REPORT

40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Client: Allams

Reference: PA3653-RHD-WR-RP-CI-0002

Status: Final/03

Date: 10 December 2024

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Document title:	40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation
Subtitle:	
Reference:	PA3653-RHD-WR-RP-CI-0002
Your reference	40-80 & 82 Chapmans Rd Hydrology
Status:	Final/03
Date:	10 December 2024
Project name:	Tuncurry
Project number:	PA3653
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Date:	10/12/2024
Approved by:	Andrew Morris
Date:	10/12/2024

Classification
Confidential

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1 Background

1.1 Development Application - 40 – 80 Chapmans Road (DA 2022/0214)

Allams Group Pty Ltd (Allams) submitted a Development Application for 40 – 80 Chapmans Road, North Tuncurry, which is registered as Lot 100 DP1286524. The site is a total of 6.07 Hectares (ha) and was zoned R2, Low Density Residential. The original development plans showed a proposed manufactured home estate consisting of 88 lots plus roads, drainage and other supporting infrastructure. The development application was identified as DA2022/0214.

The initial application was refused by Mid Coast Council (MCC). Subsequent to the refusal, Allams appealed in the Land and Environment Court. In considering the reasons for the refusal, Allams engaged ADW Johnson to prepare updated civil engineering plans and stormwater management plans, Douglas Partners to continue with groundwater monitoring at the site and Royal HaskoningDHV (RHDHV) to prepare a Flood Impact Assessment and review the stormwater management plans and groundwater monitoring.

The revised development application for the proposed design within Lot 100 DP1286524 has since been approved by MCC, as part of the Land & Environment Court appeal, this was dated 6th August 2024. The report, *40 – 80 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation* (RHDHV, 5/6/2024) details the approved design's impact on flooding.

DA2022/0214 was approved by the Land and Environment Court, with the documents amended in accordance with the court decision.

1.2 Proposed Development – 40 – 80 & 82 Chapmans Road

Subsequent to the approval of DA2022/0214, Allams is proposing to develop both 40 – 80 Chapmans Road, as well as the adjoining allotment, 82 Chapmans Road, identified as Lot 11 DP615229. The proposal involves the submission of a new development application to cover the development of both sites. The updated development layout "Sorrento Masterplan" which was prepared by ADW Johnson Engineers dated 9th December 2024 was assessed as part of this present study. The landform, which is shown in **Figure 1-1** comprises a site with a total area of approximately 22.4 ha and would include a community centre, 283 lots for a manufactured home estate and a system of raingardens and detention basins to manage run-off off-site.

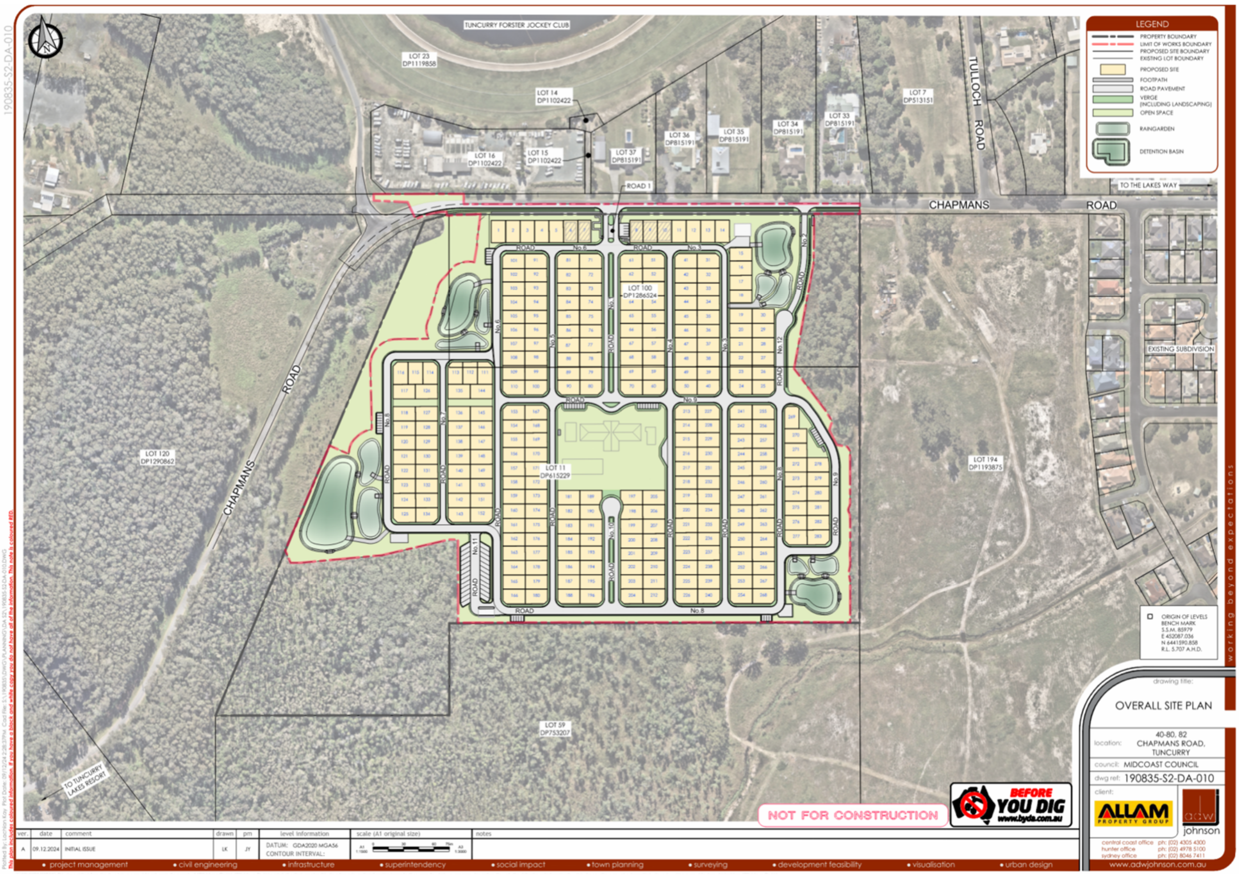


Figure 1-1 Proposed Development Site at 40 – 80 & 82 Chapmans Road, Tuncurry

2 Scope of Works

To support Allam's development application, the following works have been undertaken:

- A Flood Impact Assessment, to evaluate the impact of the proposed works on flood behaviour in the surrounding environment.
- An assessment of the potential to evacuate persons safely from the site during extreme flood events.
- An evaluation of the impact of the proposed stormwater management system on the existing hydrological regime, in accordance with the requirements of site specific development control plan.
- A summary of the groundwater monitoring across the site and the implications of the proposed development on groundwater.

3 Flood Impact Assessment

3.1 Basis of Modelling

Wallamba River Flood Study (WMAwater, 2015)

The development site is located within the floodplain of the Wallamba River. A flood study was undertaken by WMAwater for the Wallamba River on behalf of the then Great Lakes Council (now MCC). As part of the flood study, WMAwater developed a two dimensional hydraulic model using the TUFLOW modelling software, a copy of which was provided to RHDHV for the purpose of undertaking a FIA.

The hydraulic model extends across the floodplain from Nabiac upstream of the site, down to Tuncurry along the Wallamba River close to its junction with the Coolongolook River (see **Figure 3-1**). The site of interest is situated on the eastern floodplain of the Wallamba River along Chapmans Road, approximately 3.6 km upstream from the junction of the Wallamba River and the Coolongolook River (see **Figure 3-2**).

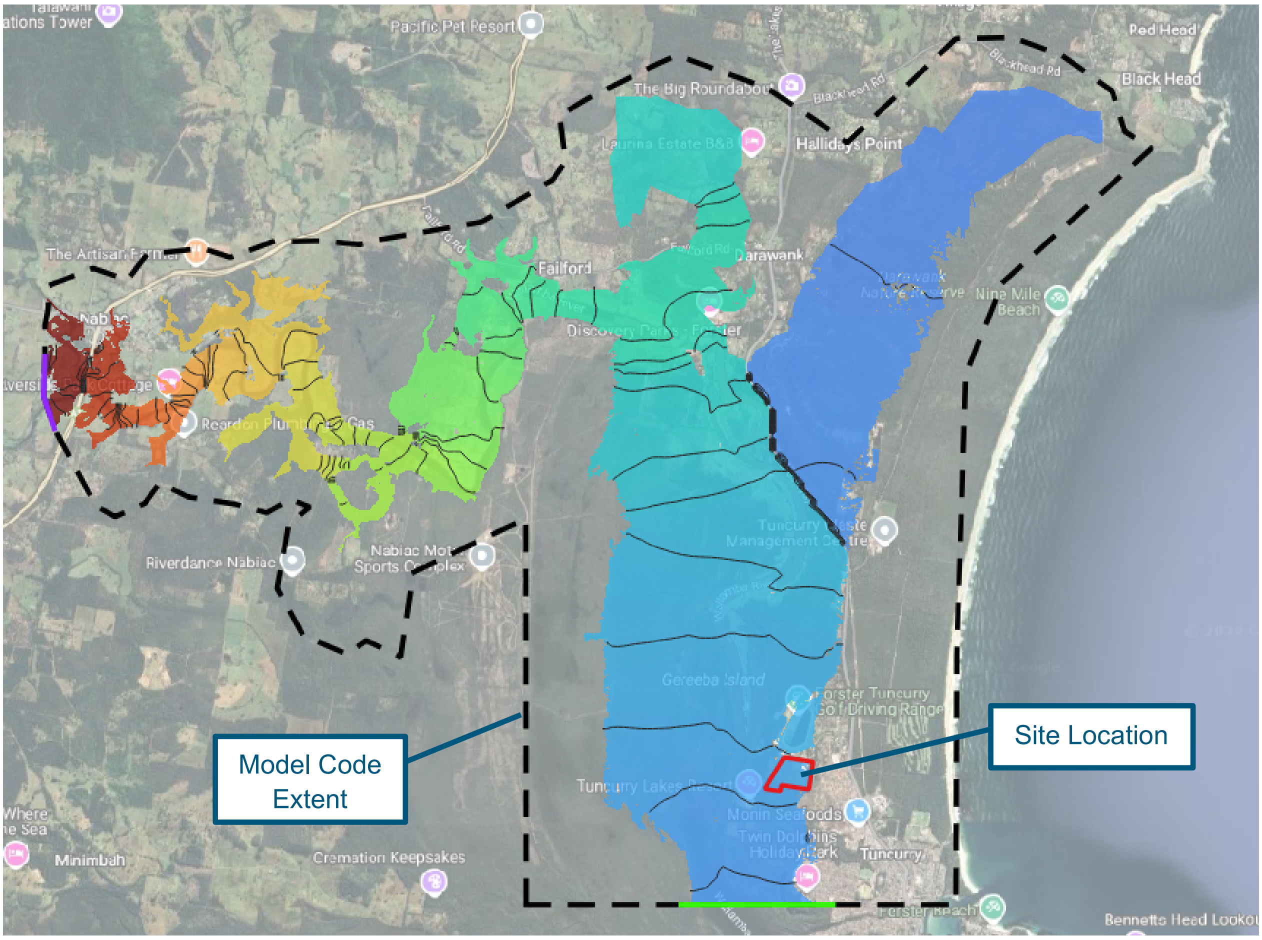


Figure 3-1 Wallamba River Model Code Extent with 1% AEP design flood extent

Figure 3-2 *Site Location with 1% AEP flood extent as reported in the Wallamba River Flood Study overlaid*

The model's topography comprises the following sources (WMAwater, 2015):

- LiDAR survey capture in 2007 from Great Lakes Council (5 m resolution); and
- River Channel Bathymetry captured October to November in 1998 from the Department of Land and Water Conservation, which was used in preference over the LiDAR survey where it is present.

Model inflows were derived from WBNM hydrologic modelling, where catchment inflows are inputted into the model code extent upstream of the site location as seen in **Figure 3-3**.

The downstream model boundary tailwater levels adopted for the *Wallamba River Flood Study* (WMAwater, 2015) are based on stage hydrographs developed as part of the *Wallis Lakes Flood Study Review* (WMAwater, 2011). **Table 3-1** indicates the peak tailwater levels from the adopted hydrographs for the design events that were relevant to this assessment. This study notes that the tailwater levels are derived from rainfall dominant flood events. Inflow Boundary locations are indicated in **Figure 3-3**.

Table 3-1 *Adopted Downstream Model Boundary – Peak Tailwater Levels (WMAwater, 2011)*

Design Flood Events	Peak Tailwater Level at Downstream Boundary
5% AEP (20-year ARI)	1.58 m AHD
1% AEP (100-year ARI)	1.99 m AHD
Probable Maximum Flood (PMF)	4.48 m AHD

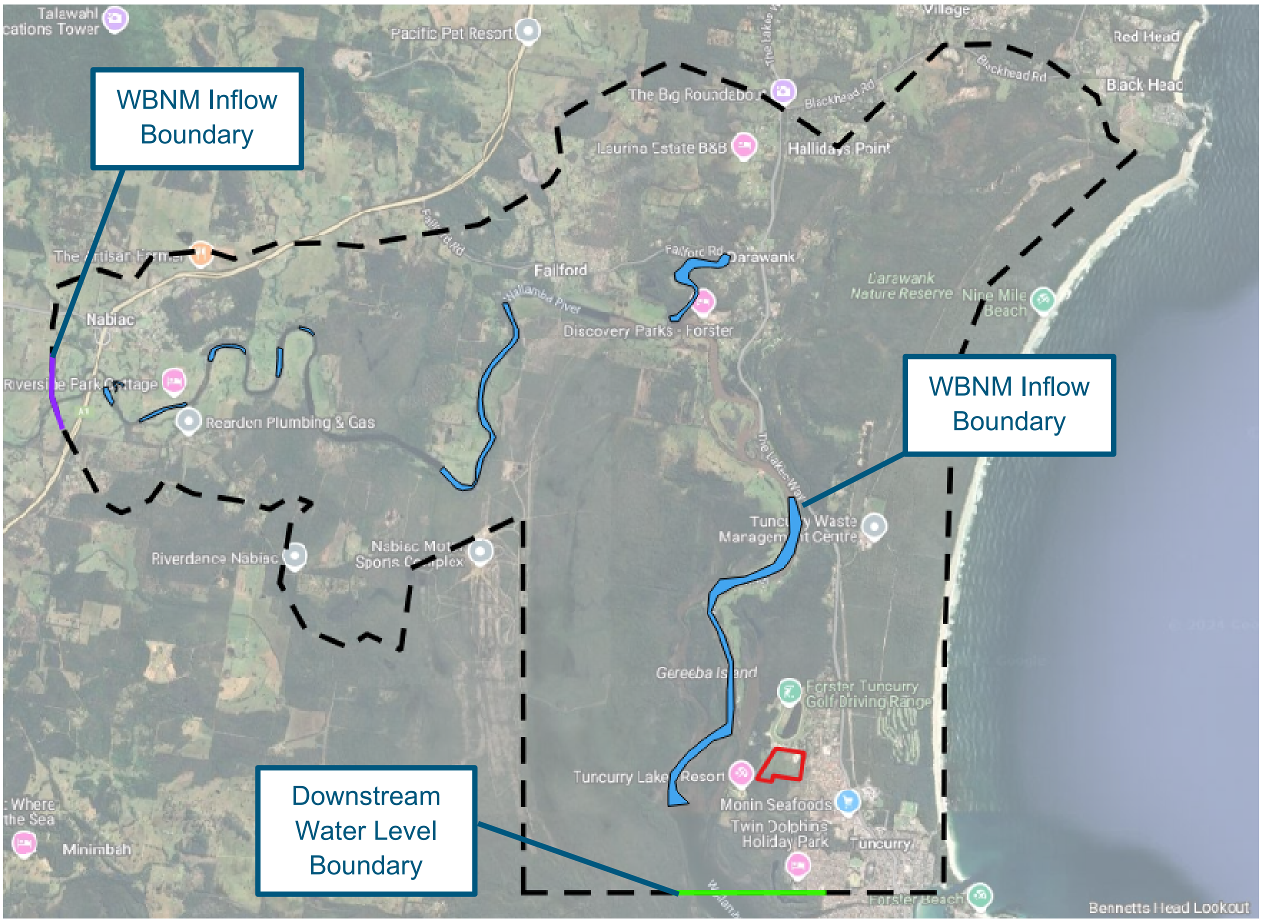


Figure 3-3 Inflow Boundaries & Downstream Water Level Boundaries

The received flood study results show the 1% AEP design flood level at site to be up to 2.15 m AHD.

40 – 80 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation (RHDHV, 2024)

The hydraulic TUFLOW model that was the basis of the 40 – 80 Chapman Road, Tuncurry Stage 1 FIA and Hydrology Final Report (RHDHV, 2024) updated the Wallamba River Flood Study model for the purposes of the FIA with the following:

- Adoption of 2023-03-AC-iSP TUFLOW engine version.
- Adoption of Heavily Parallelised Compute (HPC) TUFLOW solver and utilisation of Graphics. Processor Unit (GPU) hardware enabling fast simulation runtime.
- Inclusion of detailed topographic survey captured 28/6/2022
- Inclusion of detailed topographic survey captured 3/8/2023

The results of the updated modelling were comparable to the Flood Study model results, with localised variation attributable to the better resolution survey data.

3.2 Approved Design Surface for Base Case Scenario

As part of this current assessment, the Proposed Design – "Sorrento Masterplan" will be assessed against the filling of the site approved as part of a previous bulk earthworks development application (circa 2008) (refer **Figure 3-4**). This design surface was included into the model to represent the Base Case Scenario (see **Figure 3-4**) (also referred to as the “Approved Design Surface – Stage 1”). The design was a fill pad, which raised the ground surface of allotment above approximately 2.7 m AHD, in accordance with the approved bulk earthworks Development Application.

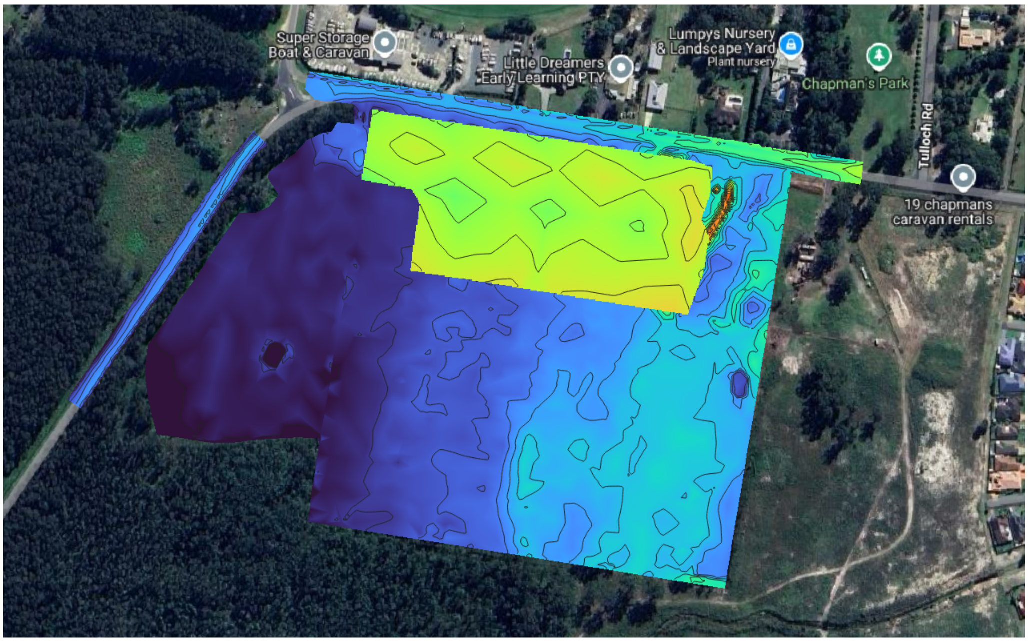


Figure 3-4 *Revision of the Approved Design Surface – dated (31/1/2024)*

3.3 Proposed Design Conditions

The proposed design will be assessed against the Base Case Scenario as described in **Section 3.2**. The proposed design surface, the Sorrento Masterplan is shown in **Figure 3-5** and was inputted into the model to represent the post development conditions. The proposed design surface extends the fill platform to a section of the southern and eastern boundary of Lot 11 DP615229 and also includes a series of rain gardens and detention basins located approximately at each corner of the design footprint.

