

0 0.25 0.5 1.0km
1:20 000

Legend
- Project Area
- Proposed Extraction Area
- Section Line
- 95% Groundwater Level Contour (HWC)

FIGURE 1

Proposed Quarry in Proximity to Residences

File Name (A4): 3251_102.dgn
20160808 10.27

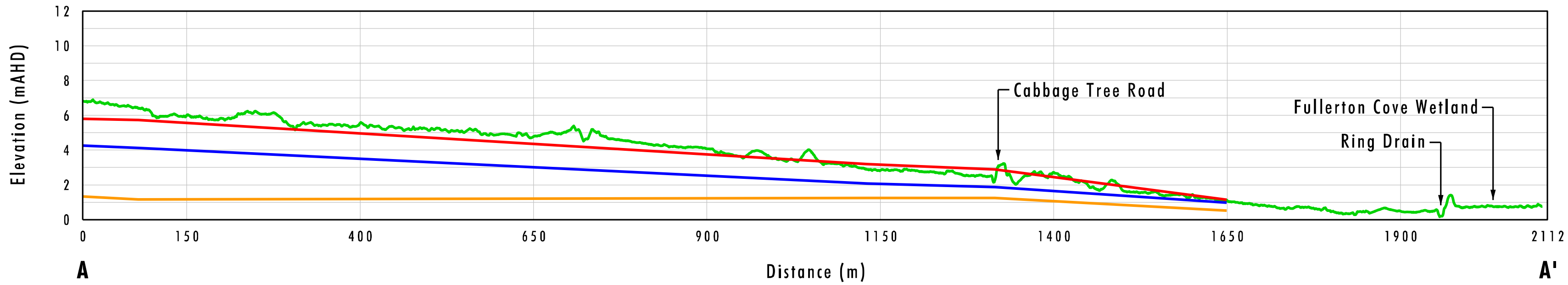
2.0 Topography and drainage

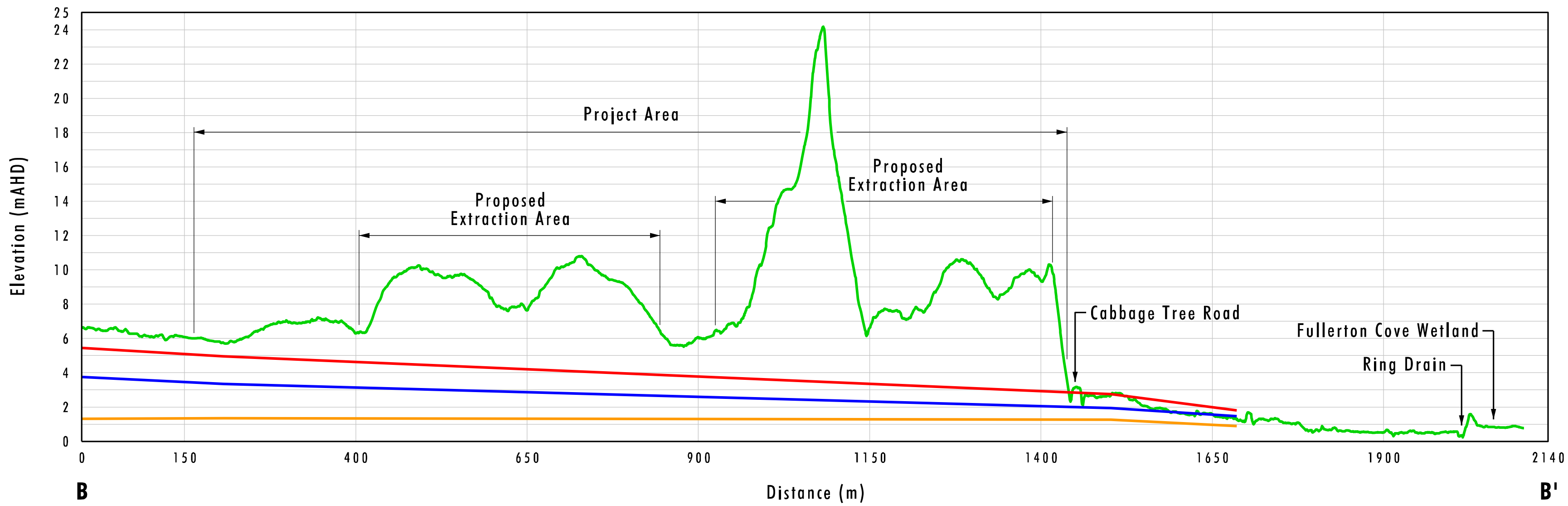
The proximity of the proposed quarry to low-lying areas adjoining the quarry is shown on **Figure 1**. The low-lying area adjoining the quarry drains to Fullerton Cove and forms part of the Hunter River floodplain (see **Figure 1**). The area is low-lying and is subject to prolonged periods of water logging. As can be seen on **Figure 1**, a network of surface drains have been constructed in this area by the former Drainage Union to assist in removing water from the area to reduce ponding and water logging. These drains convey water to the Ring Drain which has been constructed around the northern perimeter of Fullerton Cove wetland and conveys runoff from the area to Fullerton Cove.

To assist in understanding the topography and its influence on flooding and waterlogging, two cross-sections (**Figure 2**) through the landform have been extracted from topographic information. **Figure 2** shows the variation in elevation from north to south in the vicinity of the proposed quarry. Locations of the cross-sections (A-A1 and B-B1) are shown on **Figure 1**. The cross-sections have a vertical exaggeration of approximately 25 to 1 making the landform look 25 times as steep as it is in reality.

As can be from **Figure 2** there is a major change in slope of the landform near Cabbage Tree Road with the landform north of Cabbage Tree Road comprising elevated dunes. These dunes extend up to a height of approximately 24 m and exhibit high infiltration capacity. As a result there is negligible surface runoff from the dunes with rainfall infiltrating vertically to the underlying groundwater aquifer.

The landform between Fullerton Cove and the quarry forms part of the floodplain. The elevation of this landform ranges from approximately 2 to 3 mAHD adjacent to Cabbage Tree Road to approximately 0.4 mAHD near the Ring Drain adjacent to Fullerton Cove. In this area the average slope of the landform is very flat (typically 0.3% to 0.5% slope). The floodplain area has low infiltration capacity due to the close proximity of groundwater to the surface in this area.





Legend
- LiDAR Landform 2013
- Groundwater Level 5th Percentile - Dry
- Groundwater Level 50th Percentile - Average
- Groundwater Level 95th Percentile - Wet

Note: Vertical Exaggeration 1:25

Horizontal Scale 1:10 000

Vertical Scale 1:400

FIGURE 2

Landform Cross-Section (Sections A-A' and B-B')

File Name (A4): ?
20160808 11.17

3.0 Groundwater levels

Hunter Water Corporation has monitored groundwater levels in this area for approximately 50 years. Information from Hunter Water Corporation's groundwater database has been analysed and used to interpolate groundwater contours in the area surrounding the quarry as shown on **Figure 1**.

To calculate the maximum predicted groundwater level a transient model using rainfall data for the period 1997 to 2015 was used. The highest modelled groundwater levels during the period 1997 to 2015 occurred in July/August 1999 and June/July 2007.

Results for highest predicted groundwater levels for the existing landform are shown on Figures 5.2 of Appendix 7 of the EIS. Calibration results from the groundwater modelling undertaken are shown in **Plate 1** which is reproduced from Figure 4.2 of Appendix 7 of the EIS (Umwelt 2016).