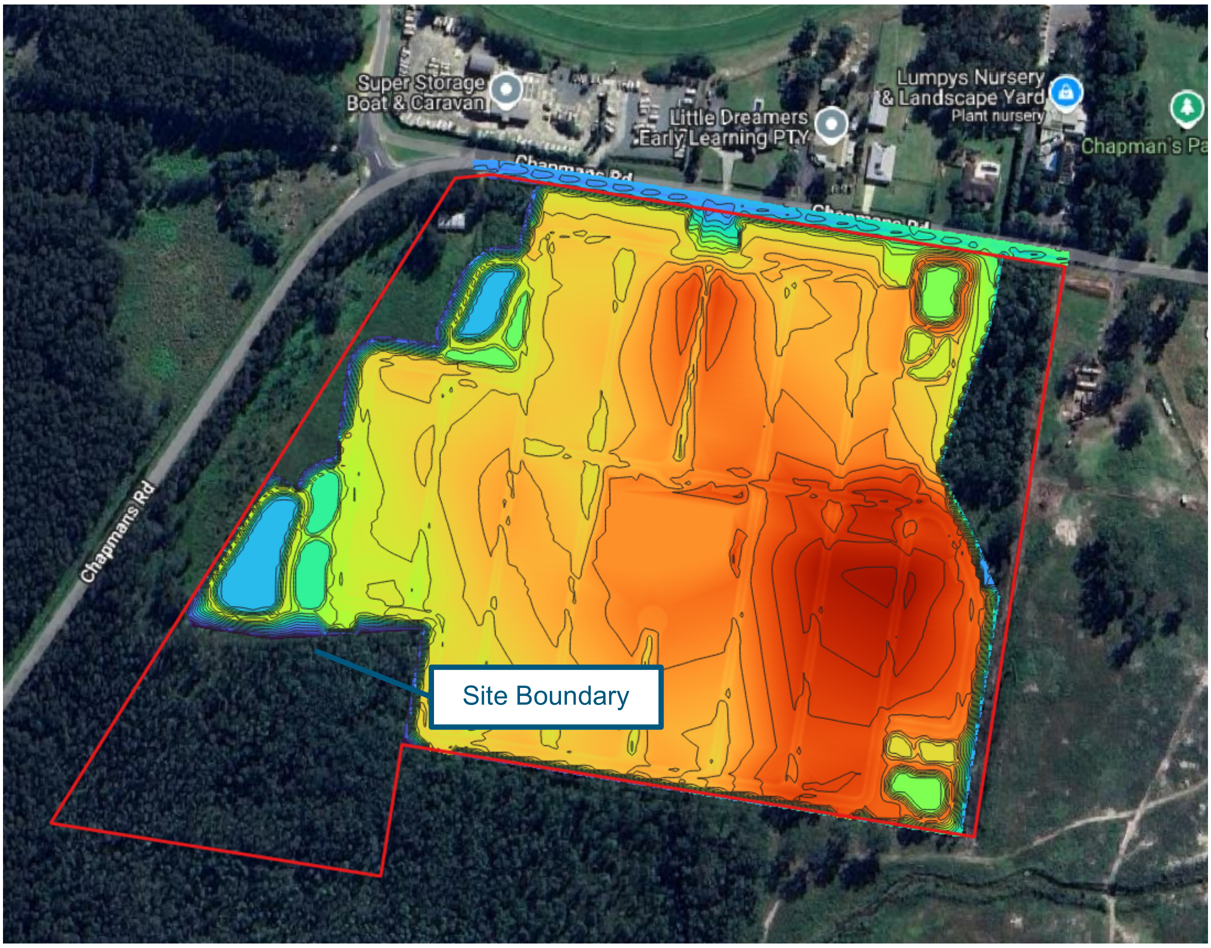


__Figure 3-5__ Proposed Design Surface - dated 8/10/2024

3.4 Modelling Results

The updated hydraulic TUFLOW model was used to simulate the 5% AEP and 1%AEP design flood events for both Base Case and Proposed Development Scenario.

The design flood events were modelled for their respective critical storm durations determined in the Wallamba River Flood Study (WMAwater, 2015):

- 1% AEP - 36-hour storm event
- 5% AEP - 36-hour storm event (adopted for the flood study)

No changes were made to the hydrology of the model. In order to assess the impact of the proposed works on the existing development, the results of the Proposed Development Scenario were compared with the Base Case scenario. Results for modelled events have been provided in **Appendix A,** including:

- Flood Levels
- Flood Velocity
- Flood Hazard
- Flood Level Impact
- Flood Hazard Impact
- Flood Hazard Impacts

The relevant figures summarised in **Table 4-1** below.

Table 3-2 *Summary of Flooding Figures*

Figure No.	Description
A1.0	Peak flood level, base case conditions, 5% AEP event
A1.1	Peak flood level, proposed conditions, 5% AEP event
A1.2	Impact on flood levels – proposed vs base case
A2.0	Peak flood level, Base case conditions 1% AEP
A2.1	Peak flood level, proposed conditions, 1% AEP event
A2.2	Impact on peak flood levels – proposed vs base case
A4.0	Peak flow velocity – base conditions 5% AEP event
A4.1	Peak flow velocity – proposed conditions – 5% AEP event
A4.2	Impact on peak flow velocity – proposed vs base case, 5% AEP event
A5.0	Peak flow velocity – base case conditions 1% AEP
A5.1	Peak flow velocity – proposed conditions 1% AEP
A5.2	Impact on peak flow velocity – proposed vs base case 1% AEP
A7.0	Flood hazard, base case conditions, 5% AEP event
A7.1	Flood hazard, proposed conditions, 5% AEP event
A7.2	Change in flood hazard – 5% AEP event
A8.0	Flood hazard, base case conditions, 1% AEP event
A8.1	Flood hazard, proposed conditions, 1% AEP event
A8.2	Change in flood hazard – 1% AEP event

3.4.1 Summary of Flood Characteristics – Base Case Condition

Under the Base Case Conditions, part of the proposed development site becomes inundated during the 5% AEP, 1% AEP and PMF design flood events. Water levels within the Wallamba River rise and overtop onto the eastern overbank, over Chapmans Road to the east, around the southern side of Tuncurry Lakes Resort and onto the site. **Figure 3-6** shows the stage hydrographs during Base Case Conditions at the proposed development site, where ground levels of the lowest lying areas of the proposed development site are approximately between 0.5 and 0.8 m AHD, with highest levels occurring at the eastern boundary and as part of filling undertaken within 40 -80 Chapmans Road as part of previous development approvals.

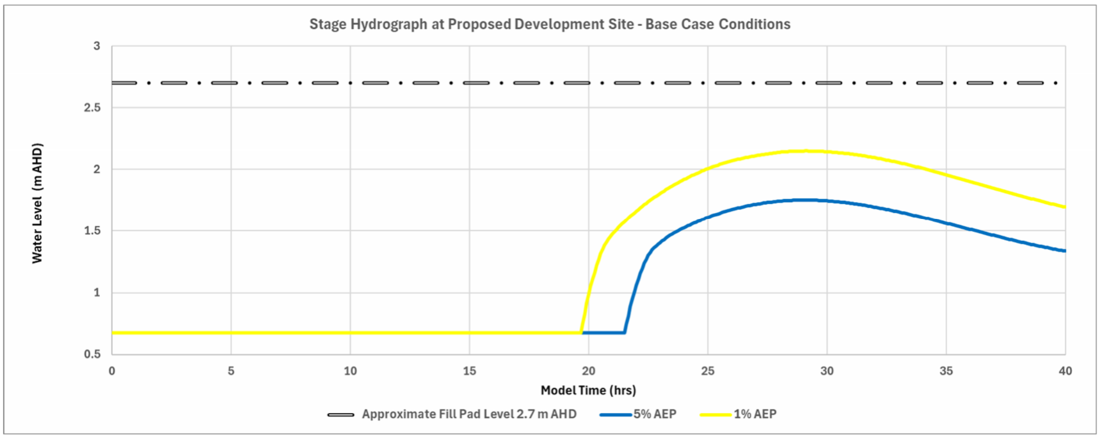


Figure 3-6 *Stage Hydrograph - Design Flood Events – Approved Design Conditions – Proposed Development Site*

Further details of the results of the modelling can be seen in **Appendix A**.

3.4.2 Summary of Flood Characteristics – Proposed Design Conditions

During the Proposed Design Conditions, the proposed design surface is affected by the elevated river water levels only in events rarer than the 1% AEP event plus 0.5m freeboard. The stage hydrographs of the modelled flood events are shown in **Figure 3-7**.

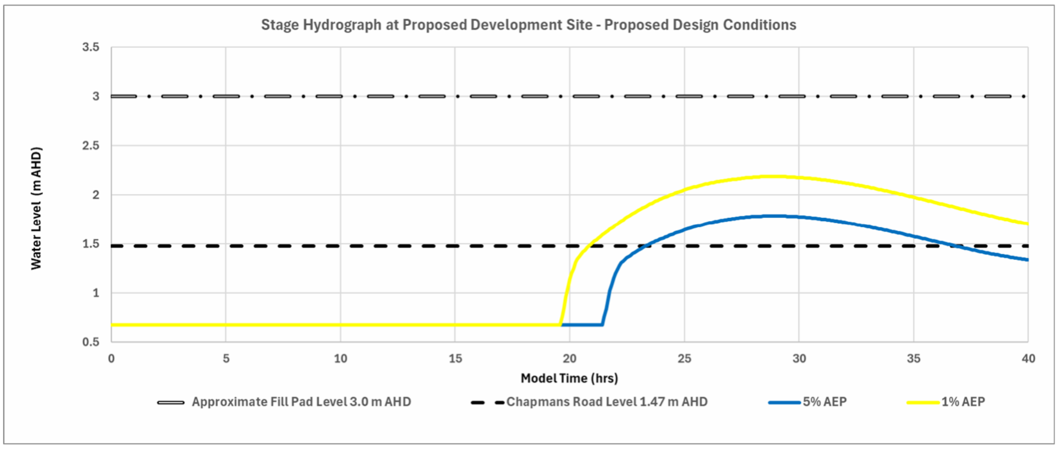


Figure 3-7 *Stage Hydrograph - Design Flood Events – Proposed Design Conditions – Proposed Development Site*

3.4.3 Discussion of Modelling Results

The following observations are made about the increases in peak water levels associated with the proposed works. The predicted increase in peak water level is summarised in **Table 3-3**.

***Table 3-3** Maximum Peak Water Level Increase in Adjacent Allotment – Design Flood Events*

Design Flood Event	Maximum Peak Water Level Increase In Allotment (m)	
	Western Adjacent Allotment Lot 120 DP1290862	**Chapmans Road Road Reserve***
5% AEP	0.033 (Appendix A – Figure 01.2)	0.032 (Appendix A – Figure 01.2)
1% AEP	0.038 (Appendix A – Figure 02.2)	0.035 (Appendix A – Figure 02.2)

**Representative observed flood impact values*

An evaluation of the results of the hydraulic modelling provides the following observations:

- In the 5% AEP event, two minor areas of land adjacent to the Tuncurry-Forster Jockey Club racing track experience increases in peak water levels up to 0.039 and 0.072 m (**Appendix A – Figure 01.2**). However, this change is not material to the predicted peak of rarer flood events.
- In the 1% AEP event, there is an area along Chapmans Road approximately 10m wide by up to 15m long where a report increase of approximately 0.07 – 0.13m is predicted to occur. This does not result in a change to the hazard along the roadway.
- In the 1% AEP, the main increases are observed in Lot 2 DP593602. The increase observed in Lot 2 occurs in an area that is undeveloped and predominantly RU2 Rural Living and C2 Environmental Conservation. There is a thin strip of R2 Residential zoning, however it is difficult to envisage how this could be developed in isolation. The increase will not result in any change to the hazard experienced along the private access road and will not result in any increase in hazard within the rural living area, which is predominantly cleared farmland. There are no habitable properties in the affected area.
- In the 1% AEP event, there is a minor area within the carpark of Lumpy's Nursery & Landscape Yard, next to Chapman's Park, that experiences increases in peak water levels up to 0.069 m (**Appendix A – Figure 02.2**). These minor impacts result from negligible peak water increases on the floodplain, between 0.002-0.005 m. The magnitude of these negligible increases are within the margin of error for the TUFLOW model's accuracy, and below what would be considered tolerable impacts (< 0.010 m). They can ultimately be attributed to the resolution of the model in this area.
- The negligible increases results in the minor increases in overtopping flows of hydraulic controls such as ground level crests near the racing track or in carpark. Additionally, the minor impacts at these locations do not result in notable changes to flood hazard.
- In the 5% AEP event, the predicted increase in peak flow velocity is less than 0.2 m/s off site. The 1% AEP event is similar, with velocity predominantly below 0.2 m/s. There is a small zone immediately adjacent to the boundary where the velocity approaches 0.3 m/s. Neither is considered to change the potential risk to the floodplain or its inhabitants.

3.5 Conclusions

A summary of the flood impact posed by the proposed design and recommendations are outlined below:

- During modelled events, changes to peak flood levels due to the proposed design are minor and not considered notable. There are no notable changes in flood hazard and impacts for the 5% and 1% AEP events are confined to Chapmans Road.
- Where the increase occurs, this is limited to < 40 mm and occurs either in the public roadway or in non habitable areas. There is no notable change in flood hazard.

4 Flood Evacuation Consideration

4.1 Proposed Design Conditions

During the Proposed Design Conditions, the proposed design surface is affected by the elevated river water levels only in the 1% AEP plus 0.5 metre freeboard and rarer events, which is outlined by **Figure 3-6**. Given evacuation would only occur during events much rarer than the 100 year ARI event, it is proposed that this evacuation would occur via the emergency evacuation route in the north eastern corner of the site. **Table 4-1** shows when the Proposed Design Fill Pad and emergency evacuation route is inundated and when the emergency evacuation route at the north eastern corner of the site is inundated with flood depths above 0.15 m. Flood depths of 0.15 m may be considered the depth at which small vehicles begin to float. The stage hydrographs of the modelled flood events are shown in **Figure 4-1**.

The post development modelling of the Probable Maximum Flood event is included in **Appendix A** as **Figure A9.0**.

Table 4-1 *Peak Water Levels – Proposed Design Conditions*

Design Flood Event	Peak Water Level (m AHD)[1]	Inundation of Intersection at Chapmans Road of emergency evacuation route (approx. 2.15 m AHD)[2]	Inundation of Access Road above depths of 0.15 m	Inundation of Proposed Design Fill Pad (approx.3.0 m AHD)[3]
5% AEP	1.79	No	No	No
1% AEP	2.19	Yes	No	No
PMF	4.65	Yes	Yes	Yes

[1] Values are extracted from the low point at the access road into the Proposed Design
[2] Crest Level at Sag of entrance into development allotment road network from Chapmans Road
[3] Approximate lowest level on Proposed Design surface raised area

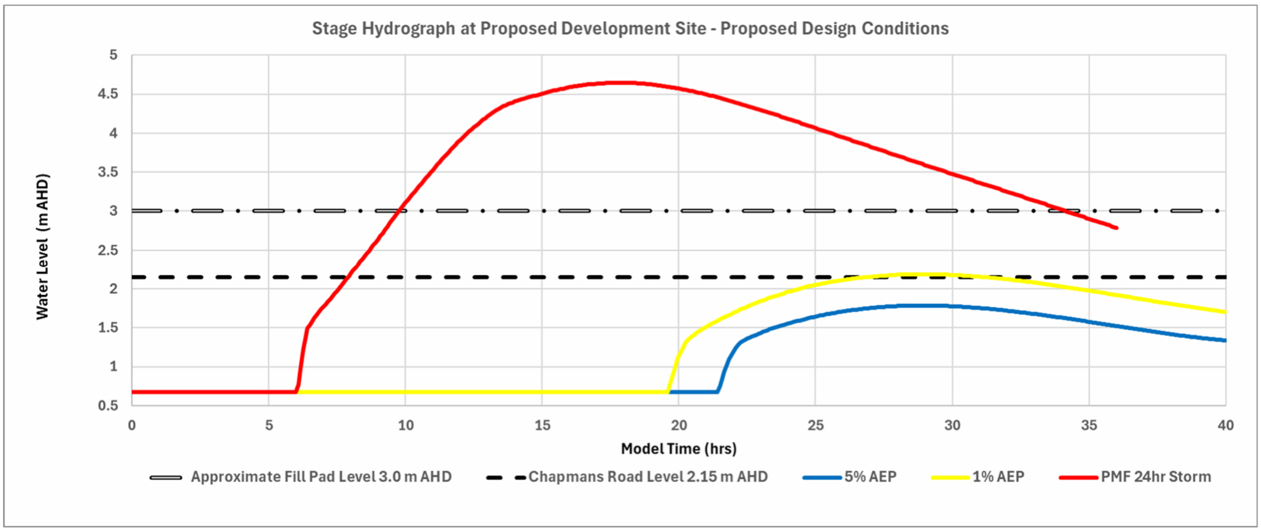


Figure 4-1 *Stage Hydrograph - Design Flood Events – Proposed Design Conditions – Proposed Development Site*

The above information indicates that evacuation would only be necessary to avoid the potential for the site to become isolated rarer than the 1% AEP event. Evacuation of the site should be based around the development of a site specific evacuation plan for the development. The plan should consider:

- Identification of appropriate rainfall gauges in the upper and lower parts of the Wallamba River catchment to allow for monitoring of potential rainfall depths that are likely to cause extreme flooding. It is expected that this would be in conjunction with advice from the Bureau of Meteorology and the State Emergency Service regarding predicted levels in Wallis Lake.
- Identification of a trigger level to facilitate sufficient time for evacuation of the site in a storm event rarer than the 1% AEP event. This would potentially be at a Lake level of 1.7 m AHD, as per the current SES requirements for Wallis Lake.
- Where the level of the development site is predicted to be exceeded by Lake levels, evacuation of the site would be initiated to the nearest nominated evacuation centre.
- Separately, it is noted that the site is very close to the edge of the PMF extent and a distance of less than 50 metres would be required to travel from edge of the emergency evacuation route to the flood free area.

These requirements should be documented further as part of a site specific evacuation plan.

5 Hydrological Assessment

The subject site is required to conform to a number of requirements that are detailed in Part 16 of the Mid Coast Council Development Control Plan – Site Specific Development Controls. The specific details are outlined in Section 16.5 of the DCP. The following specific controls apply to the area under this current application, which is identified as the "Western Precinct" in the DCP. This includes the following objectives:

- *ensure stormwater treatment measures within the "Western Precinct" substantially achieve the Great Lakes Water Quality Improvement Plan (2009) target of no net increase in average annual pollutant loads relative to existing land use.*
- *Ensure an average of 5 days of surface run-off per year or less is achieved within the "Western Precinct" for the flow objective*
- *Responsibility for provision of maintenance is shared fairly between landowners/occupiers and Council; and*
- *Treatment measures implemented are consistent with the Chapman's Road, Tuncurry – Stormwater Management Strategy adopted 27/4/10.*

The DCP goes on to list a number of specific requirements, including the provision of a stormwater strategy detailing the stormwater management measures. The stormwater strategy for the development of 40 – 80 and 82 Chapmans Road is discussed further in the following.

5.1 Stormwater Management

The Stormwater Management Strategy and associated plans have been developed by ADW Johnson for the development site at 40 – 80 & 82 Chapmans Road, Tuncurry. The stormwater management plans have been developed in accordance with the requirements of DCP and in the context of consultation with Council as part of the approval associated with 40 – 80 Chapmans Road.

The proposed stormwater management plan is presented in **Figure 5-1**. It consists of dividing the proposed development site into approximately 4 equal catchments which drain to the proposed bio-retention basins and on-site stormwater detention basins. The basins have been designed in accordance with the requirements of the DCP and the Chapmans Road Stormwater Management Strategy, including:

- Ensuring that run-off from hard stand areas is treated prior to infiltration into groundwater or discharge off site.
- Maintaining treatment measures at a minimum of 1 metre above the estimated groundwater level (refer **Section 5.2**).
- Treating the run-off in accordance with the requirements of the DCP.
- Maximising the opportunity for recharge of the groundwater system.
- Providing on-site stormwater detention to achieve the off site discharge requirements, that accord with the DCP.

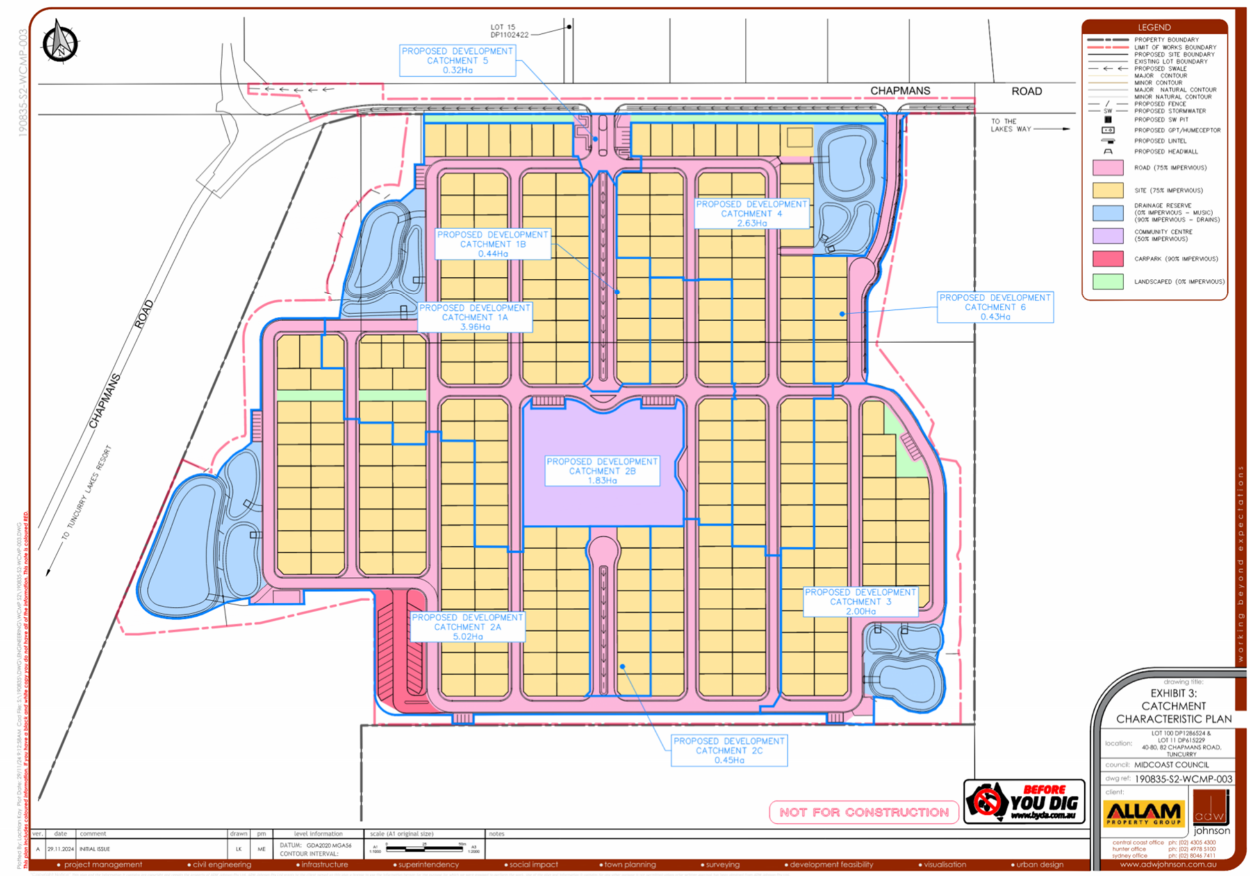


Figure 5-1 *Proposed Stormwater Management Plan*

5.2 Groundwater Management

5.2.1 Groundwater Monitoring at 20 – 80 & 82 Chapmans Road

Groundwater monitoring has been carried out by Douglas Partners for the development site. A total of seven groundwater monitoring points currently operate across the site, with an additional monitoring point having been destroyed. The groundwater monitoring locations were selected to capture the potential for variation in infiltration across the site as reflected of the sub-soil conditions and permeability. In general, previous investigations have established that the eastern third of the site consists of relatively high permeable sands. Permeability gradually reduces across the middle third of the site and the western third appears to be transition to a greater proportion of silty material with lower permeability.

The location of the groundwater modelling bores is shown in **Figure 5-2**.

Monitoring points 101 and 105 (which replaced MW1) coincide with the eastern side of the site, where Predominantly sandy soils have been observed as part of previous investigations. Points 102, MW3 and MW4 are located in the middle third of the site (moving from east to west) where there is a transition in the soil type observed, while points 103 and 104 are located on the western boundary. From permeability testing previously undertaken, it is expected that soil permeability will reduce in the western 3rd of the site.

The record of groundwater monitoring is presented in **Figure 5-3** and **Figure 5-4**.

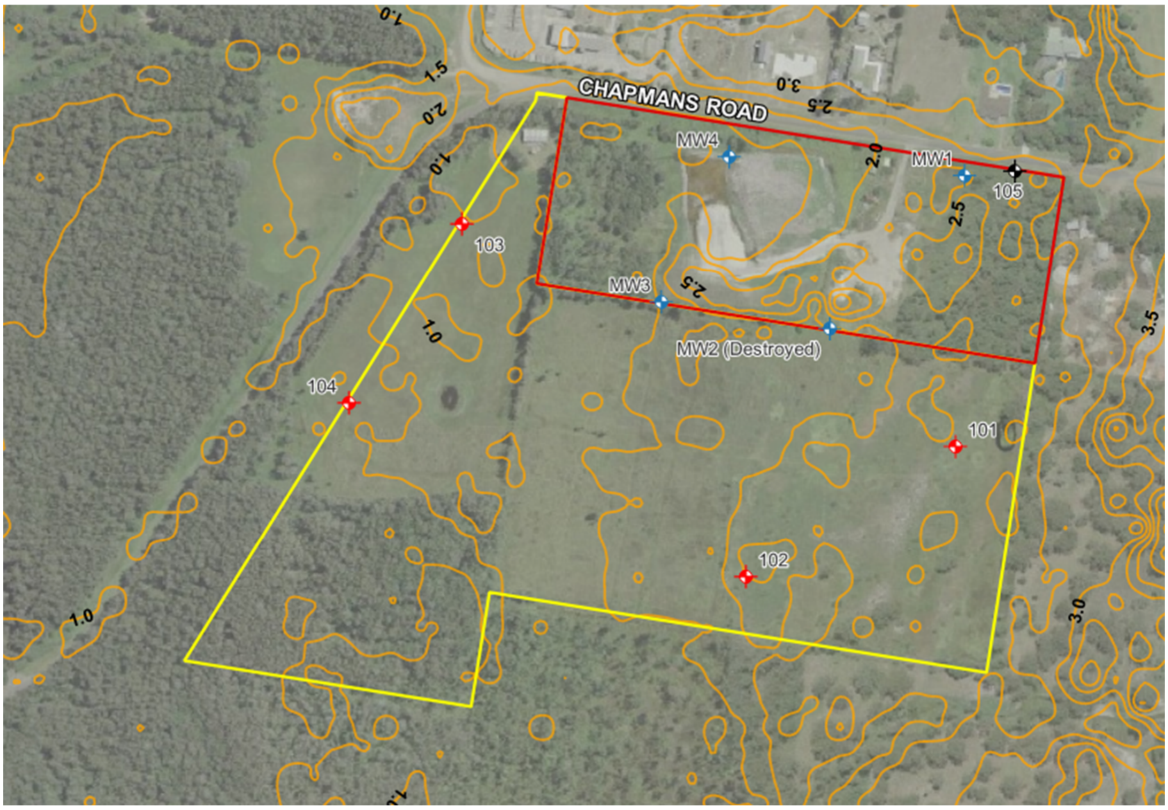


__Figure 5-2__ Location of Groundwater Monitoring Points

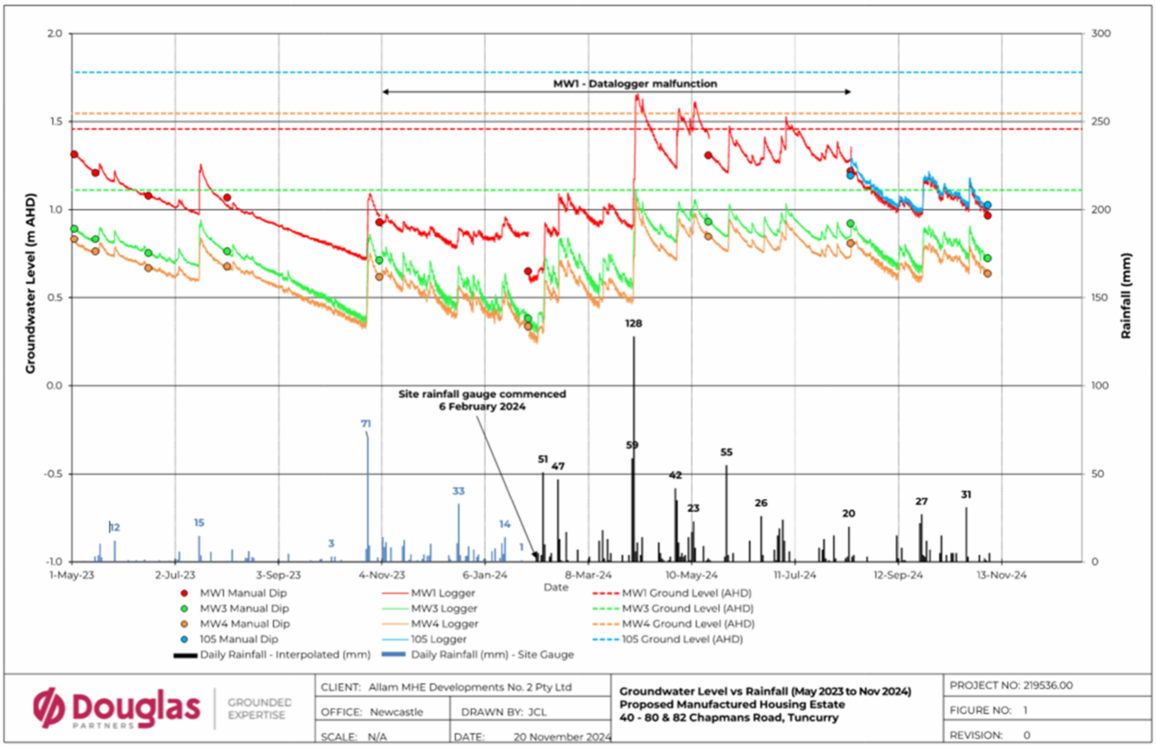


__Figure 5-3__ Groundwater Monitoring Record MW1, MW3, MW4 & 105

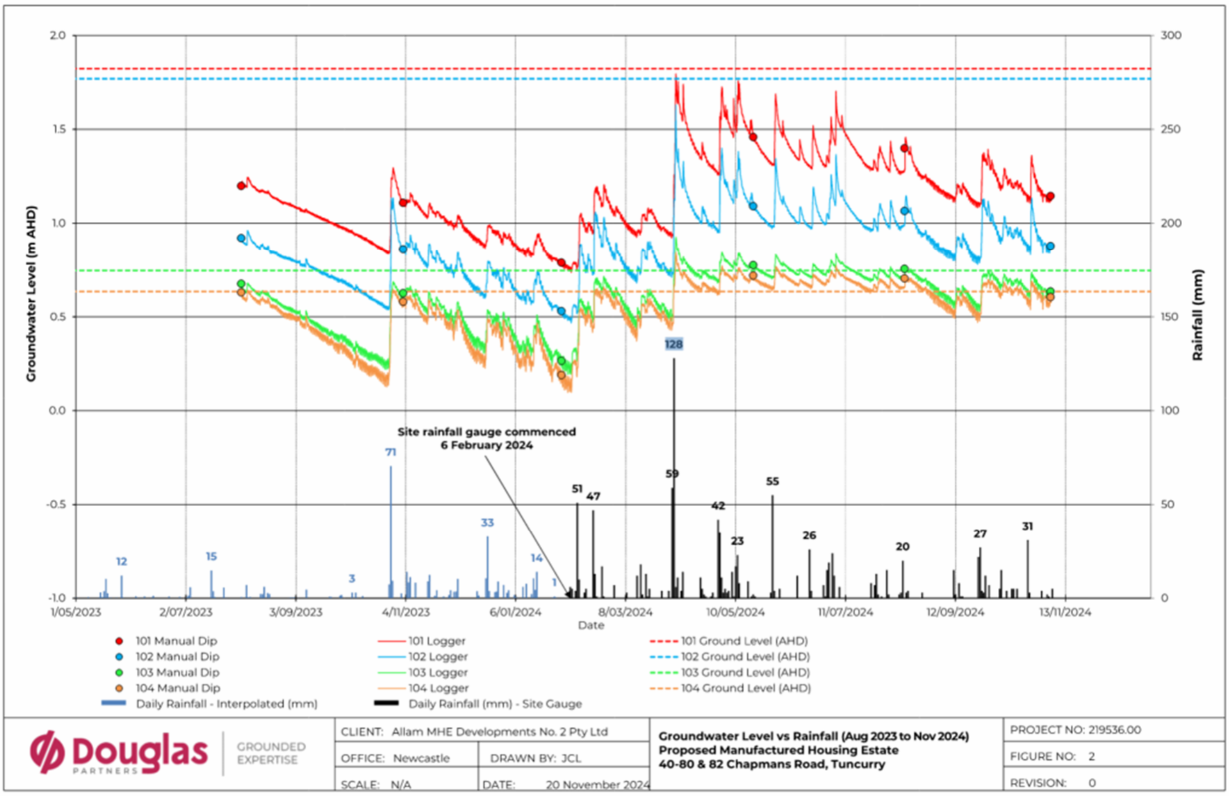


Figure 5-4 *Groundwater Monitoring Record 101,102,103, and 104*

The results of the groundwater monitoring indicate the following trends for the period of reporting between 1 May 2023 to November 2024:

- The record indicates that for the eastern and middle monitoring points (105/M1,101, 102, MW3 and MW4) the groundwater level remains below the surveyed level of the ground surface for the period of monitoring.
- Groundwater levels remained around the surface level at points 103 and 104 for the period between around the storm event on the 6th April 2024 through to around the middle of August where the groundwater levels drop off. However following a series of storm events in Mid October, the levels at gauge 104, the southern gauge increase and remain elevated at around ground level.
- The record includes of a daily rainfall total around the 6th of April 2024 of 128 mm, which represents between a 2 and 5 year ARI rain event (for a 24 hour storm duration).
- Based on historical rainfall data (refer below), the rainfall recorded in the year to date, as reported at the Forster Tuncurry Marine Rescue Gauge indicates that the total annual rainfall is approaching the 90%ile for annual rainfall totals (i.e. only 10% of years recorded a greater depth of rainfall).
- It is only those gauges on the very western boundary of the site where groundwater exceeds the surface level of the site – i.e. right on the boundary. Even for MW3 and MW4, although they are located towards the siltier ground conditions, groundwater levels remained below the surface, despite the above average annual rainfall only approaching the surface on the date of the 6th April storm event.
- Gauges located in the eastern half of the site indicate a greater variation in the groundwater level. This is indicative of the sub-soil conditions that are more permeable, but also indicates that the average groundwater level is below the surface level.

A copy of the Douglas Partners Report is provided in **Appendix B**.

5.2.2 Corresponding Rainfall data

Rainfall for 2024 has been analysed to evaluate the characteristics of the rainfall record at the site for 2024. To facilitate this assessment, the Gauge Forster Tuncurry Marine Rescue (Gauge No. 60013) site has been use to evaluate the characteristics of the rainfall record for 2024 compared with the long term average. The year 2024 has been focused on as the record for 2023 indicates that rainfall was below average, at least until November with groundwater remaining below the surface level for this period of record.

Table 5-1 *Rainfall Record for 2024 and Long Term Median Rainfall for Forster Tuncurry Marine Rescue*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
2024 Highest Daily	*14.0*	*44.4*	*22.8*	*129.0*	*45.6*	*37.0*	*42.8*	*23.2*	*37.2*	*42.0*	*19.4*	*N/A*
Monthly Total - 2024	*57.0*	*170.6*	*82.6*	*264.4*	*173.0*	*101.8*	*118.0*	*65.2*	*82.4*	*97.4*	87.4*	1299
Median monthly total for Gauge	*90.0*	*102.7*	*116.5*	*103.0*	*96.4*	*101.8*	*58.8*	*51.4*	*46.0*	*64.7*	*74.2*	905
Difference – monthly total to median monthly total	*-33*	*67.9*	*-33.9*	*161.4*	*76.6*	*0*	*59.2*	*13.8*	*36.6*	*32.7*	*13.2*	394.5

* Up to 29th November

The above data suggests that the rainfall recorded in 2024 to 29th November is above average. Compared with the long term record, it suggests that this rainfall depth would approach the 90th percentile for annual rainfall, i.e. only 10% of years would be wetter than the recorded data.

Therefore, this indicates that the site can be expected to maintain infiltration in the middle and eastern parts of the catchment for the majority of years expected. Some upwelling and run-off would be expected from the western part of the site.

5.3 Management of inflows to Adjoining wetland

It is noted that there is an existing sensitive receiving wetland located to the south western corner of the site. It will be necessary to maintain the hydrological regime into he wetland. It is expected that this will be achieved via the control of outflows from Catchment Basin 3, with the release of treated water and a level spreader to distribute run-off. While the volume of run-off required would be subject to further advice from an ecologist, it is suggested that the proposed scheme outlined in the Water Cycle Management Plan prepared by ADW Johnson would represent an appropriate starting point, where there is no increase in run-off volume from the development site to the wetland.

6 Conclusions & Recommendations

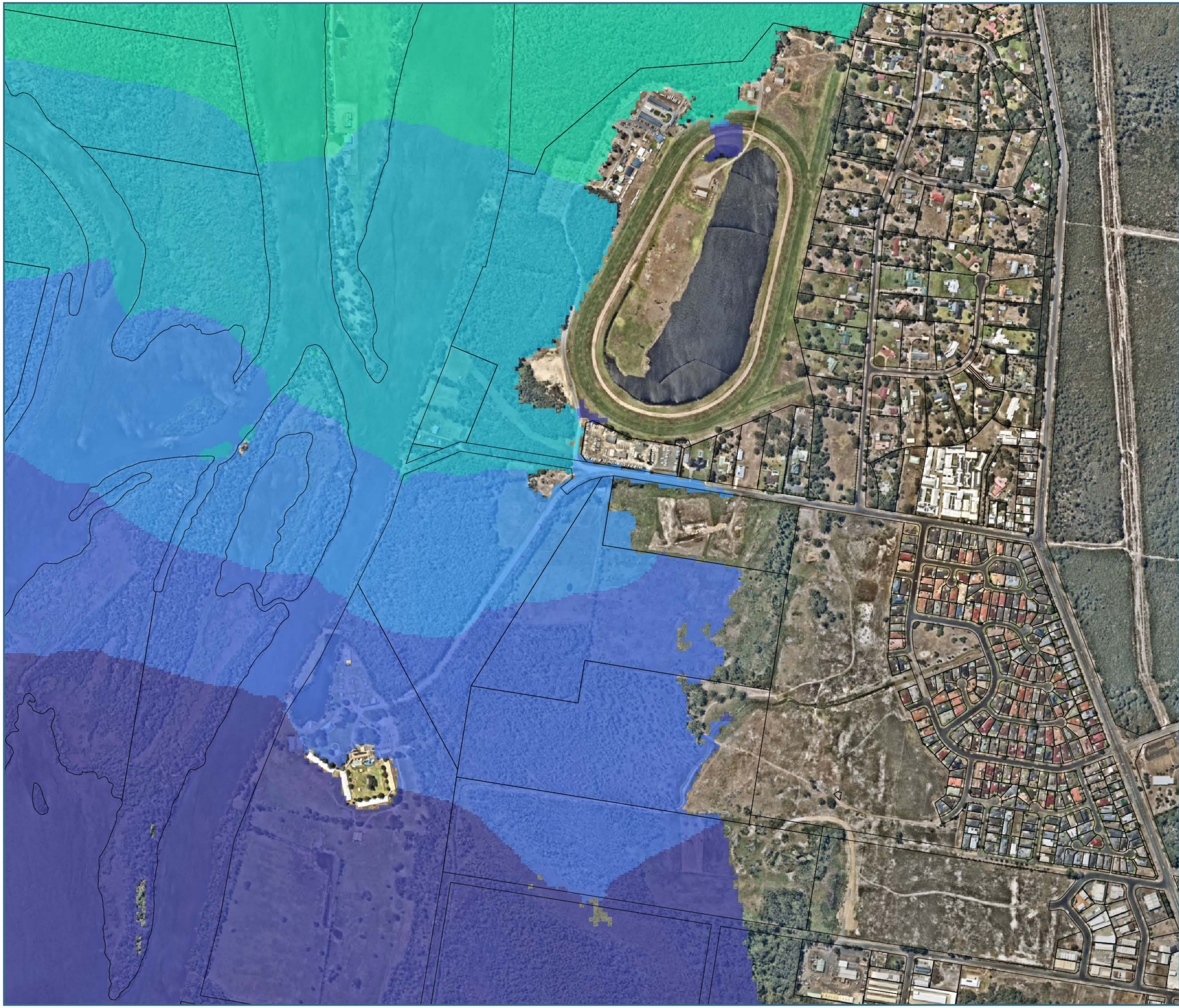
This report provides a summary of the Flood impacts associated with the proposed development of 40 – 80 & 82 Chapmans Rd, Tuncurry.