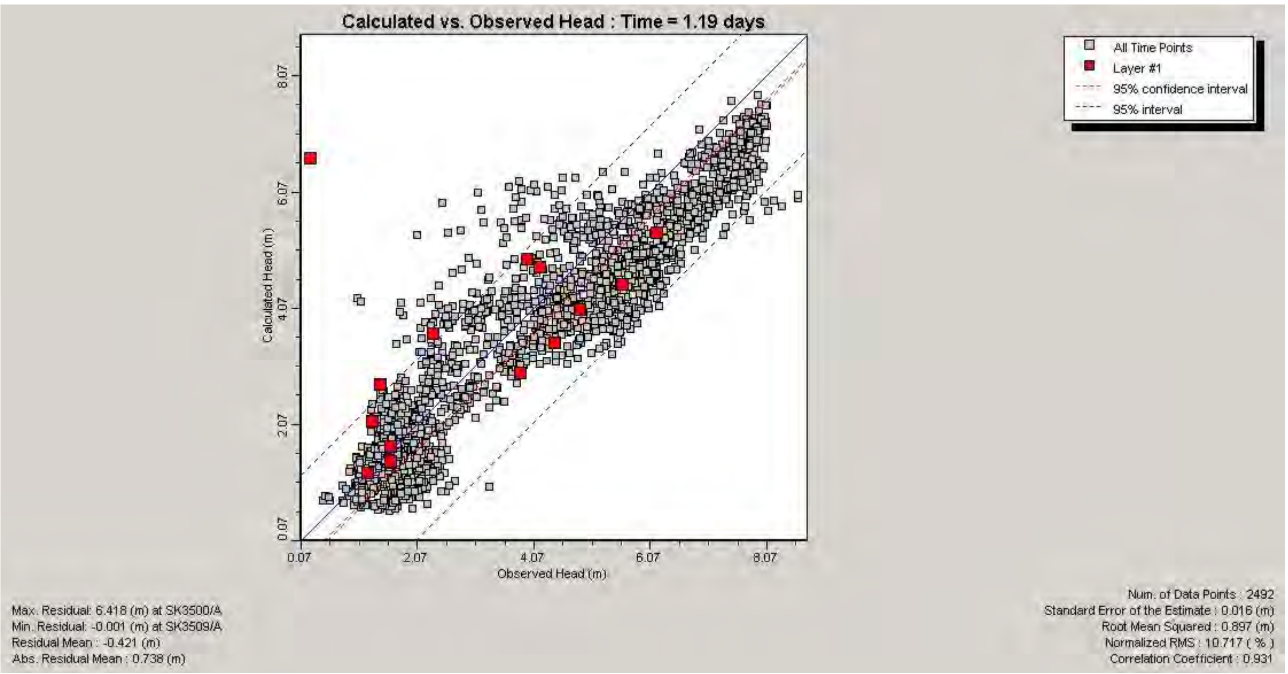


Plate 1 Groundwater Model Calibration Results

Predicted maximum groundwater levels are slightly lower at the northern edge of the proposed extraction area than the maximum levels that have been interpolated from Hunter Water Corporation monitoring bores.

As can be seen from **Plate 1** a reasonably good level of calibration was achieved with a correlation coefficient of 93% and a standard error of the estimate of 0.016 m.

The interpolation shown on **Figure 1** is based on maximum recorded groundwater levels recorded at Hunter Water Corporation's monitoring bores that are located around the proposed project area. This interpolation does not take into account any influences that localised variation in topography may have on groundwater levels. In many instances the recorded maximum levels occurred at different times at different bores and as a result do not represent a point in time when groundwater was at maximum levels across the entire area. In addition the interpolated contours are based on recorded levels that are in excess of 1 km from the proposed quarry.

Predicted maximum groundwater levels have been modelled using a groundwater modelling software Virtual Modflow 2011.1. The model uses a 25 m grid to represent the landform and was calibrated to recorded groundwater levels in 14 of Hunter Water Corporation's surrounding monitoring bores.

Taking these factors into consideration and the overall calibration achieved, these differences in groundwater levels between maximum observed and maximum predicted are considered to be within acceptable levels.

As can be seen from **Figure 1**, the 95% groundwater level (i.e. approximately maximum recorded groundwater level) ranges from approximately 5 mAHD in the north to approximately 1.5 mAHD in the south with the general direction of groundwater flow being from north to south (i.e. towards Fullerton Cove). As the elevation of the landform decreases, groundwater level coincides with the land surface resulting in groundwater in this area either ponding on the surface or free draining across the surface via the constructed drainage system.

As shown in **Figure 2** groundwater levels within the sand dunes are largely independent of the ground elevation. Even though the elevation of the dune landscape varies dramatically, groundwater levels show a reasonably uniform decrease from north to south for dry, average and wet conditions.

Analysis of the 95% groundwater level shows that north of Cabbage Tree Road (i.e. within the sand dunes) the groundwater has a hydraulic gradient of approximately 0.3%. In the low-lying areas adjoining the quarry the hydraulic gradient matches the slope of the landform at approximately 0.5% indicating a rate of groundwater movement in this area under the above 95% conditions of approximately 160 mm.

Based on the hydraulic conductivity of the sand and the observed hydraulic gradient, the horizontal rate of movement of groundwater through the sand aquifer would be approximately 100 mm per day. By comparison, previous field investigations by the author in similar windblown sand dune systems have indicated that the rate of vertical infiltration of rainfall into the dunes would be approximately 100 mm/hour or more which is approximately 20 times faster than the rate of horizontal movement of groundwater in the area.

As a result, the rate of groundwater movement from the dunes to the low-lying areas adjoining the quarry is controlled by the rate of horizontal flow through the aquifer not the rate of vertical infiltration through the dunes. Provided extraction remains above the groundwater table as is proposed, reducing the thickness of sand by sand extraction will not change the rate of horizontal movement of groundwater through the aquifer and hence will not adversely impact on low-lying areas adjoining the quarry.

4.0 Climatic influences

As set out in Appendix 7 of the EIS, the closest meteorology station to Cabbage Tree Road Quarry is Williamtown RAAF (Station 061078), approximately 4 km from the Project site. Approximately 72 years of rainfall data is available for Williamtown RAAF (Station 061078), from 1942 to present. Average annual rainfall at Williamtown RAAF for the 72 years of record is 1120.9 mm with recorded annual rainfall ranging from 541 mm in 1980 to 1793.7 mm in 1963.

Average monthly rainfall recorded at Williamtown RAAF is provided in **Figure 3** which shows that typically the majority of rainfall occurs in the first six months of the year with June being on average the wettest month of the year with an average of 121 mm/month. September is on average the driest month of the year with 59 mm/month.