The following conclusions are drawn from the report:

- Filing of the site is proposed to achieve a minimum 500mm freeboard above the 100 year ARI event.
- The impact of filling has been compared with the base case conditions, representing the previously approved bulk earthworks development. The results of the modelling indicate that there will be minor increases in the flood level along Chapmans Road and no change to the hazard. There is less than a 40 mm increase in the adjoining allotment to the west.
- Provision has been made to evacuate the site during flood events rarer than the 1% AEP plus 0.5 m freeboard. This will be further developed via site specific flood evacuation plan.
- The stormwater management system, as developed by ADW Johnson is consistent with the requirements of the Site Specific DCP for Chapmans Road.
- The groundwater record has been assessed for 2024, which was to date has experienced rainfall consistent with the 90^{th}%ile annual rainfall. This indicates that upwelling only occurs in the western portion of the site.

Appendix

Appendix A – Flood Modelling Results



Royal HaskoningDHV
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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Approved Design Surface Stage 1 Conditions
Figure A1.0
Event: 5% AEP
Results: Flood Levels

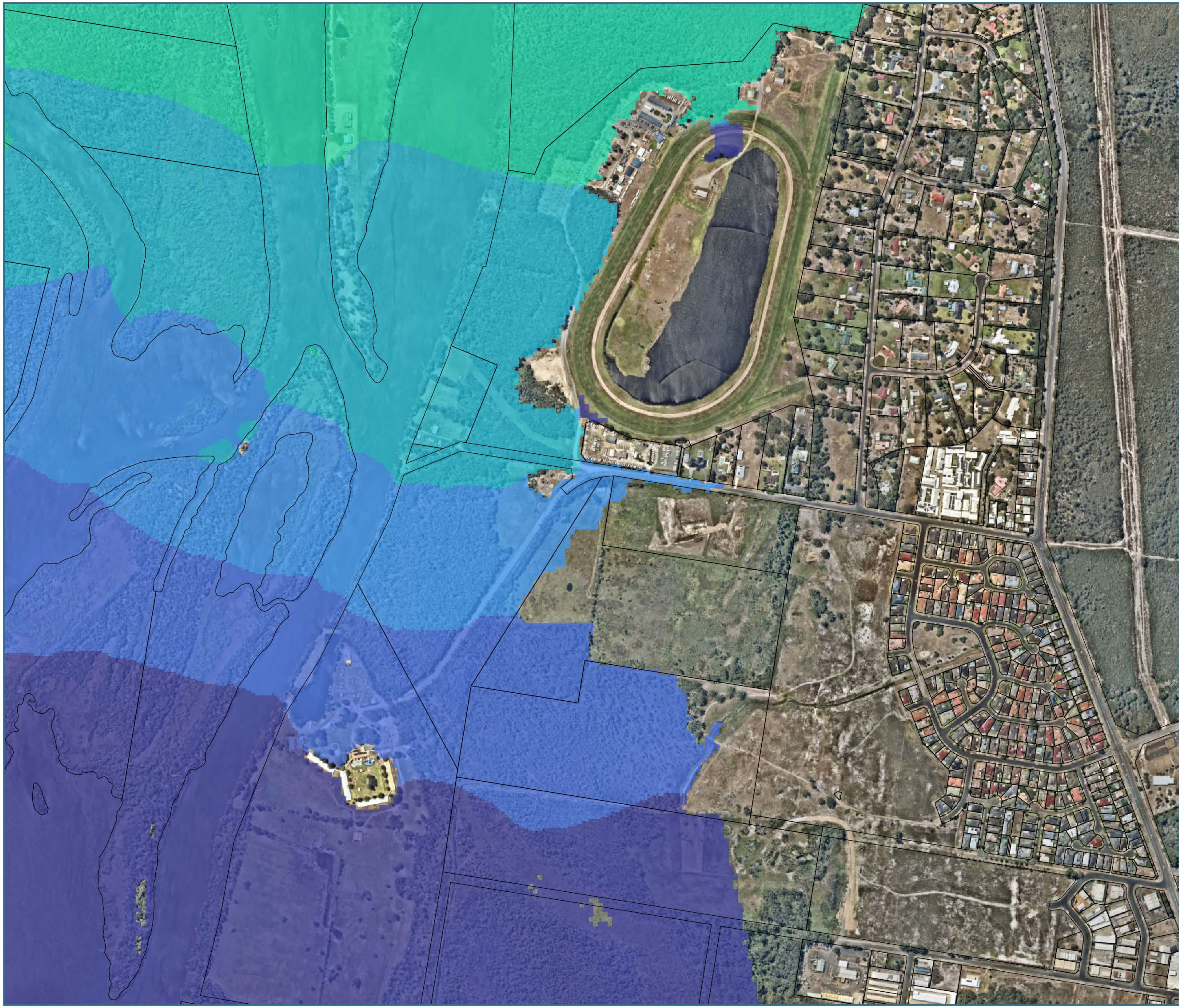
Legend

Peak Flood Levels (m AHD)

<= 1.7
1.70 - 1.75
1.75 - 1.80
1.80 - 1.85
1.85 - 1.90
1.90 - 1.95
1.95 - 2.00
2.00 - 2.05
2.05 - 2.10
2.10 - 2.15
2.15 - 2.20
2.20 - 2.25
2.25 - 2.30
2.3 - 2.3
> 2.3

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3
0 100 200 300 m
N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A1.1
Event: 5% AEP
Results: Flood Levels

Legend

Peak Flood Levels (m AHD)

- <= 1.7
- 1.70 - 1.75
- 1.75 - 1.80
- 1.80 - 1.85
- 1.85 - 1.90
- 1.90 - 1.95
- 1.95 - 2.00
- 2.00 - 2.05
- 2.05 - 2.10
- 2.10 - 2.15
- 2.15 - 2.20
- 2.20 - 2.25
- 2.25 - 2.30
- 2.3 - 2.3
- > 2.3

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP

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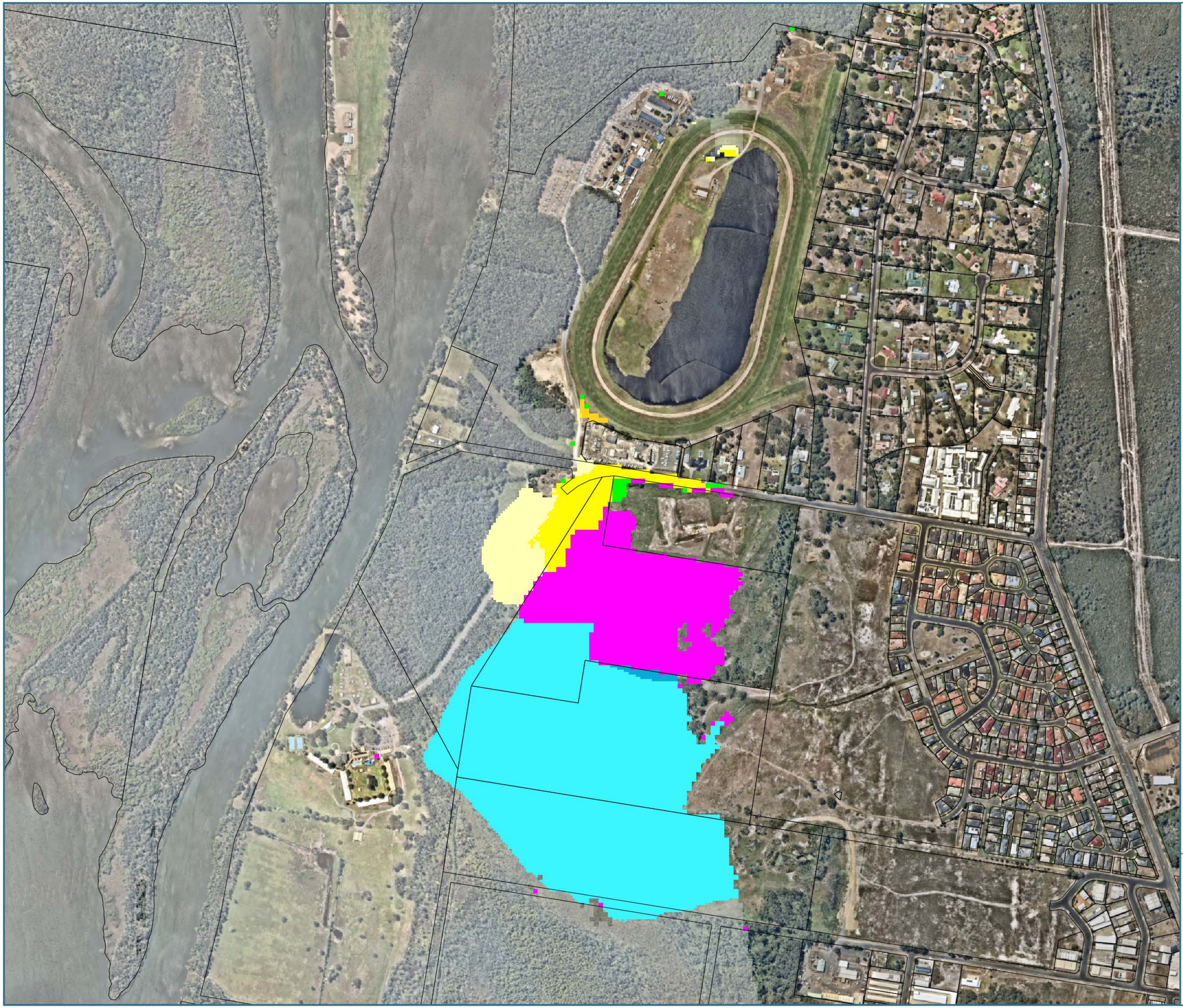

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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A1.2
Event: 5% AEP
Results: Flood Level Impacts

Legend

Change to Peak Flood Level

- >25 cm lower
- 10 - 25 cm lower
- 3 - 10 cm lower
- 1 - 3 cm lower
- <1cm difference
- 1 - 3 cm higher
- 3 - 5 cm higher
- 5 - 10 cm higher
- 10 - 20 cm higher
- 20 - 30 cm higher
- 30 - 40 cm higher
- >40 cm higher

Change to Flood Extent

- Was Wet, Now Dry
- Was Dry, Now Wet

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

ALLAM PROPERTY GROUP

0 100 200 300 m
N

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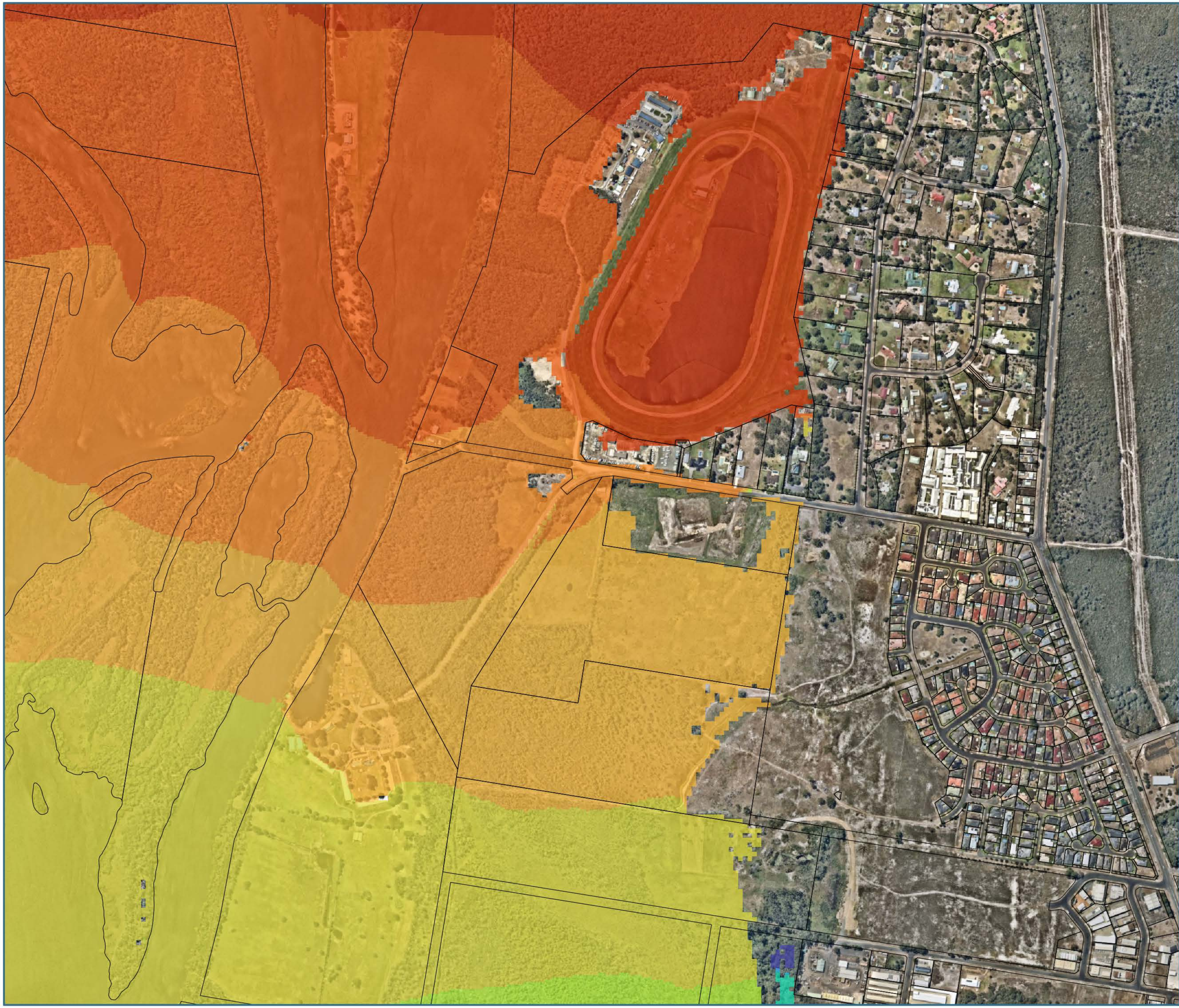

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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Approved Design Surface Stage 1 Conditions
Figure A2.0
Event: 1% AEP
Results: Flood Levels

Legend

Peak Flood Levels (m AHD)

<= 1.7
1.70 - 1.75
1.75 - 1.80
1.80 - 1.85
1.85 - 1.90
1.90 - 1.95
1.95 - 2.00
2.00 - 2.05
2.05 - 2.10
2.10 - 2.15
2.15 - 2.20
2.20 - 2.25
2.25 - 2.30
2.3 - 2.3
> 2.3

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

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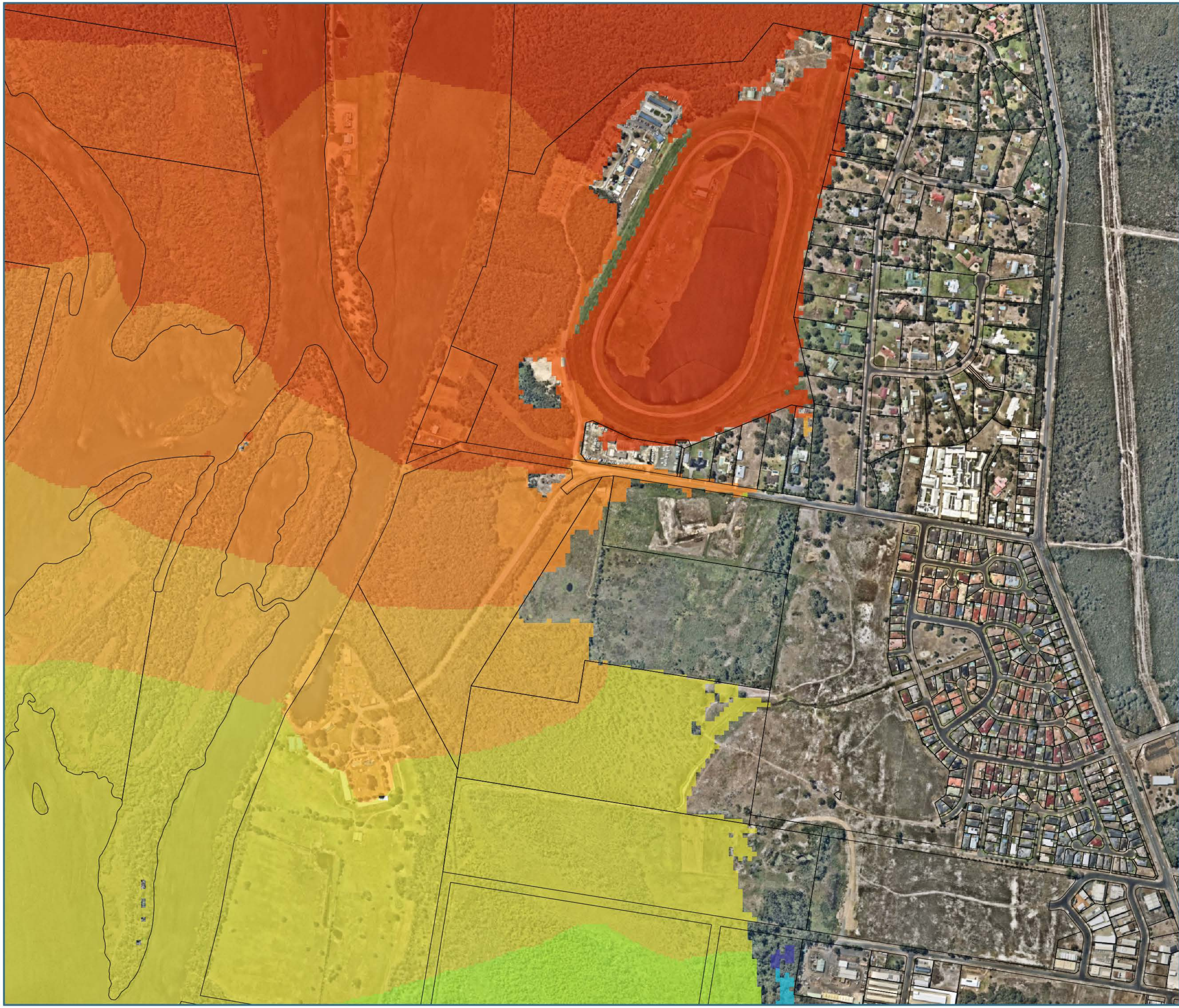

Royal HaskoningDHV
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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A2.1
Event: 1% AEP
Results: Flood Levels

Legend

Peak Flood Levels (m AHD)