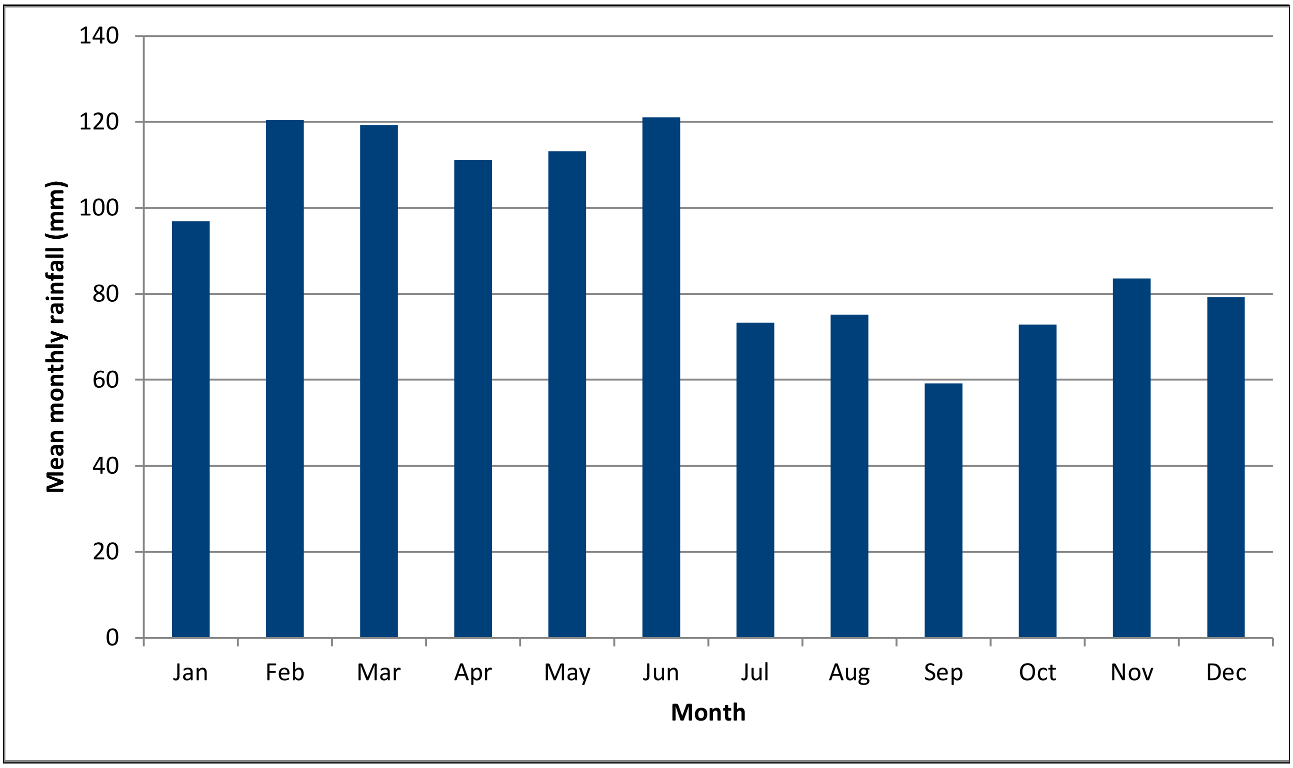


Figure 3

Average Monthly Rainfall for Williamtown RAAF (Station 061078)

Source: Bureau of Meteorology 2015

Average daily evaporation at Williamtown RAAF for the 41 years of record (1972 to present) is 4.8 mm/day, or approximately 1752 mm/year with June having the lowest average evaporation at 2.5 mm/day *(75 mm/month).

Average daily evaporation recorded at Williamtown RAAF is provided in **Figure 4**.

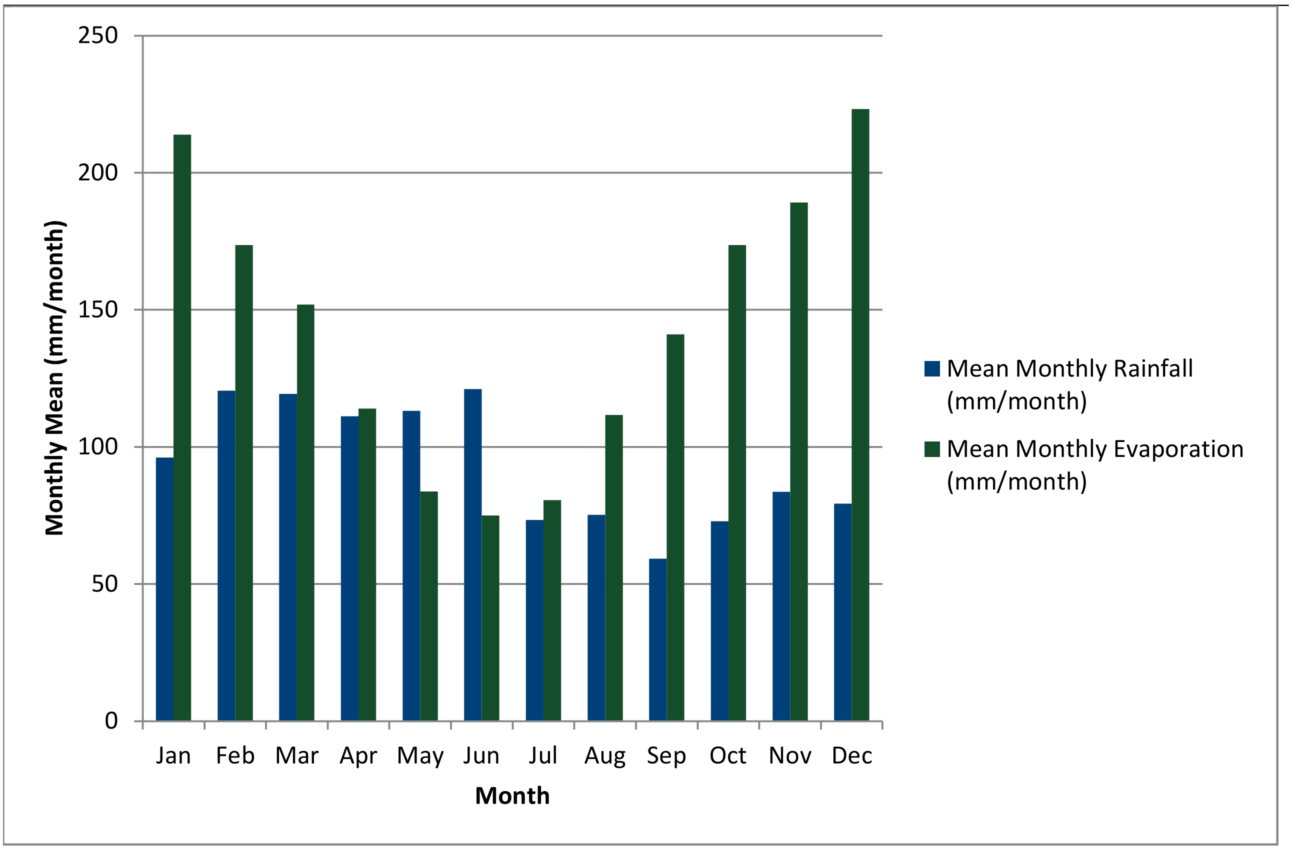


Figure 4

Mean Monthly Rainfall vs Evaporation for Williamtown RAAF (Station 061078)

Source: Bureau of Meteorology 2015

As can be seen from **Figure 4**, on average, rainfall exceeds evaporation during May and June resulting in a net surplus of water during this period. The monthly excess of rainfall over evaporation combined with wet periods throughout the year where rainfall exceeds evaporation, result in periods of flooding and water logging particularly in the low-lying areas adjoining the quarry.

5.0 Extraction and rehabilitation timing

As set out in **Table 1**, the 42.65 ha extraction area will be quarried in a series of sectors with areas commencing to be rehabilitated once sand has been extracted and the final landform elevation achieved within each sections of each sector. Quarrying sectors, extraction and indicative rehabilitation sequences are shown on Figures 3 to 8 in **Attachment A**.

As stated above, the high infiltration capacity of the dune sand to be quarried means that there will be negligible runoff from the quarried surface with this runoff being predominantly associated with road surfaces.

Table 1 Extraction sectors and rehabilitation timing

Extraction Sector	Area (ha)	Estimated Production (Tonnes)	Approximate Extraction Year	Approximate Year Rehabilitation to Commence
1	4.4	265639	1	1
2	0.94	76299	2	2
3	3.71	236335	2	2
4	2.95	161303	3	3
5	3.96	249101	3	3
6	4.84	282093	4	4
7	11.60	589909	5	5
8	3.56	456382	6	6
9	2.87	225461	7	7
10	3.82	505234	8	8
Total	**42.65**	**3047756**		

Ongoing rehabilitation combined with keeping the extraction level at least 0.7 m above the highest predicted groundwater level across the site while extraction is occurring will ensure that there is negligible change to surface runoff regime from within the extraction area. The final landform will be shaped to be at least 1.0 m above the highest predicted groundwater level.

6.0 Impact of sand extraction on groundwater levels

As described in the EIS, a detailed groundwater model of the area has been developed using Virtual Modflow 2011.1. The model extends from north of the proposed quarry south to Fullerton Cove. The groundwater model was calibrated using 50 years of groundwater level data for the area as recorded by Hunter Water Corporation and took into account permeability and porosity of the aquifer, boundary conditions, evapotranspiration and extinction depth.

In modelling the maximum extraction scenario, it was assumed that infiltration capacity of the final landform, the porosity of the underlying sand aquifer would not be significantly changed by quarrying (i.e. quarrying is unlikely to further compact the sand or change the void space in the sand). It was also assumed that boundary conditions, evapotranspiration and extinction depth would also not change significantly.

These assumptions are based on the fact that the dune sand that is to be extraction is predominantly clean sand grains with limited amounts of included material that has the potential to be compacted.