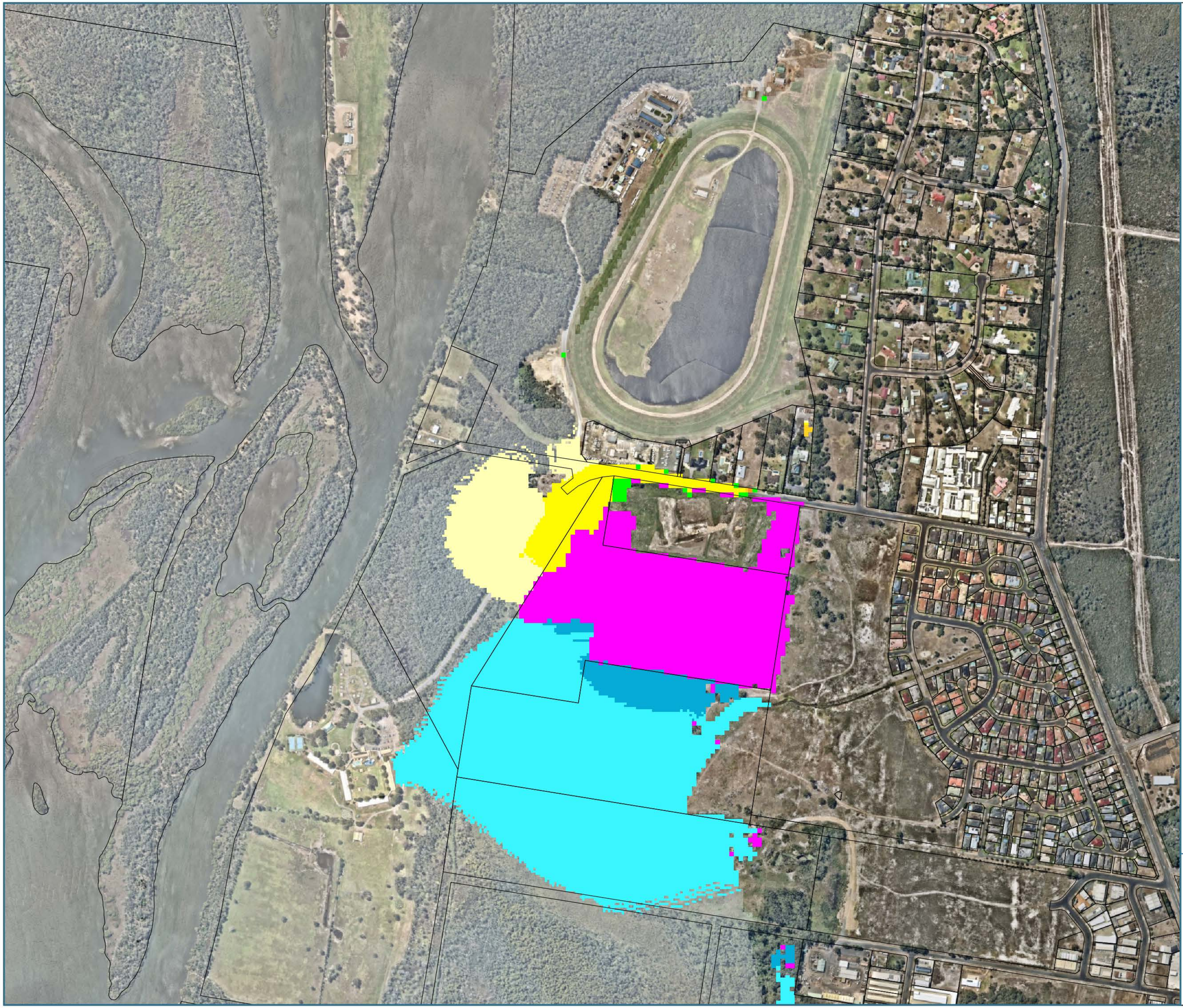
- <= 1.7
- 1.70 - 1.75
- 1.75 - 1.80
- 1.80 - 1.85
- 1.85 - 1.90
- 1.90 - 1.95
- 1.95 - 2.00
- 2.00 - 2.05
- 2.05 - 2.10
- 2.10 - 2.15
- 2.15 - 2.20
- 2.20 - 2.25
- 2.25 - 2.30
- 2.3 - 2.3
- > 2.3

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A2.2
Event: 1% AEP
Results: Flood Level Impacts

Legend

Change to Peak Flood Level

- >25 cm lower
- 10 - 25 cm lower
- 3 - 10 cm lower
- 1 - 3 cm lower
- <1cm difference
- 1 - 3 cm higher
- 3 - 5 cm higher
- 5 - 10 cm higher
- 10 - 20 cm higher
- 20 - 30 cm higher
- 30 - 40 cm higher
- >40 cm higher

Change to Flood Extent

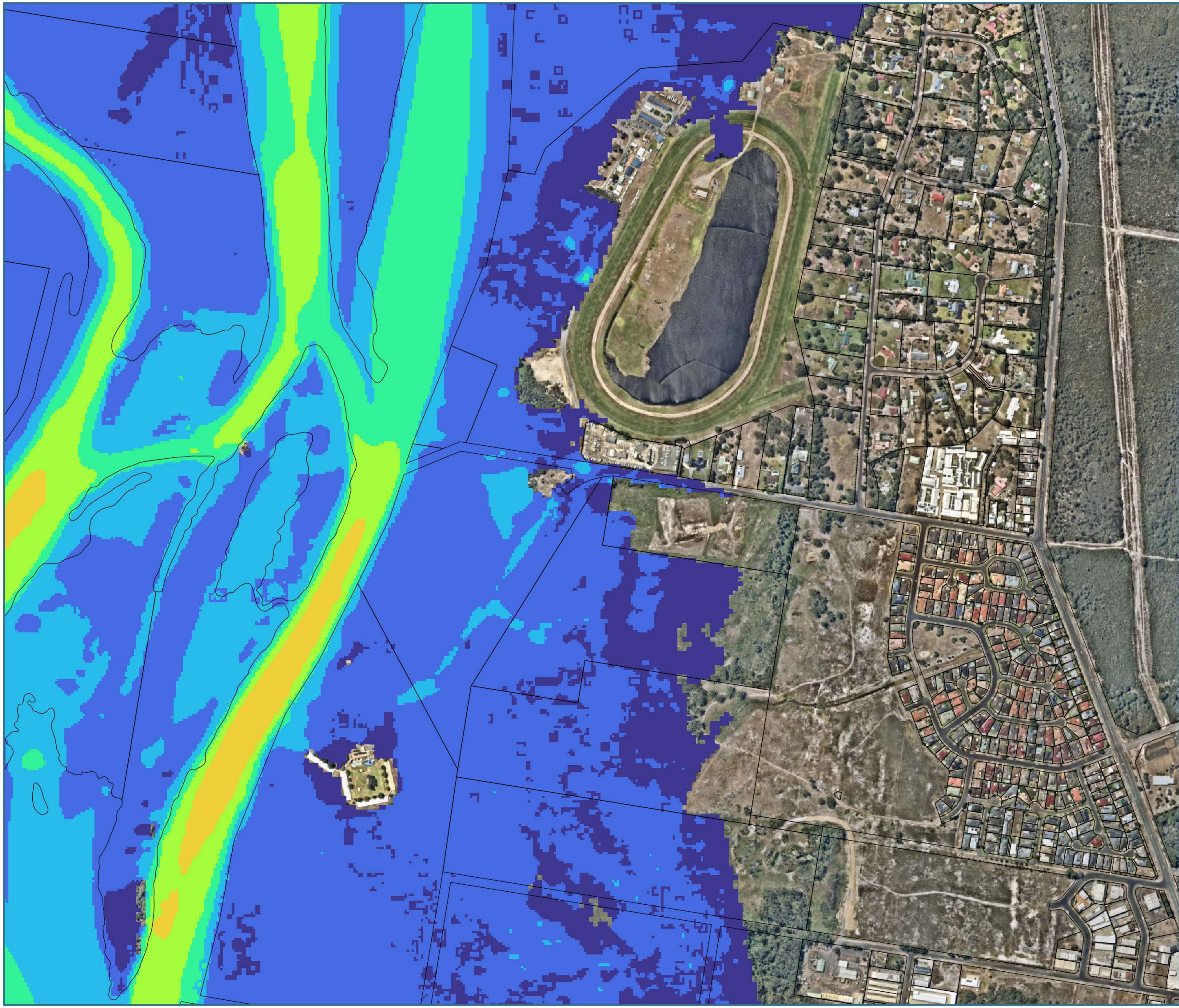
- Was Wet, Now Dry
- Was Dry, Now Wet

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Approved Design Surface Stage 1 Conditions
Figure A4.0
Event: 5% AEP
Results: Peak Flow Velocities

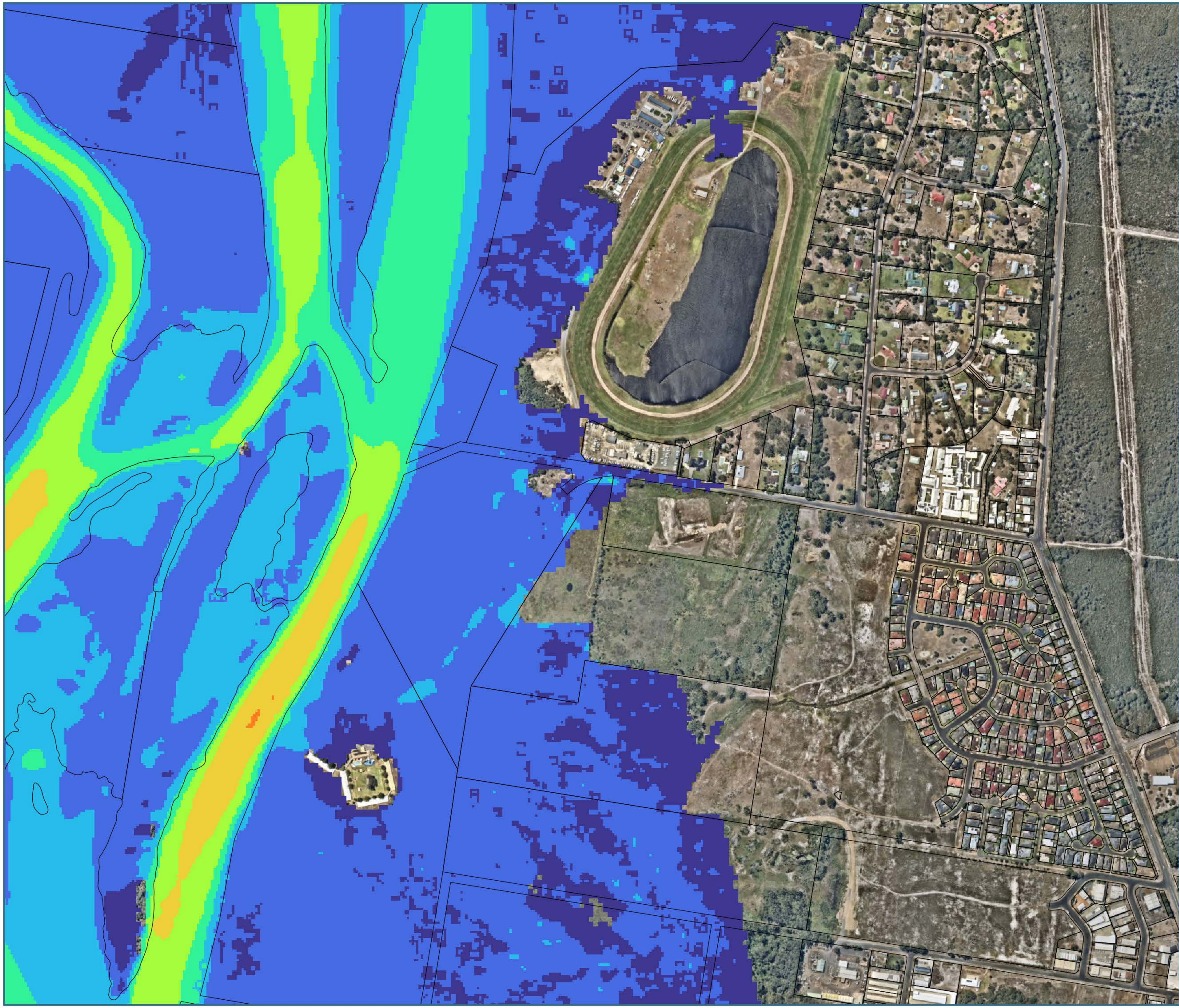
Legend

Peak Flow Velocity

- <= 0.10 m/s
- 0.10 - 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 0.75 m/s
- 0.75 - 1.00 m/s
- 1.00 - 1.25 m/s
- 1.25 - 1.50 m/s
- 1.50 - 1.75 m/s
- > 1.75 m/s

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3
0 100 200 300 m
N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A4.1
Event: 5% AEP
Results: Peak Flow Velocities

Legend

Peak Flow Velocity

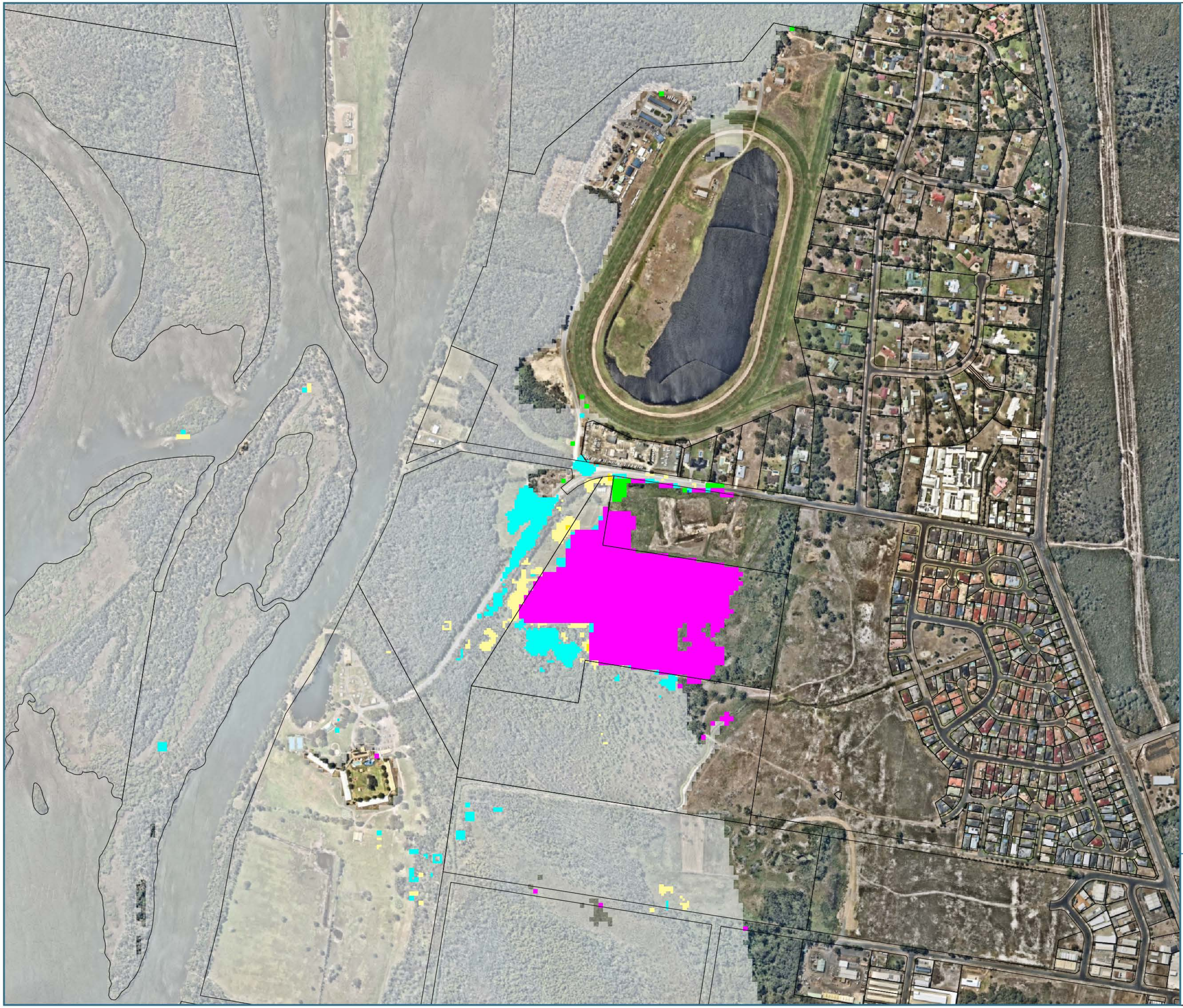
- <= 0.10 m/s
- 0.10 - 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 0.75 m/s
- 0.75 - 1.00 m/s
- 1.00 - 1.25 m/s
- 1.25 - 1.50 m/s
- 1.50 - 1.75 m/s
- > 1.75 m/s

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A4.2
Event: 5% AEP
Results: Peak Flow Velocity Impacts

Legend

Change to Peak Flow Velocities

- >0.5m/s lower
- 0.2-0.5 m/s lower
- 0.05-0.2 m/s lower
- < 0.05 m/s change
- 0.05-0.2 m/s higher
- 0.2-0.5 m/s higher
- >0.5m/s higher

Change to Flood Extent

- Was Wet, Now Dry
- Was Dry, Now Wet

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

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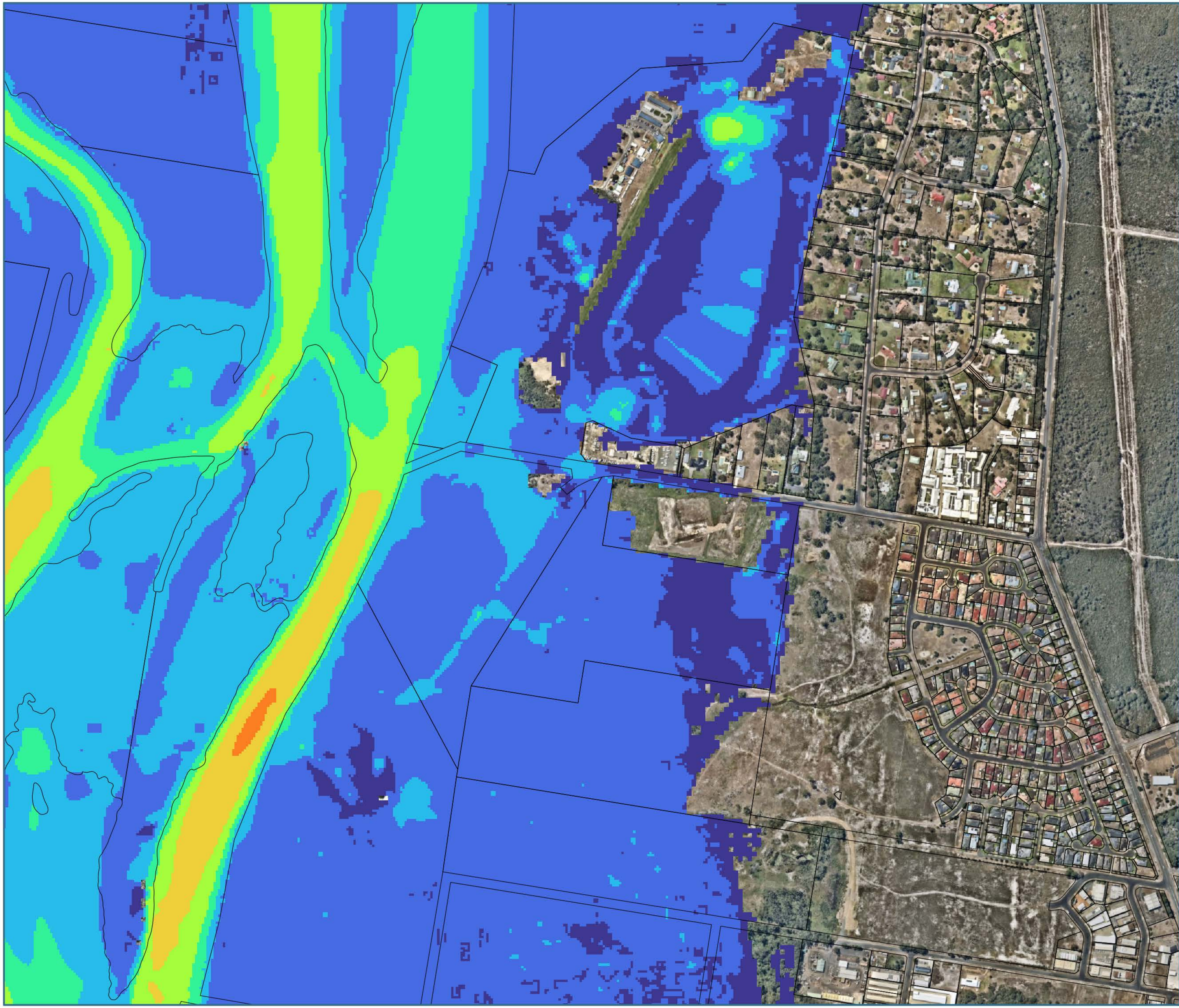

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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Approved Design Surface Stage 1 Conditions
Figure A5.0
Event: 1% AEP
Results: Peak Flow Velocities

Legend

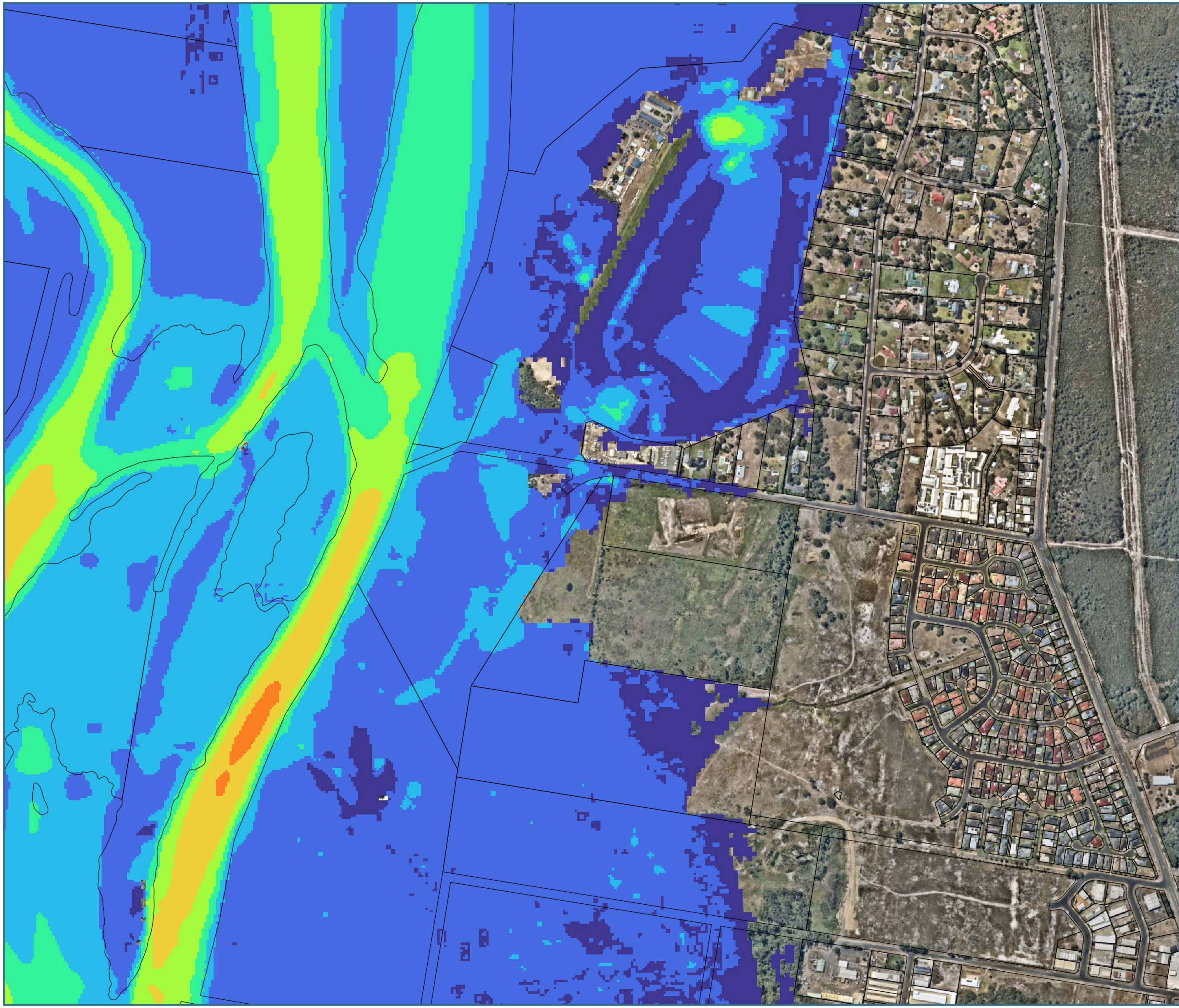
Peak Flow Velocity

- <= 0.10 m/s
- 0.10 - 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 0.75 m/s
- 0.75 - 1.00 m/s
- 1.00 - 1.25 m/s
- 1.25 - 1.50 m/s
- 1.50 - 1.75 m/s
- > 1.75 m/s

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N



40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A5.1
Event: 1% AEP
Results: Peak Flow Velocities

Legend

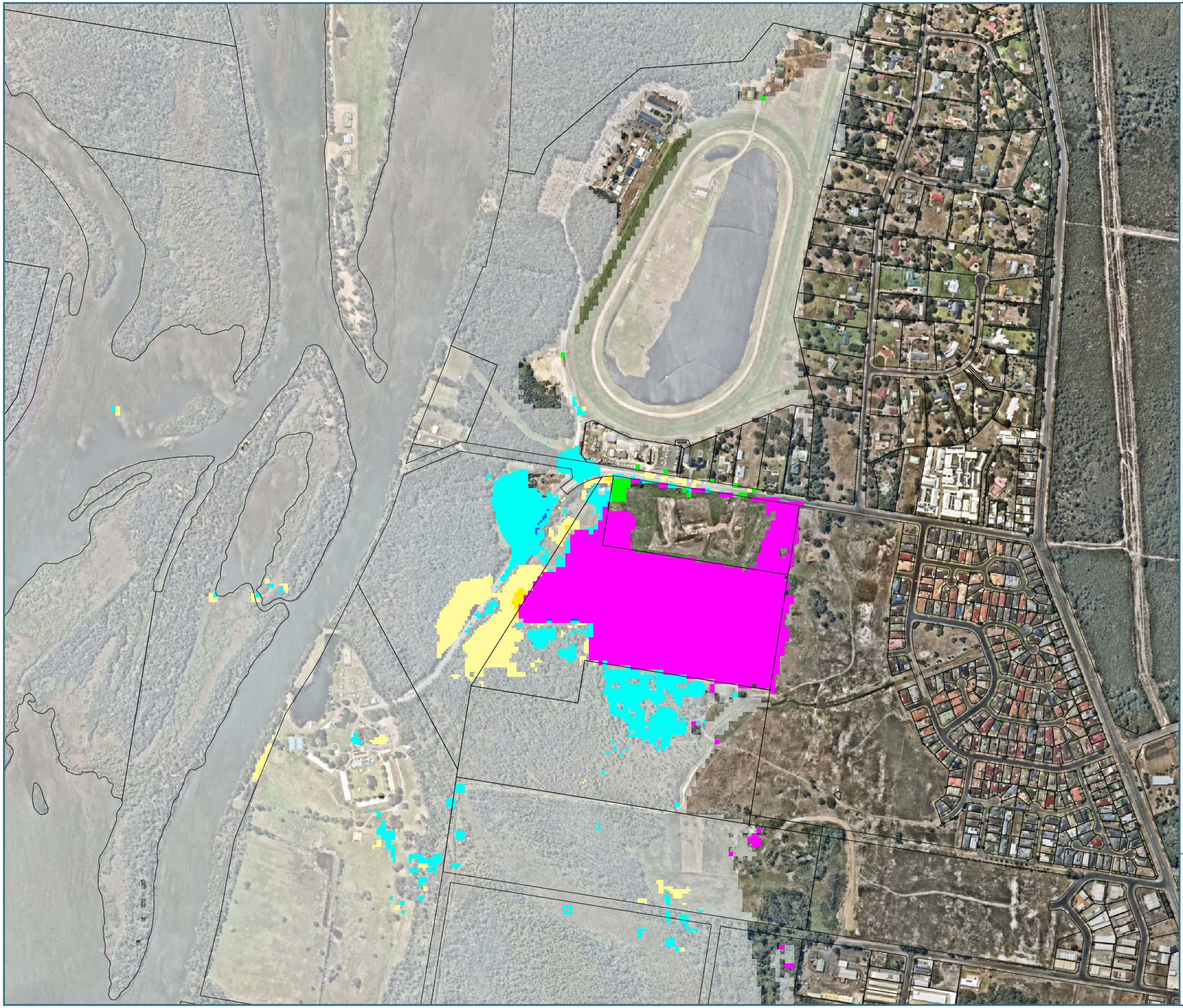
Peak Flow Velocity

- <= 0.10 m/s
- 0.10 - 0.25 m/s
- 0.25 - 0.50 m/s
- 0.50 - 0.75 m/s
- 0.75 - 1.00 m/s
- 1.00 - 1.25 m/s
- 1.25 - 1.50 m/s
- 1.50 - 1.75 m/s
- > 1.75 m/s

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A5.2
Event: 1% AEP
Results: Peak Flow Velocity Impacts

Legend

Change to Peak Flow Velocities

- >0.5m/s lower
- 0.2-0.5 m/s lower
- 0.05-0.2 m/s lower
- < 0.05 m/s change
- 0.05-0.2 m/s higher
- 0.2-0.5 m/s higher
- >0.5m/s higher

Change to Flood Extent

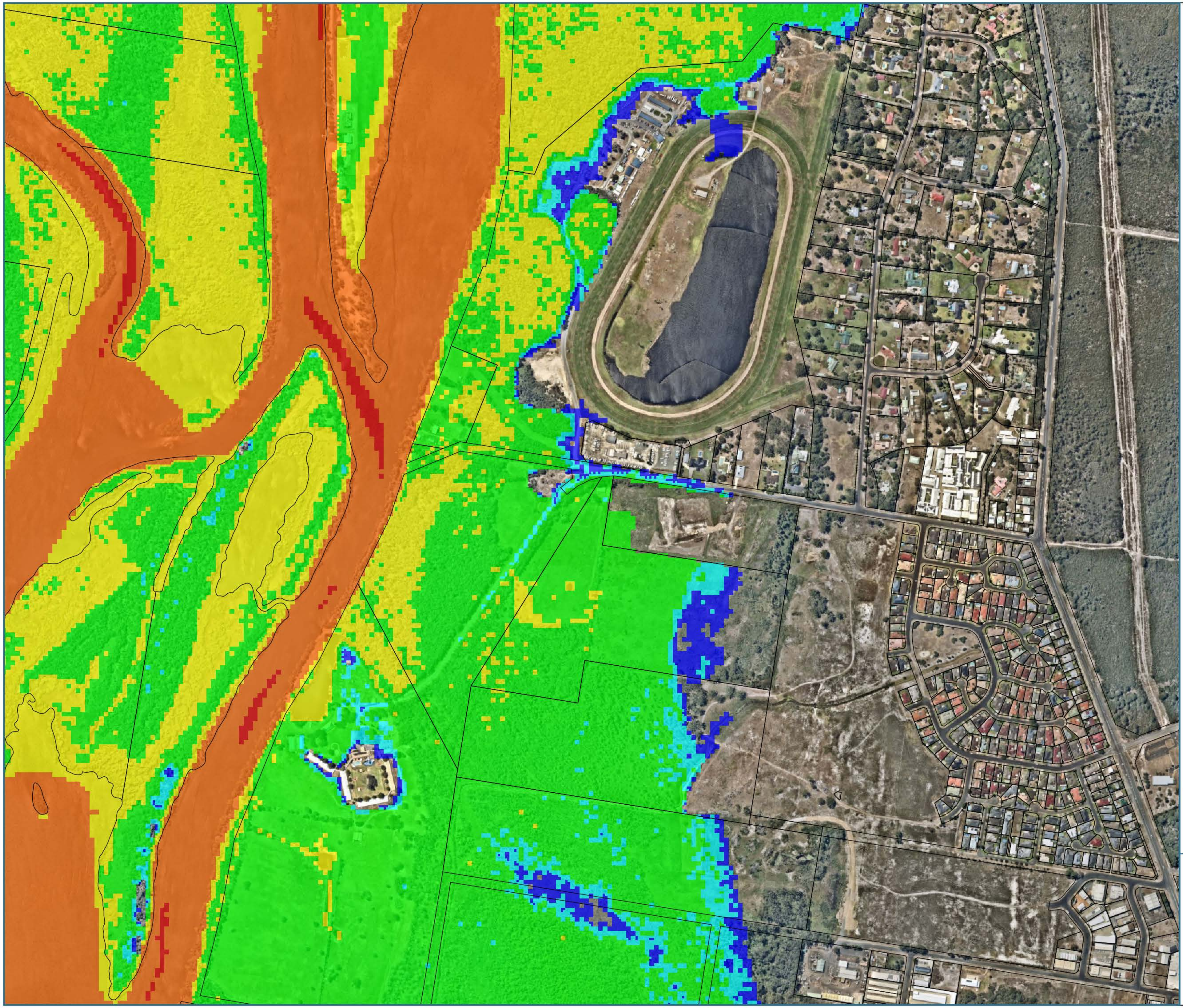
- Was Wet, Now Dry
- Was Dry, Now Wet

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Approved Design Surface Stage 1 Conditions
Figure A7.0
Event: 5% AEP
Results: Flood Hazard

Legend

Flood Hazard

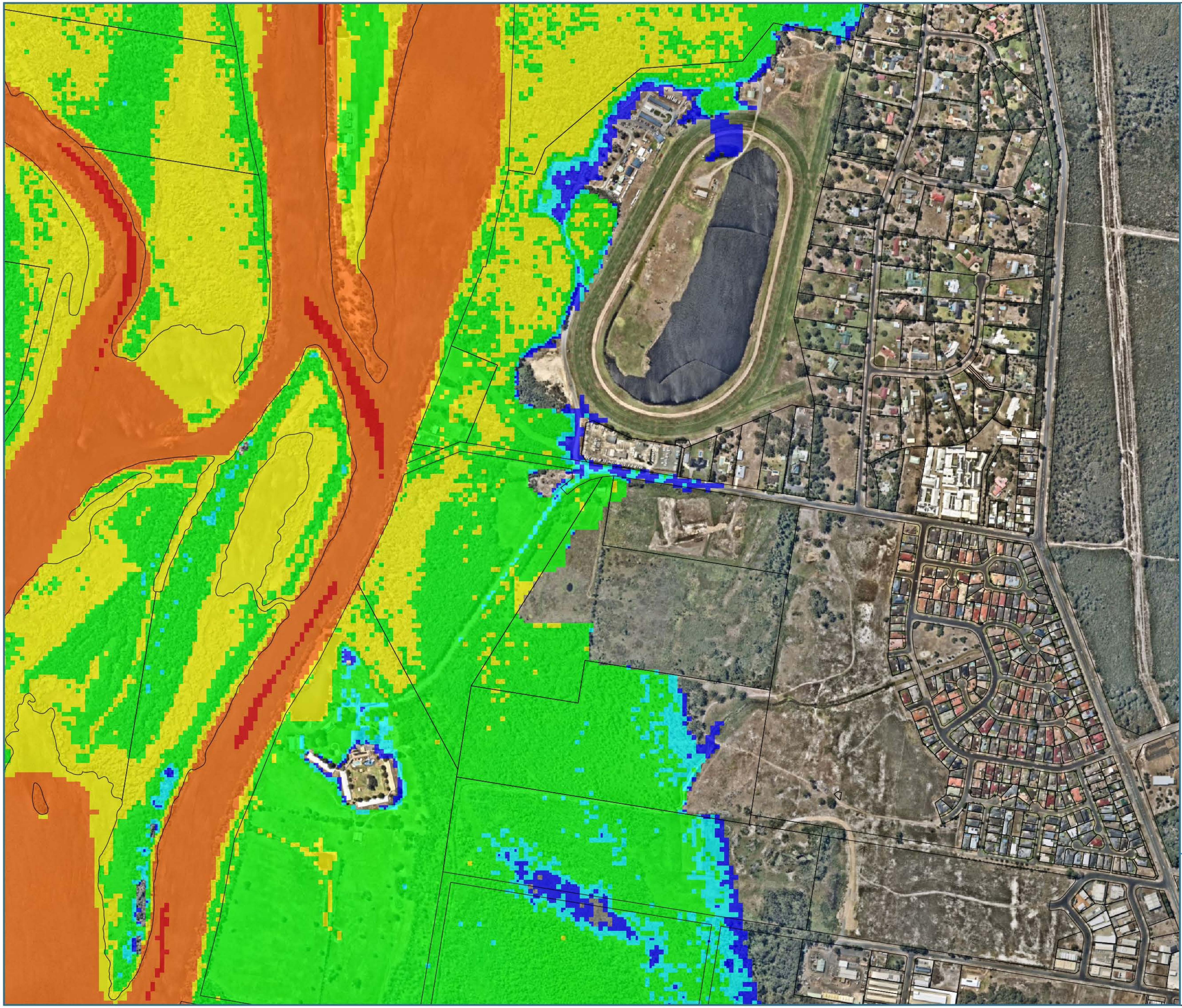
- H1 - No Vulnerability Constraints
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children and the elderly
- H4 - Unsafe for all people and all vehicles
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design & construction
- H6 - Unconditionally Dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A7.1
Event: 5% AEP
Results: Flood Hazard

Legend

Flood Hazard

- H1 - No Vulnerability Constraints
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children and the elderly
- H4 - Unsafe for all people and all vehicles
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design & construction
- H6 - Unconditionally Dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

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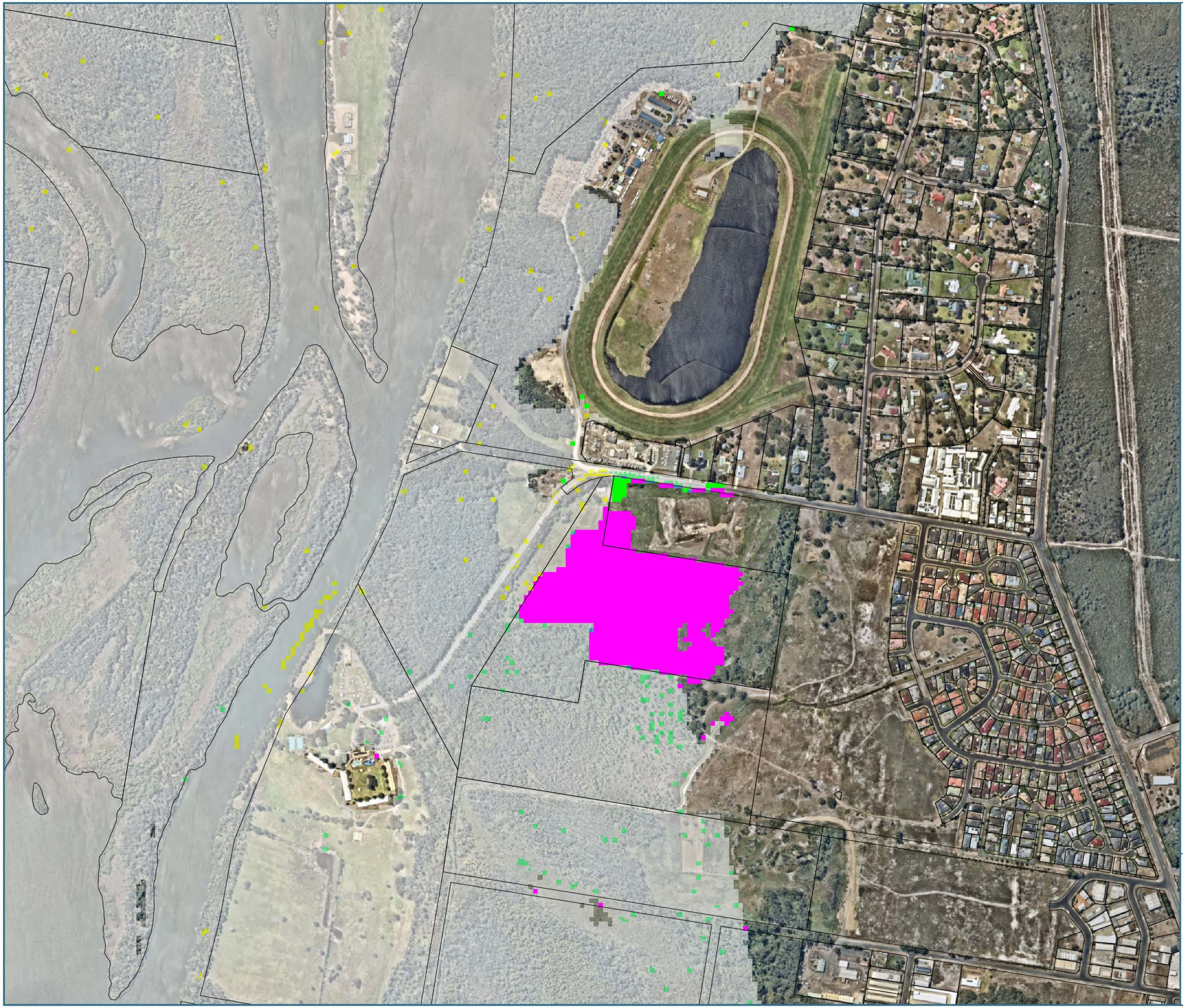