Removal of sand from the ridges that are proposed to be extracted will bring the surface of the landform closer to the groundwater table and therefore increase the potential for evaporation from the surface through capillary rise and evapotranspiration which could in turn lower the maximum predicted water table.

As a result, assuming that porosity is not going to decrease as a result of quarrying and evaporation/evapotranspiration are not going to increase as a result of quarrying, will provide a conservative upper limit of maximum predicted post-quarrying groundwater levels.

Modelled groundwater levels for the existing landform and maximum extraction final landform following quarrying are shown on Figures 5.2 and 5.3 of Appendix 7 of the EIS. A comparison of the maximum predicted groundwater levels for the pre-extraction and maximum extraction scenarios is shown on Figure 5.4 of Appendix 7 of the EIS which is reproduced in **Figure 5**.

Figure 5 shows negligible change to modelled groundwater head equipotentials as a result of sand extraction activities indicating the quarrying and the resultant final landform will not result in a change groundwater levels. This also indicates that the volume of groundwater within the aquifer will not increase as a result of quarrying as quarrying will not change the void space within the sand particles and hence the available storage volume below groundwater level. It also indicates that the rate of groundwater movement through the aquifer will not change as result of quarrying as quarrying will not change the porosity or effective porosity of the aquifer nor the hydraulic gradient (i.e. the rate of change per metre in groundwater levels).

The reason that there will be negligible predicted change is that the rate of vertical infiltration of rainfall into the sand dunes is in excess of 100 mm per hour while the rate of horizontal movement of groundwater through the aquifer is less than 100 mm per day. In addition, the porosity or void space within the sand above and below the groundwater table is approximately 30% to 40% which means that the minimum 1 m depth of sand above the groundwater table can hold approximately 300 mm to 400 mm of water or 300 mm to 400 mm of rainfall assuming no horizontal movement of groundwater. Rainfall from a 1 in 100 Year Annual Recurrence Interval (ARI) 24 hour event for this area is approximately 299 mm.

This means that even if a 24 hour 1 in 100 Year ARI rainfall event occurred when groundwater level was already at maximum predicted level, the additional 299 mm of rainfall could be contained within the 1 m of sand buffer without resulting in runoff from the quarry.

Taking the above into consideration, the sand that is proposed to be extracted (i.e. 1 m above the highest predicted groundwater level) does not provide utilised additional groundwater storage capacity with runoff effectively passing vertically through sand dunes.

In addition, the quarried area will be progressively rehabilitated and returned to native vegetation which will have similar or greater levels of evapotranspiration to the existing vegetation. In the groundwater model developed for the site, evapotranspiration has been assumed to be 0.6 times pan evaporation for the existing and developed models. This is considered conservative as with no allowance made for the potential for greater evapotranspiration that may occurs as trees and shrubs are being replanted on the site and transitioning from juveniles to mature plants.

The depth from which evapotranspiration occurs within the sand dunes is called the extinction depth which is controlled by the general depth of the root system and proximity of the root system to capillary rise in the sand dunes. In the sand dunes at the proposed Cabbage Tree Road quarry site the modelled extinction depth is approximately 2.5 m.

As discussed, the extinction depth is a combination of capillary rise and evapotranspiration via the root system of vegetation on the aquifer surface. Capillary rise in the fine sand would be approximately 1.0 m to 1.5 m above the groundwater table. Evapotranspiration is governed by the root depth of the overlying vegetation which would range from approximately 1 m for shrubs and low plants to several metres for mature trees. The combination of the height of capillary rise and root depth at the proposed quarry site is likely to be greater than 2.0 m with an average value across the site of 2.5 m or greater than. As can be seen on **Figure 2**, there are significant sections of the sand dunes within the proposed extraction area where the distance between the ground surface and the groundwater table is well in excess of 2.5 m indicating that in these areas the modelled evapotranspiration is not influencing groundwater levels. The surface of the proposed entire final landform will be within extinction depth of the groundwater surface and as a result evapotranspiration from the vegetation of the final landform will reduce groundwater levels with this slight reduction being reflected on **Figure 5**.

As a further sensitivity analysis, the modelled post-quarrying extinction depth within the quarry footprint was reduced from an average of 2.5 m as set out in Appendix 7 of the EIS to an average 1.0 m (i.e. minimum likely height of capillary rise in the fine sand). This was done to conservatively represent lower bound of extinction depths across the site taking into account capillary rise and root depth and would be typical of areas that have been cleared and not revegetated.

The quarry floor will be progressively cleared and rehabilitated with native vegetation over the life of the quarry so that at any point in time vegetation cover within the quarry footprint could range from bare earth to mature or advanced trees. As shown on **Figure 5**, reducing the extinction depth in the groundwater model to 1 m makes a very small change in predicted maximum groundwater levels with predicted post-extraction levels being very close to modelled pre-extraction levels.

In summary, modelling demonstrates that the proposed quarrying activities will not result in increased groundwater levels or rates of groundwater movement and will therefore not adversely impact on flooding or waterlogging in the low-lying areas adjoining the quarry.

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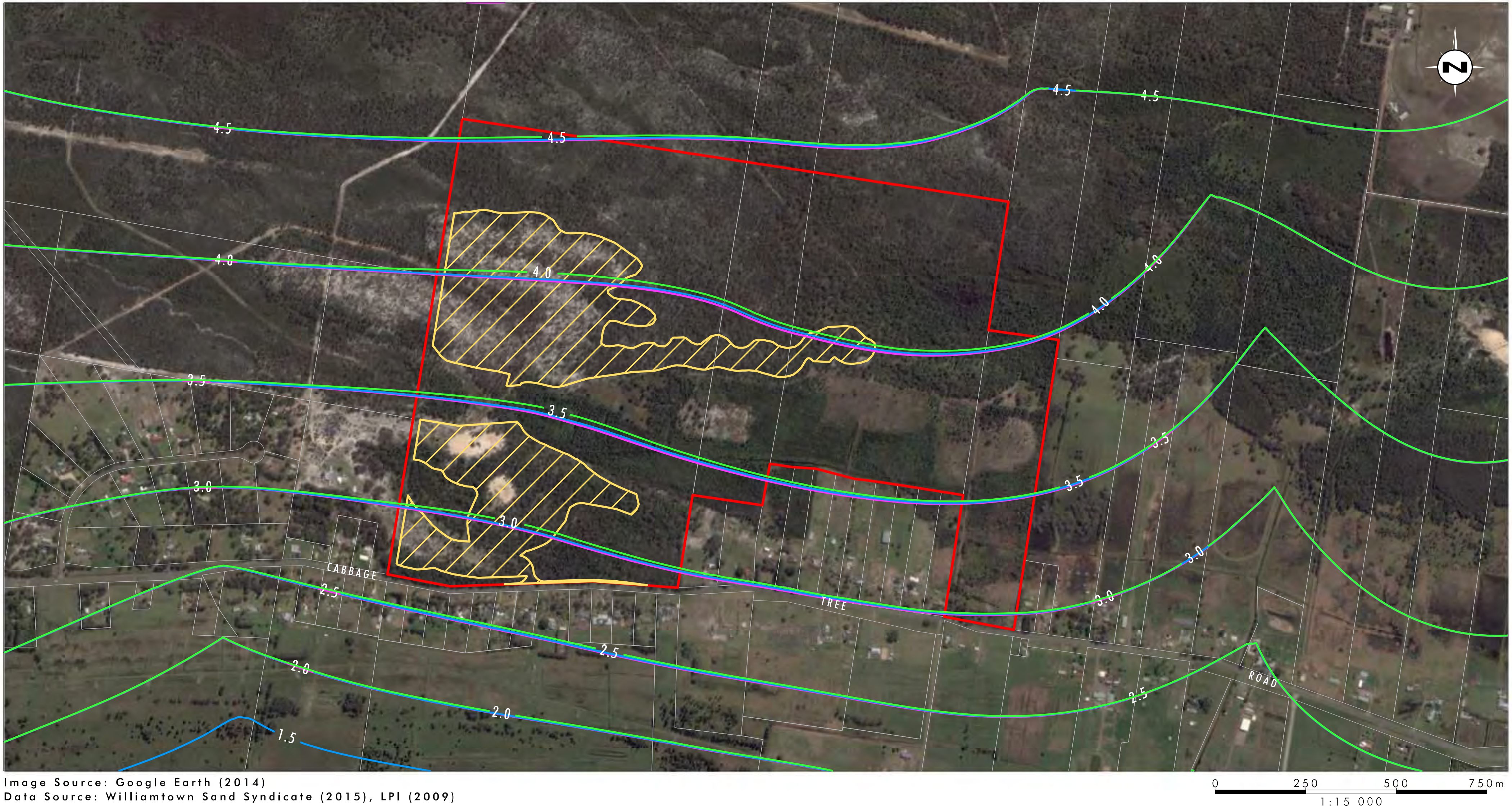