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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A7.2
Event: 5% AEP
Results: Flood Hazard Impacts

Legend

Change to Flood Hazard

- -3 Change In Hazard Category
- -2 Change In Hazard Category
- -1 Change In Hazard Category
- 0 Change In Hazard Category
- +1 Change In Hazard Category
- +2 Change In Hazard Category
- +3 Change In Hazard Category

Change to Flood Extent

- Was Wet, Now Dry
- Was Dry, Now Wet

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

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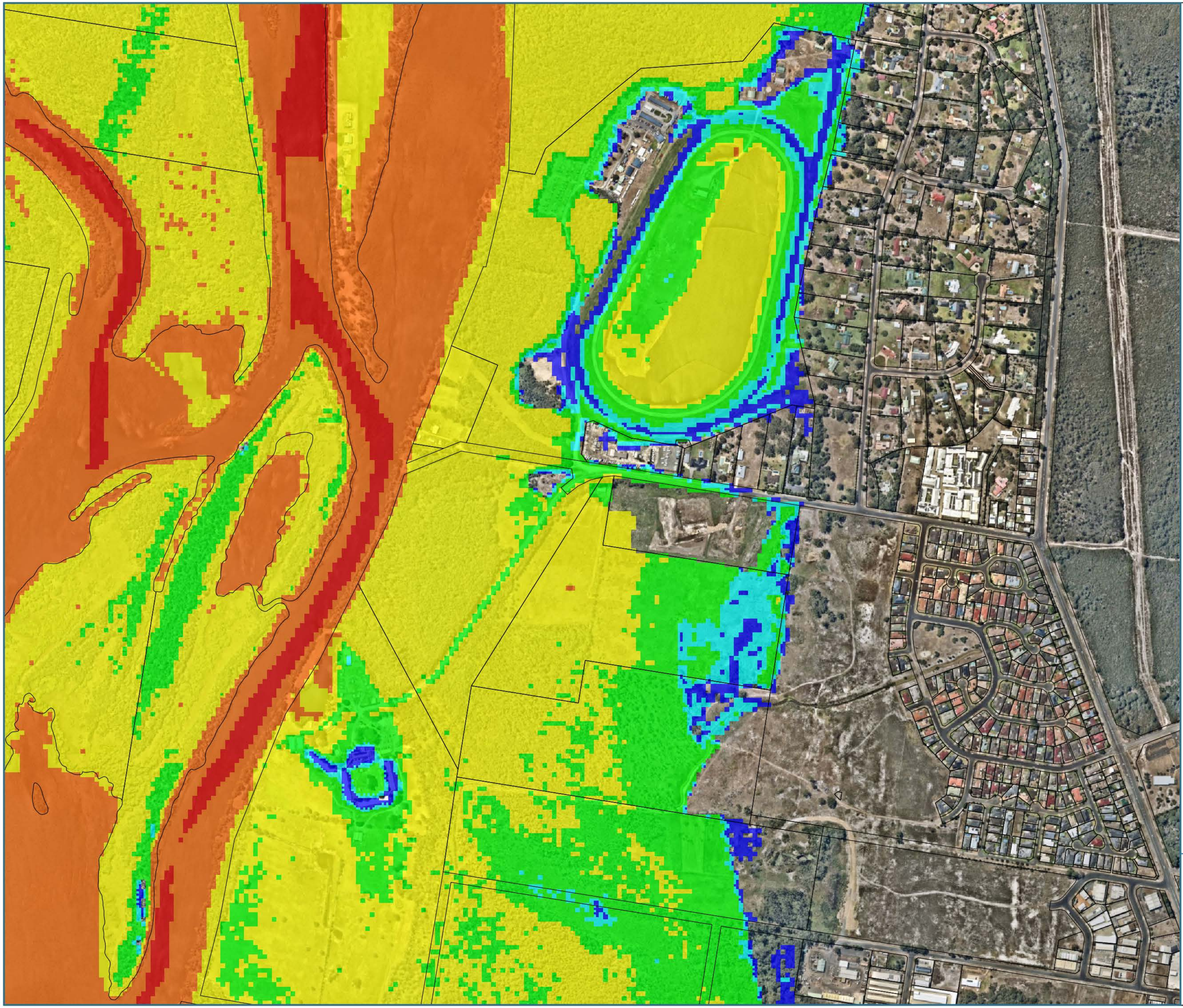

Royal HaskoningDHV
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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Approved Design Surface Stage 1 Conditions
Figure A8.0
Event: 1% AEP
Results: Flood Hazard

Legend

Flood Hazard

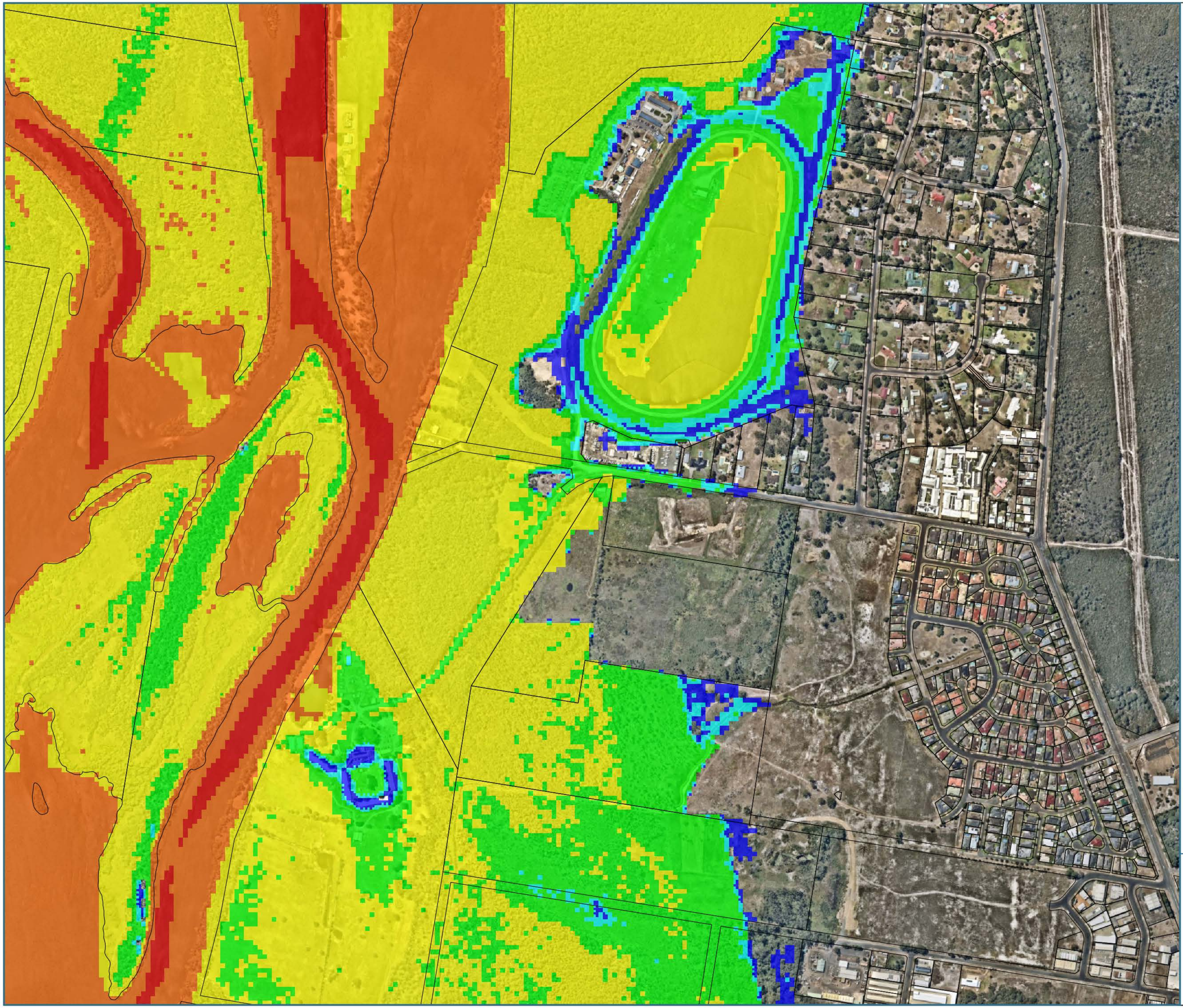
- H1 - No Vulnerability Constraints
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children and the elderly
- H4 - Unsafe for all people and all vehicles
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design & construction
- H6 - Unconditionally Dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP



Royal HaskoningDHV
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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A8.1
Event: 1% AEP
Results: Flood Hazard

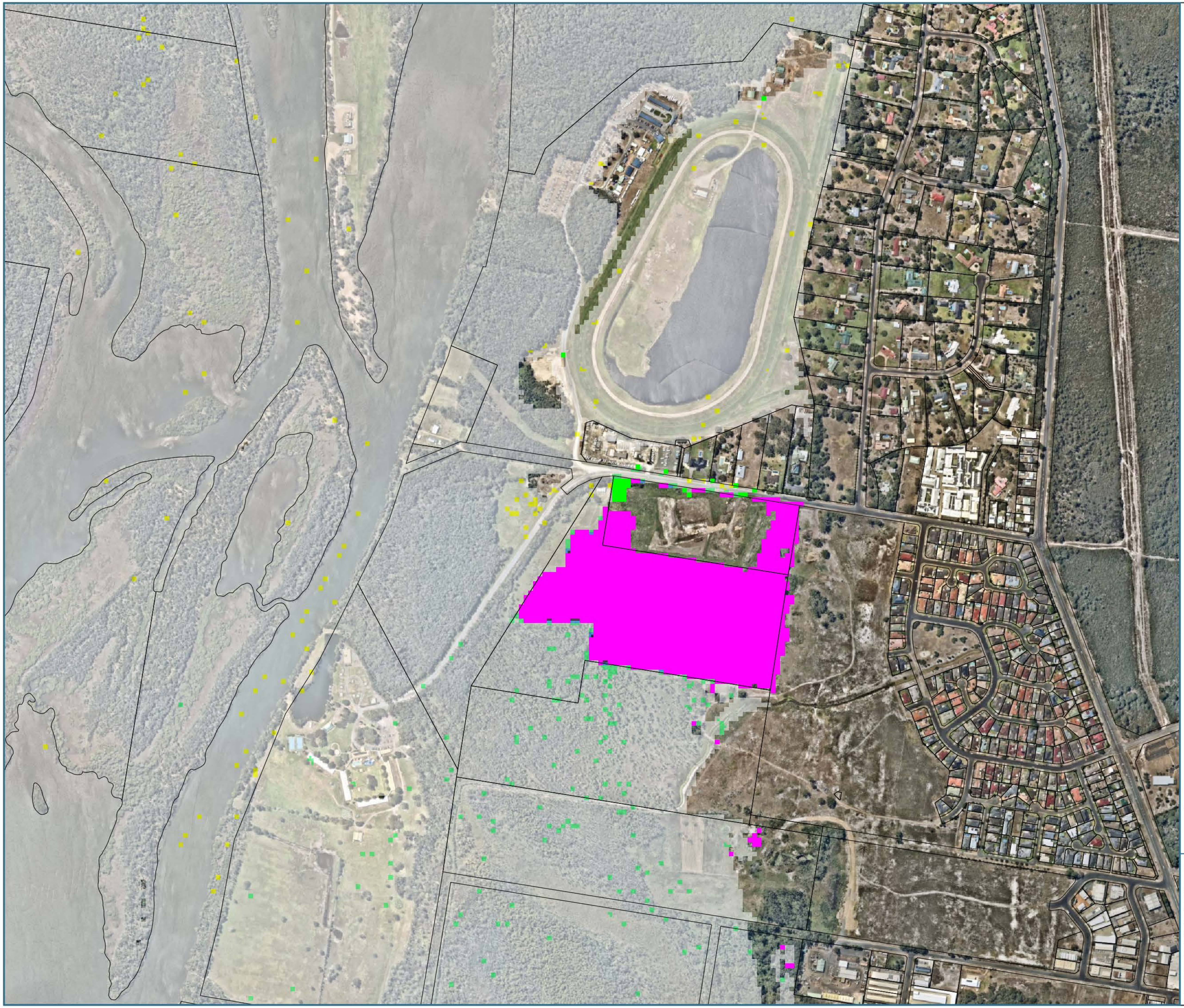
Legend

Flood Hazard

- H1 - No Vulnerability Constraints
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children and the elderly
- H4 - Unsafe for all people and all vehicles
- H5 - Unsafe for all people and all vehicles. Buildings require special engineering design & construction
- H6 - Unconditionally Dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3
0 100 200 300 m
N

ALLAM PROPERTY GROUP



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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A8.2
Event: 1% AEP
Results: Flood Hazard Impacts

Legend

Change to Flood Hazard

- -3 Change In Hazard Category
- -2 Change In Hazard Category
- -1 Change In Hazard Category
- 0 Change In Hazard Category
- +1 Change In Hazard Category
- +2 Change In Hazard Category
- +3 Change In Hazard Category

Change to Flood Extent

- Was Wet, Now Dry
- Was Dry, Now Wet

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM

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40 - 80 & 82 Chapmans Road, Tuncurry Flood Impact Assessment and Hydrological Investigation

Proposed Design Conditions

Figure A9.0
Event: PMF 24 hr Storm
Results: Flood Levels

Legend

Peak Flood Levels (m AHD)

<= 4.55
4.55 - 4.60
4.60 - 4.65
4.65 - 4.70
4.70 - 4.75
4.75 - 4.80
4.80 - 4.85
4.85 - 4.90
4.90 - 4.95
> 4.95

1:7,500
PA3653 / 2024-10-29
GDA94 / MGA zone 56
Scale at A3

0 100 200 300 m

N

ALLAM PROPERTY GROUP

Appendix

Appendix B – Groundwater Monitoring

Douglas PARTNERS | GROUNDED EXPERTISE

Allam Property Group
PO Box 7385
Baulkham Hills, NSW 2153

Project 219536.00
22 November 2024
R.009.Rev0
JCL:kd

Attention: Stephanie Vanderent

Email: stephanie.vanderent@allam.com.au

Results of Data Logger Download – November 2024
Proposed Manufactured Housing Estate
40-80 & 82 Chapmans Road, Tuncurry NSW

This letter presents the August 2024 results of groundwater monitoring at 40 – 80 & 82 Chapmans Road Tuncurry, NSW. It is understood the project is currently split into two stages i.e. 40-80 Chapmans Road ('Stage 1') and 82 Chapmans Road ('Stage 2').

The current monitoring round included installation of a new groundwater monitoring well in the north eastern area of Stage 1, and routine download of dataloggers at Stage 1 and Stage 2.

Details regarding the location of the groundwater wells (MW1 to MW4 and 101 to 104), together with their construction and associated subsurface conditions are presented in previous reports:

- Douglas Partners Pty Ltd (Douglas) Report on Groundwater Study, Proposed Manufactured Housing Estate, 40-80 Chapmans Road, Tuncurry (Douglas, 2024); and
- Douglas Report on Preliminary Groundwater Investigation, Proposed Manufactured Home Estate, 82 Chapmans Road, Tuncurry (Douglas, 2023).

The location of existing monitoring wells is shown in Drawing 1, attached.

Groundwater monitoring

Dataloggers were installed in the wells for ongoing monitoring for assessment and comment on short-term and long-term trends in groundwater levels such of groundwater fluctuations.

The current round of monitoring was undertaken on 5 November 2024 and comprised manual gauging of the groundwater monitoring wells and datalogger download. It should be noted that groundwater levels are affected by factors such as climatic conditions and soil permeability and therefore vary with time.

The following summary is provided for data collection over the monitoring period.

Table 1: Summary of groundwater monitoring – 14 August 2024 to 5 November 2024

Logger ID	Brand	Owned by	Capture	Data Quality	Comment
MW1	Aquaread	Client	100%	Good	Loan logger, removed November 2024.
MW3	Aquaread	Client	100%	Good	-
MW4	Aquaread	Client	100%	Good	-
101	Aquaread	Client	100%	Good	-
102	Aquaread	Client	100%	Good	-
103	Aquaread	Client	100%	Good	-
104	Aquaread	Client	100%	Good	-
105	Aquaread	Client	100%	Good	-

For rainfall up to 5 February 2024 the data is plotted against composited rainfall data from five Bureau of Meteorology (BOM) weather stations at (Wootton, Bungwahl, Old Bar, Forster and Taree Airport). On 6 February 2024 a site rainfall gauge was installed by ADW Johnson and therefore from 6 February 2024 onwards the data is plotted against site rainfall gauge.

The results of the current monitoring event (August 2024) suggest that loggers MW3, MW4 and 101 to 105 are currently collecting data that is generally consistent with manual monitoring records, previous data values and typically expected trends.

A loan logger was installed in MW1 during this monitoring period only. Comparison of the groundwater level recorded at MW1 to groundwater level recorded at 105 indicates groundwater level at 105 is similar to groundwater level at MW1 (i.e. 105 is a suitable long term replacement for MW1).

Continued quarterly monitoring is recommended to supplement the existing data. Quarterly cleaning / maintenance program is also recommended based on advice provided by the logger suppliers to maximise the life of the logger and integrity of the data collection. Annotations regarding periods of probable erroneous data and data loss periods are provided on the corresponding graphs.

This letter should be read in conjunction with the previous reports by Douglas including *Report on Groundwater Study* (Douglas, 2024) and *Report on Preliminary Groundwater Investigation* (Douglas, 2023) which presents the relevant background information for Stage 1 and Stage 2 respectively.

References

Douglas. (2023). *Report on Preliminary Groundwater Investigation, Proposed Manufactured Home Estate, 82 Chapmans Road, Tuncurry* . Douglas Partners Pty Ltd: Document No. 219536.01.R.001.Rev0.

Douglas. (2024). *Report on Groundwater Study, Proposed Manufactured Housing Estate, 40-80 Chapmans Road, Tuncurry.* Document No. 219536.00.R.002.Rev3: Douglas Partners Pty Ltd.

Limitations

Douglas Partners Pty Ltd (Douglas) has prepared this report for this project at 40-80 & 82 Chapmans Road, Tuncurry in line with Douglas' proposal 219536.00.P.003.Rev0 (09/04/2024), 219536.00.P.004.Rev1 (31/07/2024) and 219536.01.P.002.Rev0 (09/04/2024) acceptance received from Allam MHE Developments No 2 Pty Ltd dated 09/05/2024, 02/08/2024 and 09/05/2024 respectively. The work was carried out under Douglas' Engagement Terms. This report is provided for the exclusive use of Allam MHE Developments No 2 Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after Douglas' field testing has been completed.

Douglas' advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by Douglas in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the groundwater components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. Douglas cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by Douglas. This is because this report has been written as advice and opinion rather than instructions for construction.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully

Douglas Partners Pty Ltd

Reviewed by

Jason Lambert
Geotechnical Engineer

Scott McFarlane
Principal

Attachments: About This Report
Terminology, symbols and abbreviations
Soil descriptions
Sampling, testing and excavation methodology
Groundwater Level vs Rainfall (Figure 1 and 2)
Drawing 1 – Test Location Plan (219536.00.R.008.D.001)

About this Report

Introduction

These notes have been provided to amplify Douglas' report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

Douglas' reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, Douglas will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, Douglas cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, Douglas will be pleased to assist with investigations or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, Douglas requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. Douglas would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Terminology, Symbols and Abbreviations

Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

Abbreviation Codes

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style `XW`. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

Data Integrity Codes

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

Term	Description	Abbreviation Code
Core loss	No core recovery	KL
Unknown	Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned.	UK
No data	Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others	ND
Not Applicable	Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement	NA

Graphic Symbols

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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Introduction

All materials which are not considered to be “in-situ rock” are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:

classification | name | detailed description

(SC) Clayey SAND, trace silt; grey, fine to medium grained

The “classification” comprises a two character “group symbol” providing a general summary of dominant soil characteristics. The “name” summarises the particle sizes within the soil which most influence its behaviour. The detailed description presents more information about composition, condition, structure, and origin of the soil.