Image Source: Google Earth (2014)
Data Source: Williamtown Sand Syndicate (2015), LPI (2009)

Legend

- Project Area
- Extraction Areas
- Pre-Extraction Scenario Groundwater Contour
- Maximum Extraction Scenario Groundwater Contour
- Maximum Extraction Scenario Groundwater Contour Extinction Depth 1m

FIGURE 5

Comparison of Pre-Extraction Scenario and Maximum Extraction Scenario Modelled Maximum Predicted Groundwater Levels

File Name (A4): R10/3251_104.dgn
20160930 11.51

7.0 Potential surface runoff impacts on flooding

As discussed above, due to the inherent high infiltration capacity of the sand dunes that are proposed to be quarried, there is negligible surface runoff from this area with the major sources of surface runoff in the area being from Cabbage Tree Road, access roads and other impervious structures such as buildings and sheds.

The proposed quarry will increase the surface area of Cabbage Tree Road through the construction of the access road, deceleration and acceleration lanes and the site office.

Runoff from the access road and acceleration and deceleration lanes will be diverted to infiltration areas in the sand that will be located adjacent to the access road and on the northern side of Cabbage Tree Road. In addition the access road will be constructed with a low trafficable broad bund approximately 0.6 m high and 10 m wide near the entrance to the quarry. The low bund will be located within the road and extend either side to the adjoining sand dunes to prevent any potential surface runoff from leaving the quarry area. A similar low trafficable bund will be constructed adjacent to the entrance to the northern extraction area as shown on. This bund will also be linked into adjoining sand dunes and will contain any potential surface runoff from the northern extraction area.

Williamtown Salt Ash Flood Model (WBM 2005) indicates that the estimated 1% Annual Exceedance Probability (AEP) flood level near the site is 1.96 mAHD which would result in sections of Cabbage Tree Road and significant sections of the adjoining properties on the southern side of Cabbage Tree Road being inundated. The proposed Cabbage Tree Road quarry extraction area is above the 1% AEP flood level.

Estimated Probable Maximum Flood (PMF) level in the central section of Fullerton Cove adjacent to the site is approximately 4.6 mAHD. The southern part of the proposed extraction area which will have a finished level of approximately 4 mAHD and could be inundated to a maximum depth of approximately 0.6 m during a PMF event. The northern part of the extraction area which will have a final landform level of in excess of 4.6 mAHD and would be above the PMF level. This area would provide a safe place above the flood for people and stock to seek refuge if trapped by the PMF.

Cabbage Tree Road adjacent to the site and the entrance to the quarry site would be flooded to a depth of 1 to 2 m during a PMF event and would not be trafficable or safe for wading through.

The floor level of houses in low-lying areas adjoining the quarry is adjacent to the site and access roads will also be inundated.

Quarrying has negligible potential to increase PMF levels as flood levels will be driven by flooding from the Hunter River system.

8.0 Conclusion

As set out above, modelling indicates that the proposed quarry will not increase the volume of groundwater stored upslope of Cabbage Tree Road or the rate of groundwater movement from north of Cabbage Tree Road to Fullerton Cove. It will therefore not adversely impact on groundwater driven flooding or waterlogging around residences in low-lying areas adjoining the quarry.

The proposed development has negligible potential to increase surface runoff from the area. A series of controls such as maintaining low bunds around the perimeter of the extraction area and directing runoff to infiltration areas adjacent to the internal road system will be incorporated into the development to control any runoff that might occur. As a result the proposed development will not adversely impact on flooding or waterlogging in low-lying areas adjoining the quarry as a result of surface runoff.

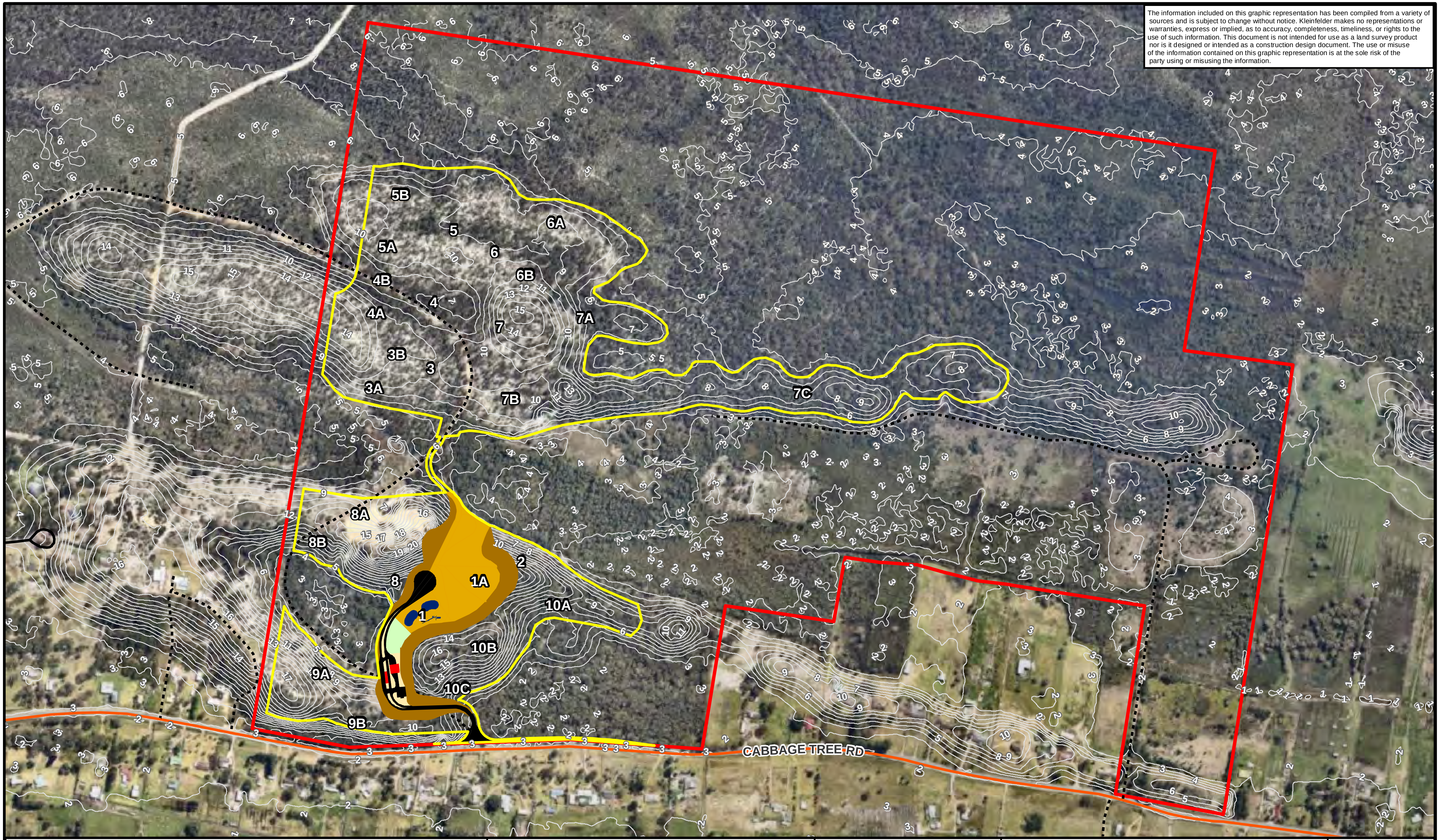
9.0 References

WBM Oceanics Australia 2005. Williamtown Salt Ash Flood Study. Final Report prepared for Port Stephens Council.

Umwelt (Australia) Pty Limited 2015. Environmental Impact Statement for Proposed Sand Quarry, Cabbage Tree Road, Williamtown. Appendix 7, Groundwater Impact Assessment. Prepared on behalf of Williamtown Sand Syndicate.

ATTACHMENT A

Quarrying sectors, extraction and indicative rehabilitation sequences



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Legend

- Subject Land
- Project Area
- Arterial Road
- Local Road
- Track
- Contours (1m)

Year 1 Quarry Progress

- Extracted
- Batter
- <2 Year-old Rehab
- Building
- Landscaping
- Not Extracted
- Road - sealed
- Processing Plant

Metres

0 50 100 200 300 400 500

N

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DRAWN BY: gjoyce

DATA SOURCE:
LPI - 2016
Nearmap - 2016

Quarry Progress Plan
Year 1

Williamtown Sand Syndicate
Rehabilitation Plan
Proposed Sand Quarry
Cabbage Tree Road, Williamtown

FIGURE:
3

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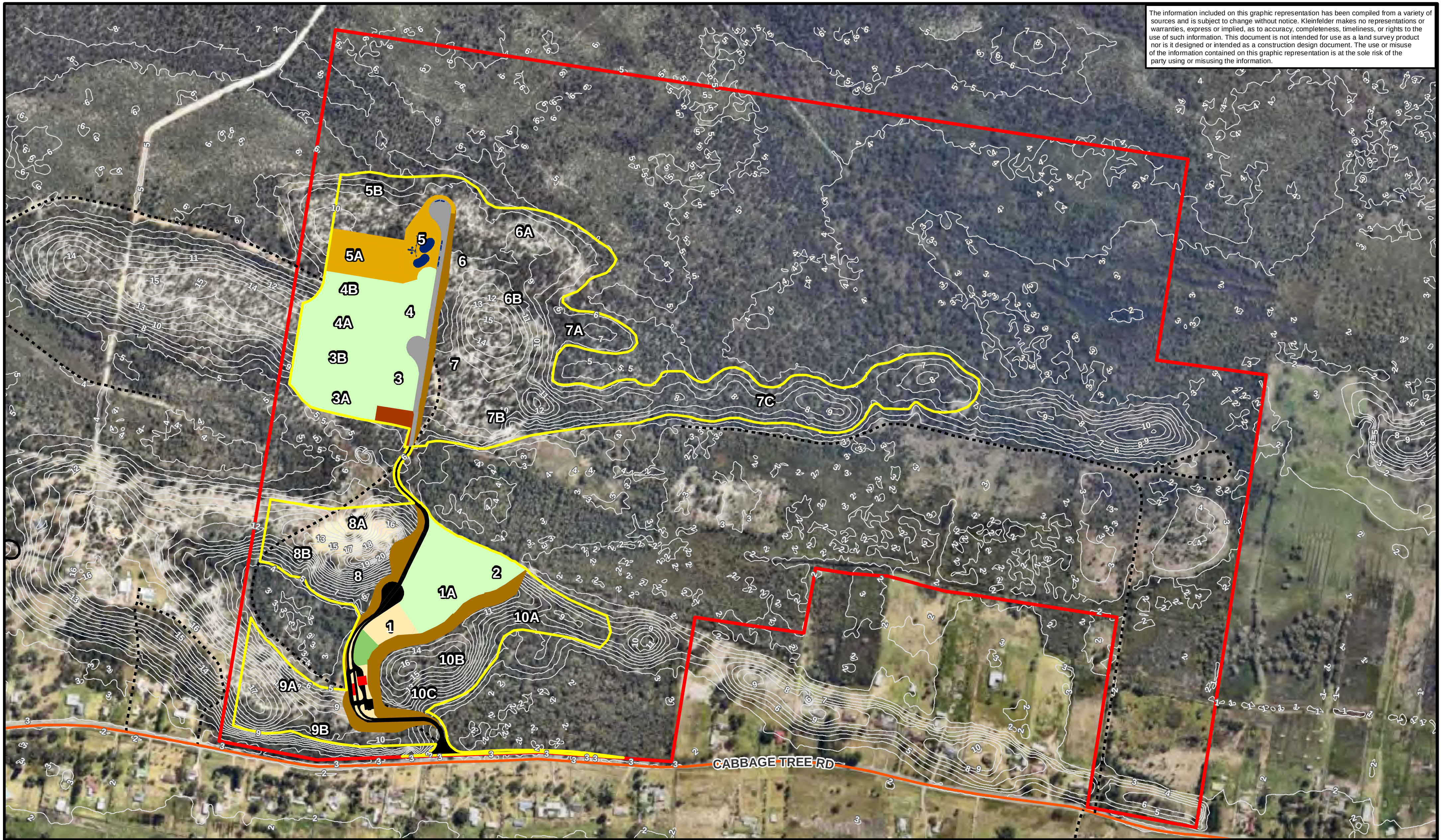

Legend

- Subject Land
- Project Area
- Arterial Road
- Local Road
- Track
- Contours (1m)

Year 3 Quarry Progress

- Extracted
- Batter
- Stockpile
- <2 Year-old Rehab
- <4 Year-old Rehab
- Building
- Landscaping
- Not Extracted
- Road - gravel
- Road - sealed
- Processing Plant

Metres

0 50 100 200 300 400 500

N

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DATE DRAWN: 2/09/2016 16:21 Version 3

DRAWN BY: gjoyce

DATA SOURCE:
LPI - 2016
Nearmap - 2016

Quarry Progress Plan
Year 3

Williamtown Sand Syndicate
Rehabilitation Plan
Proposed Sand Quarry
Cabbage Tree Road, Williamtown

FIGURE:

4

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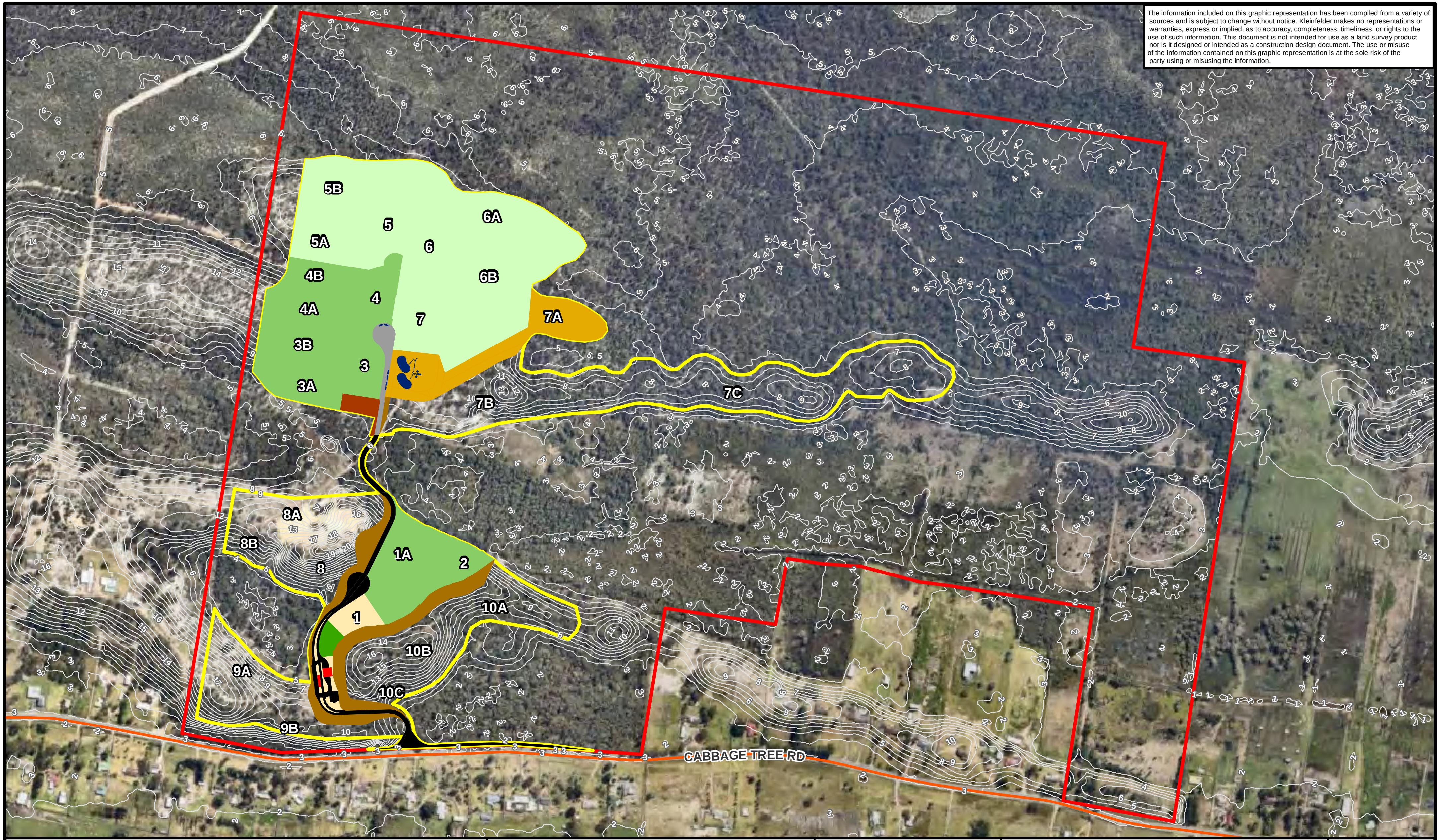