Classification, naming and description of soils require the relative proportion of particles of different sizes within the whole soil mixture to be considered.

Particle size designation and Behaviour Model

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either “fine grained” (also known as “cohesive” behaviour) or “coarse grained” (“non cohesive” behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

Particle Size Designation	Particle Size (mm)	Behaviour Model	
		Behaviour	Approximate Dry Mass
Boulder	>200	Excluded from particle behaviour model as “oversize”	
Cobble	63 - 200		
Gravel[1]	2.36 - 63	Coarse	>65%
Sand[1]	0.075 - 2.36		
Silt	0.002 - 0.075	Fine	>35%
Clay	<0.002		

[1] – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer “component proportions” below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a “Sandy CLAY”, this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

Component proportions

The relative proportion of the dry mass of each particle size fraction is assessed to be a “primary”, “secondary”, or “minor” component of the soil mixture, depending on its influence over the soil behaviour.

Component Proportion Designation	Definition[1]	Relative Proportion	
		In Fine Grained Soil	In Coarse Grained Soil
Primary	The component (particle size designation, refer above) which dominates the engineering behaviour of the soil	The clay/silt component with the greater proportion	The sand/gravel component with the greater proportion
Secondary	Any component which is not the primary, but is significant to the engineering properties of the soil	Any component with greater than 30% proportion	Any granular component with greater than 30%; or Any fine component with greater than 12%
Minor[2]	Present in the soil, but not significant to its engineering properties	All other components	All other components

[1] As defined in AS1726-2017 6.1.4.4

[2] In the detailed material description, minor components are split into two further sub-categories. Refer “identification of minor components” below.

Composite Materials

In certain situations, a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example, “INTERBEDDED Silty CLAY AND SAND”.

Soil Descriptions

Classification

The soil classification comprises a two character group symbol. The first character identifies the primary component. The second character identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

Soil Name

For most soils, the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way, the soil name also describes the general composition and indicates the dominant behaviour of the material.

Component [1]	Prominence in Soil Name
Primary	Noun (eg "CLAY")
Secondary	Adjective modifier (eg "Sandy")
Minor	No influence

[1] – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

Materials of "fill" or "topsoil" origin are generally assigned a name derived from the primary/secondary component (where appropriate). In log descriptions this is preceded by uppercase "FILL" or "TOPSOIL". Origin uncertainty is indicated in the description by the characters (?), with the degree of uncertainty described (using the terms "probably" or "possibly" in the origin column, or at the end of the description).

Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

Minor Component Proportion Term	Relative Proportion	
	In Fine Grained Soil	In Coarse Grained Soil
With	All fractions: 15-30%	Clay/silt: 5-12% sand/gravel: 15-30%
Trace	All fractions: 0-15%	Clay/silt: 0-5% sand/gravel: 0-15%

The terms "with" and "trace" generally apply only to gravel or fine particle fractions. Where cobbles/boulders are encountered in minor proportions (generally less than about 12%) the term "occasional" may be used. This term describes the sporadic distribution of the material within the confines of the investigation excavation only, and there may be considerable variation in proportion over a wider area which is difficult to factually characterise due to the relative size of the particles and the investigation methods.

Soil Composition

Plasticity

Descriptive Term	Laboratory liquid limit range	
	Silt	Clay
Non-plastic materials	Not applicable	Not applicable
Low plasticity	≤50	≤35
Medium plasticity	Not applicable	>35 and ≤50
High plasticity	>50	>50

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

Type		Particle size (mm)
Gravel	Coarse	19 - 63
	Medium	6.7 - 19
	Fine	2.36 – 6.7
Sand	Coarse	0.6 - 2.36
	Medium	0.21 - 0.6
	Fine	0.075 - 0.21

Grading

Grading Term	Particle size (mm)
Well	A good representation of all particle sizes
Poorly	An excess or deficiency of particular sizes within the specified range
Uniformly	Essentially of one size
Gap	A deficiency of a particular size or size range within the total range

Note, AS1726-2017 provides terminology for additional attributes not listed here.

Soil Condition

Moisture

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

Applicability	Term	Tactile Assessment	Abbreviation code
Fine	Dry of plastic limit	Hard and friable or powdery	w<PL
	Near plastic limit	Can be moulded	w=PL
	Wet of plastic limit	Water residue remains on hands when handling	w>PL
	Near liquid limit	"oozes" when agitated	w=LL
	Wet of liquid limit	"oozes"	w>LL
Coarse	Dry	Non-cohesive and free running	D
	Moist	Feels cool, darkened in colour, particles may stick together	M
	Wet	Feels cool, darkened in colour, particles may stick together, free water forms when handling	W

The abbreviation code NDF, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

Consistency/Density/Compaction/Cementation/Extremely Weathered Material

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials, the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered material origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description.

Quantitative engineering performance of these materials may be determined by laboratory testing or estimated by correlated field tests (for example penetration or shear vane testing). In some cases, performance may be assessed by tactile or other subjective methods, in which case investigation logs will show the estimated value enclosed in round brackets, for example (VS).

Consistency (fine grained soils)

Consistency Term	Tactile Assessment	Undrained Shear Strength (kPa)	Abbreviation Code
Very soft	Extrudes between fingers when squeezed	<12	VS
Soft	Mouldable with light finger pressure	>12 - ≤25	S
Firm	Mouldable with strong finger pressure	>25 - ≤50	F
Stiff	Cannot be moulded by fingers	>50 - ≤100	St
Very stiff	Indented by thumbnail	>100 - ≤200	VSt
Hard	Indented by thumbnail with difficulty	>200	H
Friable	Easily crumbled or broken into small pieces by hand	-	Fr

Relative Density (coarse grained soils)

Relative Density Term	Density Index	Abbreviation Code
Very loose	<15	VL
Loose	>15 - ≤35	L
Medium dense	>35 - ≤65	MD
Dense	>65 - ≤85	D
Very dense	>85	VD

Note, tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

Soil Descriptions

Compaction (anthropogenically modified soil)

Compaction Term	Abbreviation Code
Well compacted	WC
Poorly compacted	PC
Moderately compacted	MC
Variably compacted	VC

Cementation (natural and anthropogenic)

Cementation Term	Abbreviation Code
Moderately cemented	MOD
Weakly cemented	WEK

Extremely Weathered Material

AS1726-2017 considers weathered material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. less than very low strength rock). These materials may be identified as "extremely weathered material" in reports and by the abbreviation code XWM on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

Soil Origin

Term	Description	Abbreviation Code
Residual	Derived from in-situ weathering of the underlying rock	RS
Extremely weathered material	Formed from in-situ weathering of geological formations. Has strength of less than 'very low' as per as1726 but retains the structure or fabric of the parent rock.	XWM
Alluvial	Deposited by streams and rivers	ALV
Fluvial	Deposited by channel fill and overbank (natural levee, crevasse splay or flood basin)	FLV
Estuarine	Deposited in coastal estuaries	EST
Marine	Deposited in a marine environment	MAR
Lacustrine	Deposited in freshwater lakes	LAC
Aeolian	Carried and deposited by wind	AEO
Colluvial	Soil and rock debris transported down slopes by gravity	COL
Slopewash	Thin layers of soil and rock debris gradually and slowly deposited by gravity and possibly water	SW
Topsoil	Mantle of surface soil, often with high levels of organic material	TOP
Fill	Any material which has been moved by man	FILL
Littoral	Deposited on the lake or seashore	LIT
Unidentifiable	Not able to be identified	UID

Cobbles and Boulders

The presence of particles considered to be "oversize" may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with "MIXTURE OF".

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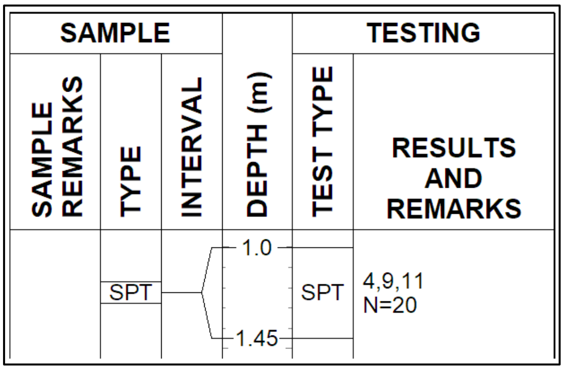
Sampling, Testing and Excavation Methodology

Terminology
Symbols
Abbreviations

October 2024

Sampling and Testing

A record of samples retained, and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:



Sampling

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

Sample Type	Code
Auger sample	A
Acid Sulfate sample	ASS
Bulk sample	B
Core sample	C
Disturbed sample	D
Environmental sample	ES
Driven Tube sample	DT
Gas sample	G
Piston sample	P
Sample from SPT test	SPT
Undisturbed tube sample	U[1]
Water sample	W
Material Sample	MT
Core sample for unconfined compressive strength testing	UCS

[1] – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

Field and Laboratory Testing

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

Test Type	Code
Pocket penetrometer (kPa)	PP
Photo ionisation detector (ppm)	PID
Standard Penetration Test x/y =*x* blows for *y* mm penetration HB = hammer bouncing HW = fell under weight of hammer	SPT
Shear vane (kPa)	V
Unconfined compressive strength, (MPa)	UCS

Field and laboratory testing (continued)

Test Type	Code
Point load test, (MPa), axial (A), diametric (D), irregular (I)	PLT(_)
Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2)	DCP9/150
Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3)	PSP/150

Groundwater Observations

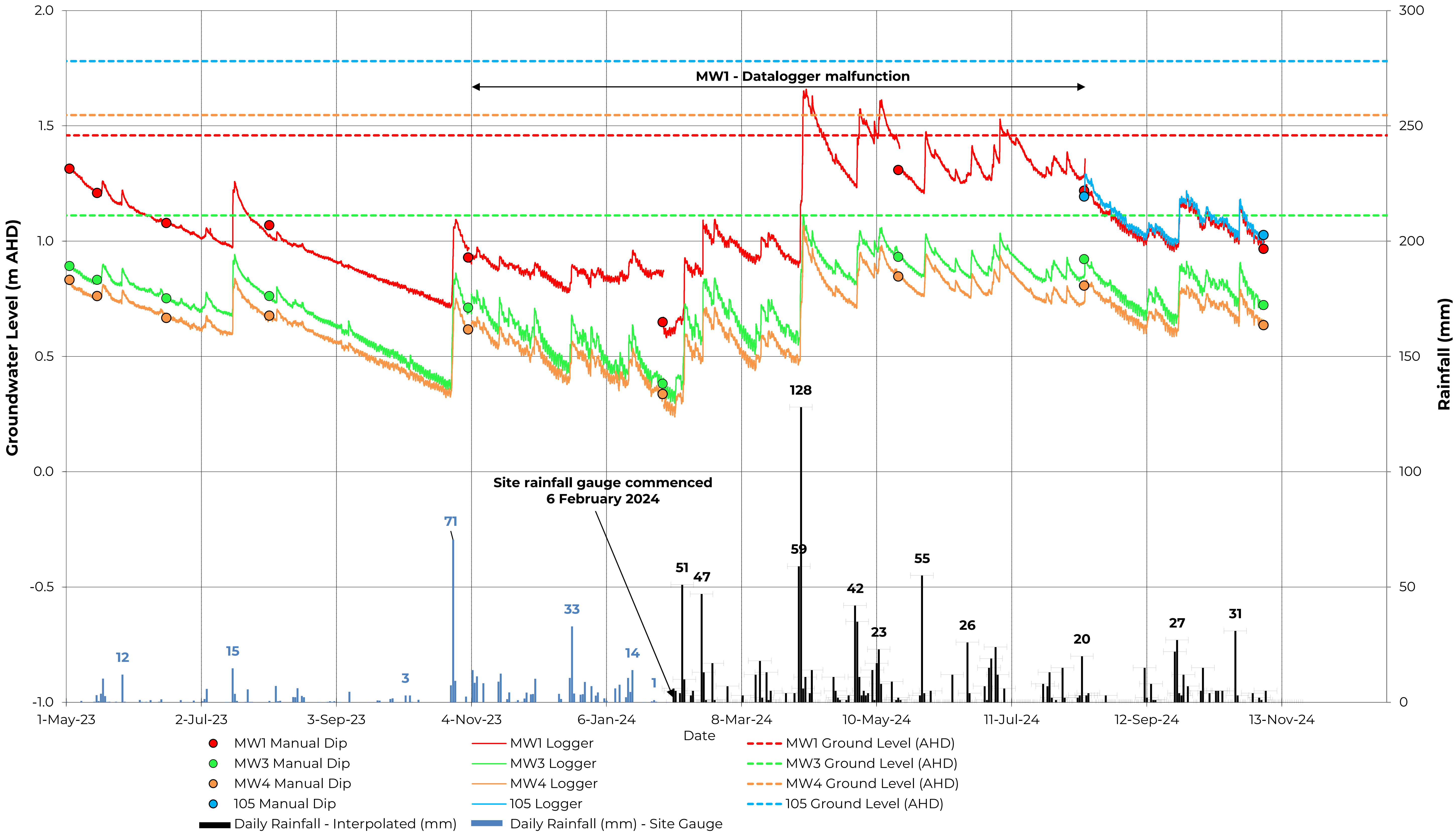
▷	seepage/inflow
▽	standing or observed water level
NFGWO	no free groundwater observed
OBS	observations obscured by drilling fluids

Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left-hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

Method	Abbreviation Code
Direct Push	DP
Solid flight auger. Suffixes: /T = tungsten carbide tip, /V = v-shaped tip	AD[1]
Air Track	AT
Diatube	DT[1]
Hand auger	HA[1]
Hand tools (unspecified)	HAND
Existing exposure	X
Hollow flight auger	HSA[1]
HQ coring	HQ3
HMLC series coring	HMLC
NMLC series coring	NMLC
NQ coring	NQ3
PQ coring	PQ3
Predrilled	PD
Push tube	PT[1]
Ripping tyne/ripper	R
Rock roller	RR[1]
Rock breaker/hydraulic hammer	EH
Sonic drilling	SON[1]
Mud/blade bucket	MB[1]
Toothed bucket	TB[1]
Vibrocore	VC[1]
Vacuum excavation	VE
Wash bore (unspecified bit type)	WB[1]

[1] – numeric suffixes indicate tool diameter/width in mm



Douglas PARTNERS | GROUNDED EXPERTISE

CLIENT: Allam MHE Developments No. 2 Pty Ltd

OFFICE: Newcastle | DRAWN BY: JCL

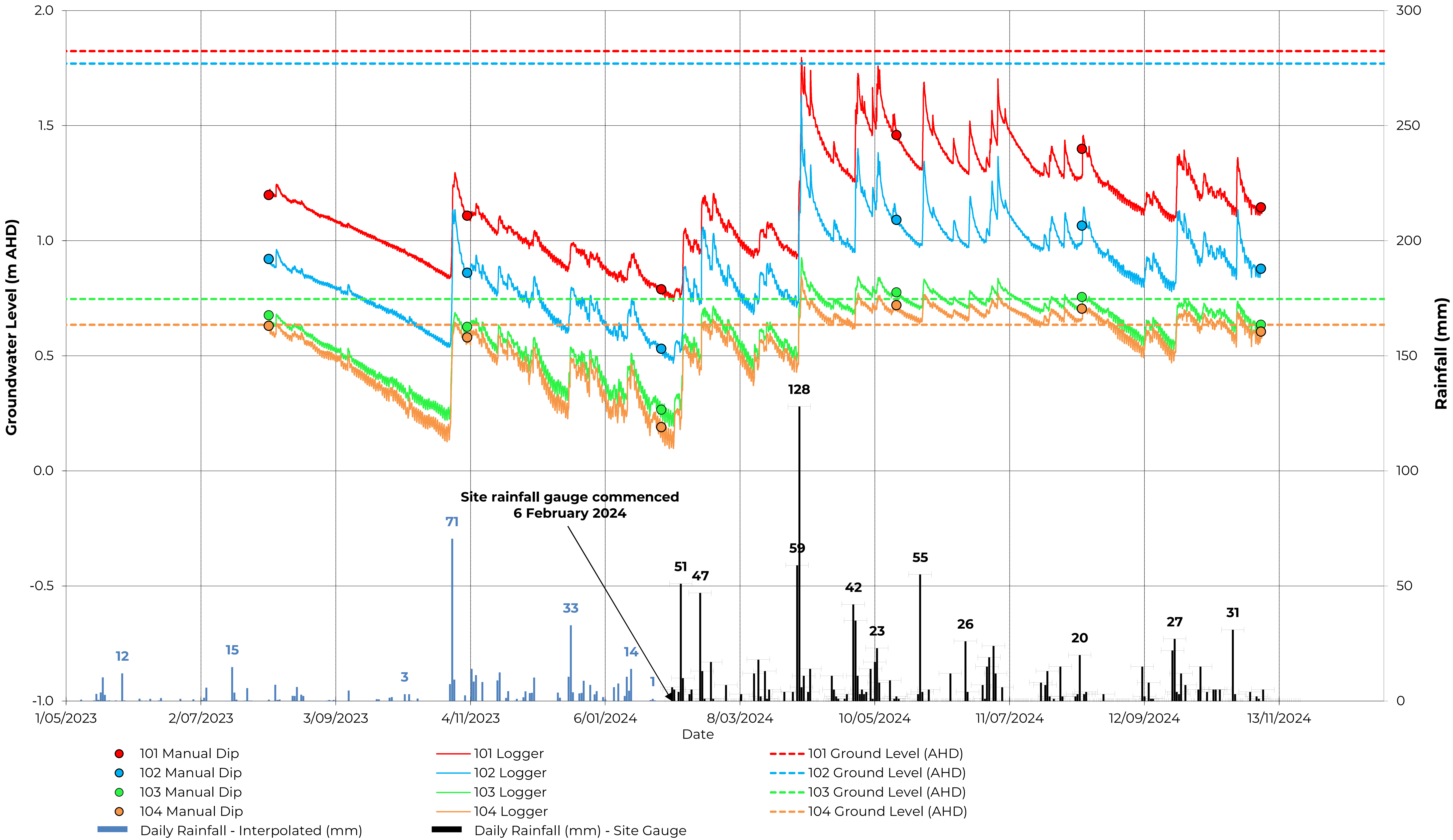
SCALE: N/A | DATE: 20 November 2024

Groundwater Level vs Rainfall (May 2023 to Nov 2024)
Proposed Manufactured Housing Estate
40 - 80 & 82 Chapmans Road, Tuncurry

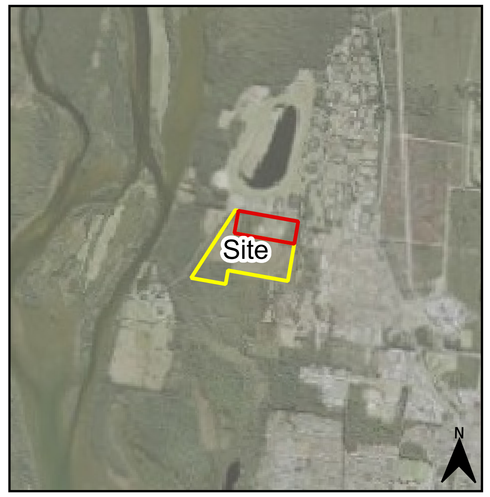
PROJECT NO: 219536.00

FIGURE NO: 1

REVISION: 0



Douglas PARTNERS GROUNDED EXPERTISE	CLIENT: Allam MHE Developments No. 2 Pty Ltd	**Groundwater Level vs Rainfall (Aug 2023 to Nov 2024)** **Proposed Manufactured Housing Estate** **40-80 & 82 Chapmans Road, Tuncurry**	PROJECT NO: 219536.00
	OFFICE: Newcastle / DRAWN BY: JCL		FIGURE NO: 2
	SCALE: N/A / DATE: 20 November 2024		REVISION: 0



Site Location

NOTE:
1. Drawing adapted from aerial imagery from Sixmaps dated approximately 2013.
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage.

Douglas PARTNERS

CLIENT: Allam MHE Developments No 2 Pty Ltd		TITLE: **Test Location Plan**
OFFICE: Newcastle	DRAWN BY: JCL	**Proposed Manufactured Housing Estate**
SCALE: 1:5000 @A3	DATE: 09.September.2024	**40-80 & 82 Chapmans Road, Tuncurry NSW**

Project:	219536.00
DRAWING No:	R.008.D.001
REVISION:	0

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