Legend

- Subject Land
- Project Area
- Arterial Road
- Contours (1m)

Year 5 Quarry Progress

- Extracted
- Batter
- Stockpile
- <2 Year-old Rehab
- <4 Year-old Rehab
- <6 Year-old Rehab
- Building
- Landscaping
- Not Extracted
- Road - gravel
- Road - sealed
- Processing Plant

Metres

0 50 100 200 300 400 500

N

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DRAWN BY: gjoyce

DATA SOURCE:
LPI - 2016
Nearmap - 2016

Quarry Progress Plan
Year 5

Williamtown Sand Syndicate
Rehabilitation Plan
Proposed Sand Quarry
Cabbage Tree Road, Williamtown

FIGURE:

5

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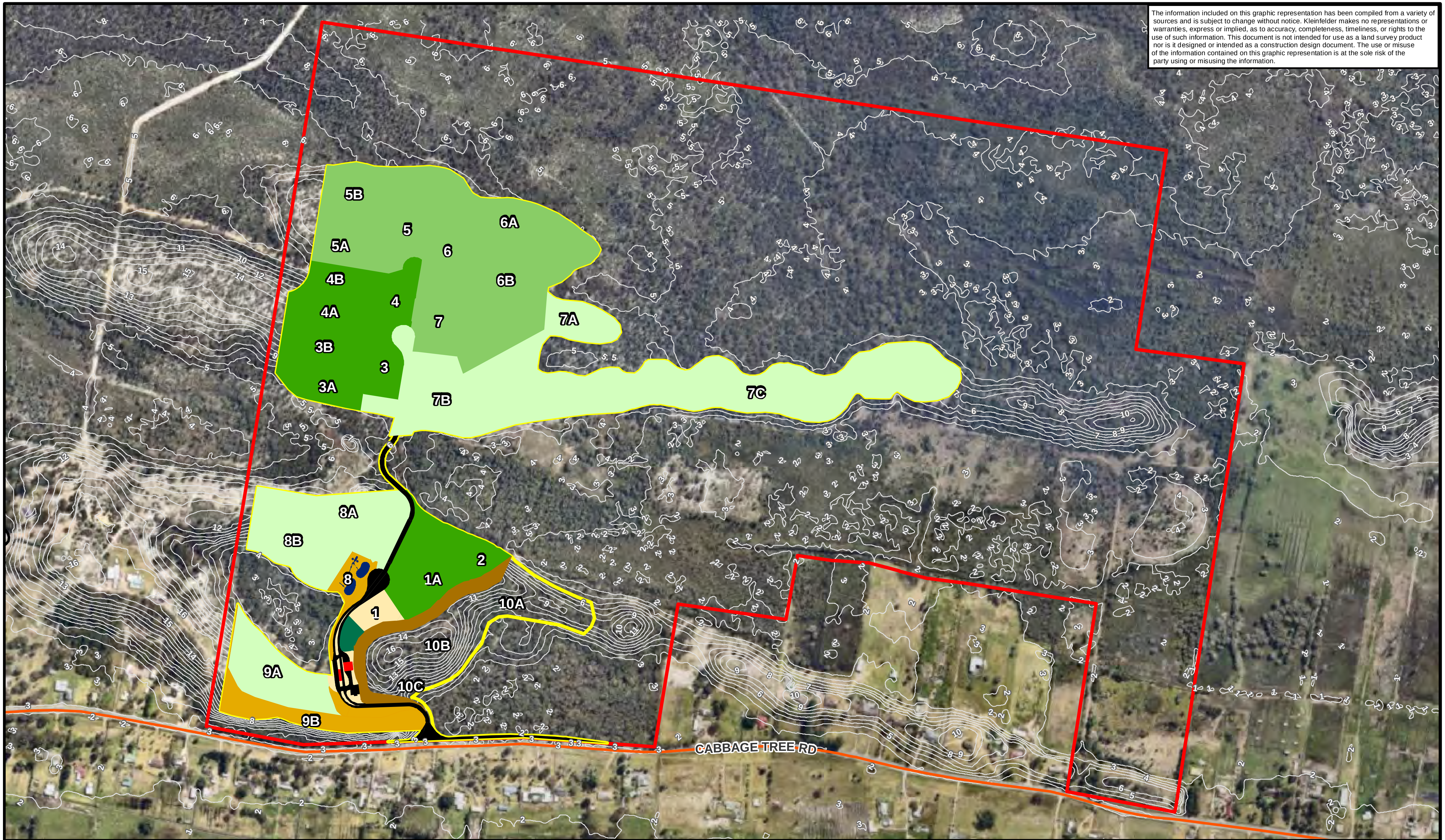

Legend

- Subject Land
- Project Area
- Arterial Road
- Local Road
- Contours (1m)

Year 7 Quarry Progress

- Extracted
- Batter
- <2 Year-old Rehab
- <4 Year-old Rehab
- <6 Year-old Rehab
- <9 Year-old Rehab
- Building
- Landscaping
- Not Extracted
- Road - sealed
- Processing Plant

Metres

0 50 100 200 300 400 500

N

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DATA SOURCE:
LPI - 2016
Nearmap - 2016

Quarry Progress Plan
Year 7

Williamtown Sand Syndicate
Rehabilitation Plan
Proposed Sand Quarry
Cabbage Tree Road, Williamtown

FIGURE:

6

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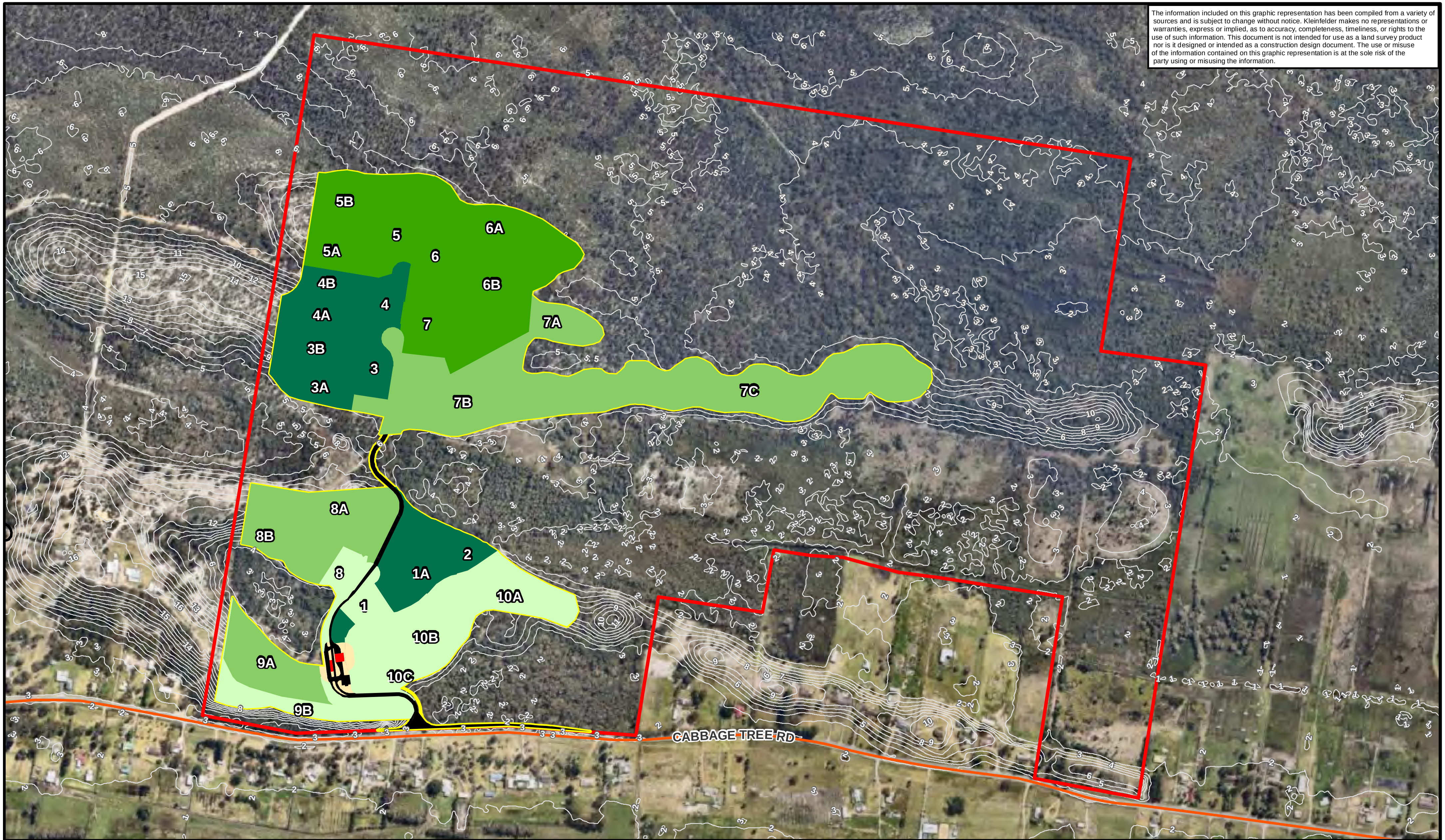

Legend

- Subject Land
- Project Area
- Arterial Road
- Local Road
- Contours (1m)

Year 9 Quarry Progress

- <2 Year-old Rehab
- <4 Year-old Rehab
- <6 Year-old Rehab
- <9 Year-old Rehab
- Building
- Landscaping
- Road - sealed

Metres

0 50 100 200 300 400 500

N

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DATA SOURCE:
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Nearmap - 2016

Quarry Progress Plan
Year 9

Williamtown Sand Syndicate
Rehabilitation Plan
Proposed Sand Quarry
Cabbage Tree Road, Williamtown

FIGURE:

7

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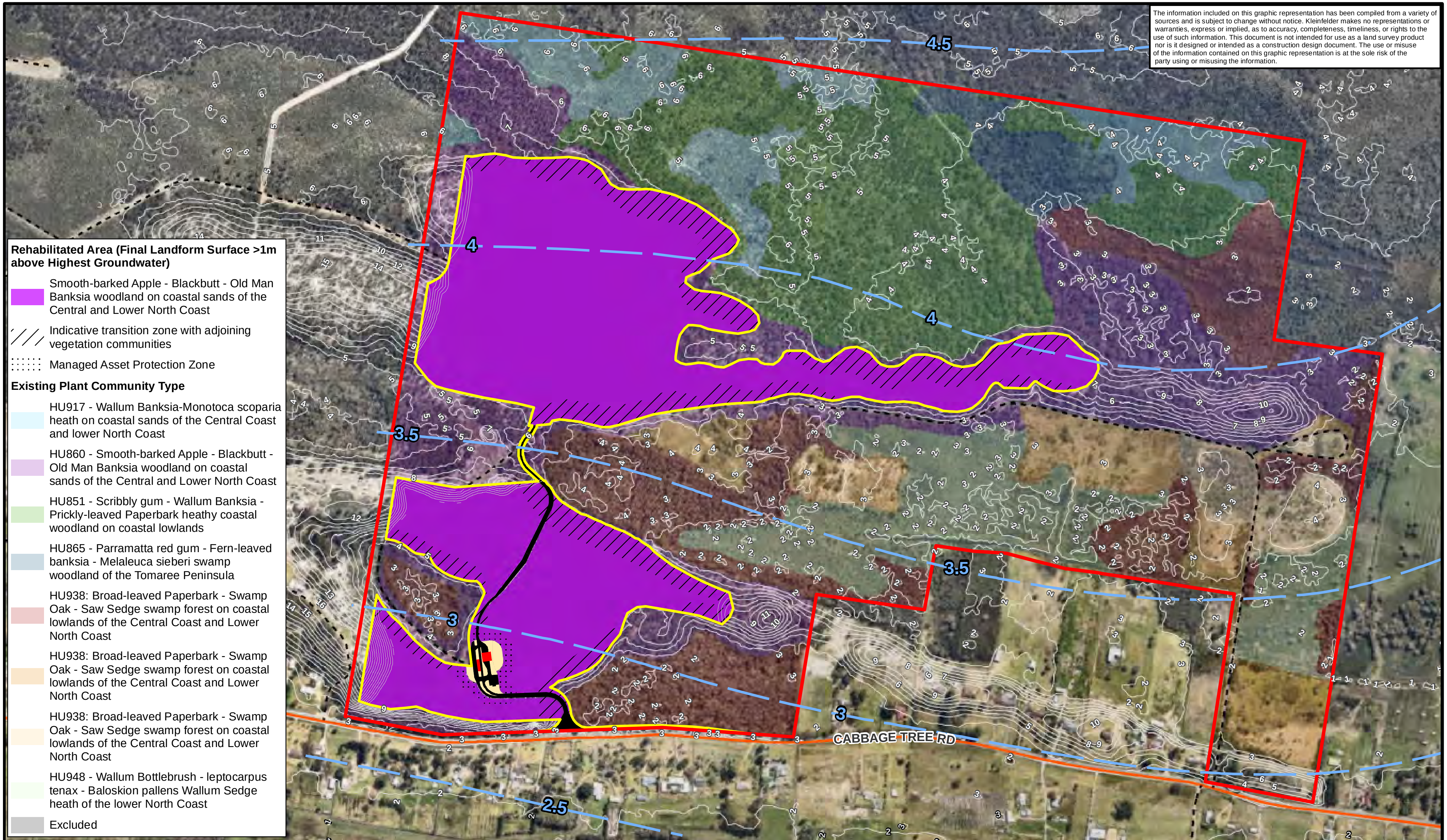

Legend

Subject Land	Highest Groundwater Level (metres
Project	Infrastructure Pads/Buildings
Arterial Road	Road - sealed
Track	Landscaping
Local Road	
Contours (1m)	

Metres

0 50 100 200 300 400 500

N

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DATA SOURCE:
LPI - 2016
Nearmap - 2016

Quarry Progress Plan
Final Landform and Rehabilitation

Williamtown Sand Syndicate
Rehabilitation Plan
Proposed Sand Quarry
Cabbage Tree Road, Williamtown

FIGURE:

8

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