

19 August 2024

Joe Fittell
Team Leader
Department of Housing, Infrastructure and Planning

Re: HVO Continuation Project (SSD-11826681 and SSD-11826621) – response to Biodiversity and Conservation Division on flooding matters

Dear Joe,

I refer to the request for further information on the HVO Continuation Project (the Project), relating to advice received by the Department from Torrent Consulting, who undertook the peer review of the Flood Risk Assessment, and comments provided in a letter dated 25 June 2024 from the Biodiversity and Conservation Division (BCD) on the flooding assessment.

The purpose of the accompanying letter and associated figures (refer to Attachment A) is to provide a response to this request. Attachment A has been prepared by Engeny, who undertook the flood modelling and assessment for the Project.

If you require any further information, please don't hesitate to contact me or Jason Martin, Approvals Manager, HVO Continuation Project, at Jason.martin@glencore.com.au.

Yours sincerely



Nicole Armit
Director
narmit@emmconsulting.com.au

Attachment A

HVO Continuation Project – Response to Torrent
Consulting and BCD in relation to flooding

14 August 2024

EMM

Via email: nicole.armit@emm.com.au

Attention: Nicole Armit

Dear Nicole

RE: HVO CP Response to Flooding Peer Review and BCS

OVERVIEW

This letter is provided to support EMM and HV Operations Pty Ltd with the response to the NSW Government Department of Planning, Housing and Infrastructure (DPHI) letter with the subject "Request for Additional Information – Response to Flooding Peer Review and BCD" noting the receipt of flooding submissions from Torrent Consulting, who undertook the peer review of the flood assessment on behalf of the DPHI, and Biodiversity Conservation and Science (BCS) (formerly Biodiversity and Conservation Division (BCD)). The submissions from Torrent Consulting and BCS are summarised below followed by a more detailed response in later sections of this letter.

Flood Peer Review (Torrent Consulting)

Torrent Consulting provided a letter to the DPHI dated 12 July 2024 with the subject "Peer Review of Flood Risk Assessment for HVO Continuation Project". As described in that letter, the focus of the review was to assess the appropriateness of the developed models and design flood assessment, and general consistency with respect to industry best practice. The key findings of the review are extracted and summarised as follows.

The flood impact assessment and supporting modelling is found to generally be fit for purpose and suitable for assessment of the proposal on design flood conditions. The following represent the key limitations of the assessment undertaken, and recommendation for further consideration:

- The methodology employed for design inflow derivation potentially underestimates peak design flows at the upstream model boundary. This may provide for a lower peak flood condition in the upstream reach of the Hunter River between Liddell and the Glennies Creek confluence. The potential for higher design flows for a given flood magnitude may warrant consideration of potential impact on design flood immunity for proposed infrastructure. However, it is not expected that inflow refinement would change the overall findings of the impact assessment, being a relative condition. The potential variation in design flow may be considered by undertaking further sensitivity testing or reviewing change in flood condition with higher order events already established.*
- A number of the topographical modifications for the proposed works are defined by direct import of design DEMs of 1 and 2m grid resolution. The underlying TUFLOW model resolution of 8m may not provide for adequate representation of the design in the modelled topography. It is recommended these be reviewed to consider impacts on design flood behaviour and potential localised impacts. It is noted any refinement in this regard is not expected to fundamentally change the flood assessment, but confirm local conditions.*

Notwithstanding these limitations, the modelling, impact assessment and design are considered to appropriately consider and address flood risk for the proposed development in accordance within industry practice and requirements of the SEARS.

Biodiversity Conservation and Science

BCS provided a letter to DPHI dated 25 June 2024 with the subject "Response re: HVO North Open Cut Coal Continuation Project (SSD-11826681)". BCS comments are provided in Attachment A of the BCS letter, which are summarised as follows.

The proponent has not provided sufficient information such that private landholders can understand the scale and nature of the adverse impacts on their properties.

The flood assessment, prepared by Engeny Water Management 2022, identifies that 31 properties, not owned by JV partners, will have adverse flood affluxes in the range of 20-50mm. However, insufficient information has been provided for impacted landholders to know they are impacted or to understand the nature of the impacts.

Recommendation 1: Produce mapping at an appropriate scale and resolution such that each landholder can clearly understand the estimated increase in flood levels, velocities and hazard as well as time of inundation.

RESPONSE TO FLOOD PEER REVIEW SUBMISSION

As outlined above, the flood peer review found the modelling, impact assessment and design to have appropriately considered and addressed flood risk for the proposed development in accordance with industry practice and requirements of the SEARs. The flood peer review identified two items described as key limitations of the assessment undertaken, and recommendation for further consideration. Following further consideration, the following responses to these limitations have been provided.

Limitation 1 - Potentially underestimated flows

It is acknowledged that there is considerable uncertainty in design flood hydrology in general due to limitations in the accuracy and duration of the historical record as well as the accuracy of stage-discharge rating curve relationships and the influence of upstream development (e.g. construction of large water storage dams) over time. Further comparison of outcomes between the HVO Continuation Project (HVO CP) flood assessment and the latest Singleton Council flood study (BMT, 2021) has previously been undertaken, following submission of the HVO CP EIS (EMM 2022). Comparison of peak flows between the studies is provided in Table 1 and indicates the HVO CP flows are typically within 10-15% of the Singleton Council flood study flows, which is commonly considered to be a reasonable level of consistency for similar hydrology studies.

While design flow estimates are lower for the HVO CP study compared to the Singleton Council flood study, the resulting flood levels for the HVO CP study are higher throughout the model domain (refer Table 2, Figure 1 and Figure 2). On further investigation, it is evident that this is due to the lower floodplain roughness value adopted in the Singleton Council flood study. Further adjustment of HVO CP design flood hydrographs should not be undertaken without consideration of other model parameters (e.g. Manning's roughness) and any calibration and/or validation undertaken.

We conclude that design flood level outcomes of the HVO CP study are more conservative relative to the Singleton Council flood study and are suitable for informing design levels and infrastructure immunity for the HVO CP. Furthermore, as noted by the peer review, "it is not expected that inflow refinement would change the overall findings of the impact assessment, being a relative condition".

TABLE 1 COMPARISON OF PEAK FLOW ESTIMATES AT LIDDELL (HVO CP VS SINGLETON COUNCIL)

AEP	Singleton Council (modelled)	Singleton Council (FFA)	HVO CP
10% (1:10)	2,614	1,970	2,420
5% (1:20)	3,973	3,380	3,578
2% (1:50)	6,450	6,160	5,465
1% (1:100)	8,311	9,140	7,164
0.5% (1:200)	11,012	13,090	9,094
0.2% (1:500)	15,154	20,120	11,996
Extreme Event	25,070		28,656

TABLE 2 1% (1:100) AEP FLOOD LEVEL COMPARISON (HVO CP VS SINGLETON COUNCIL)

Location	Singleton Council (mAHD)	HVO CP (mAHD)	Level Difference (m)
A	75	75.4 to 75.5	0.4 to 0.5
B	70	70.2 to 70.3	0.2 to 0.3
C	65	65.1 to 65.2	0.1 to 0.2
D	60	60.5	0.5
E	55	55.9 to 56.0	0.9 to 1.0

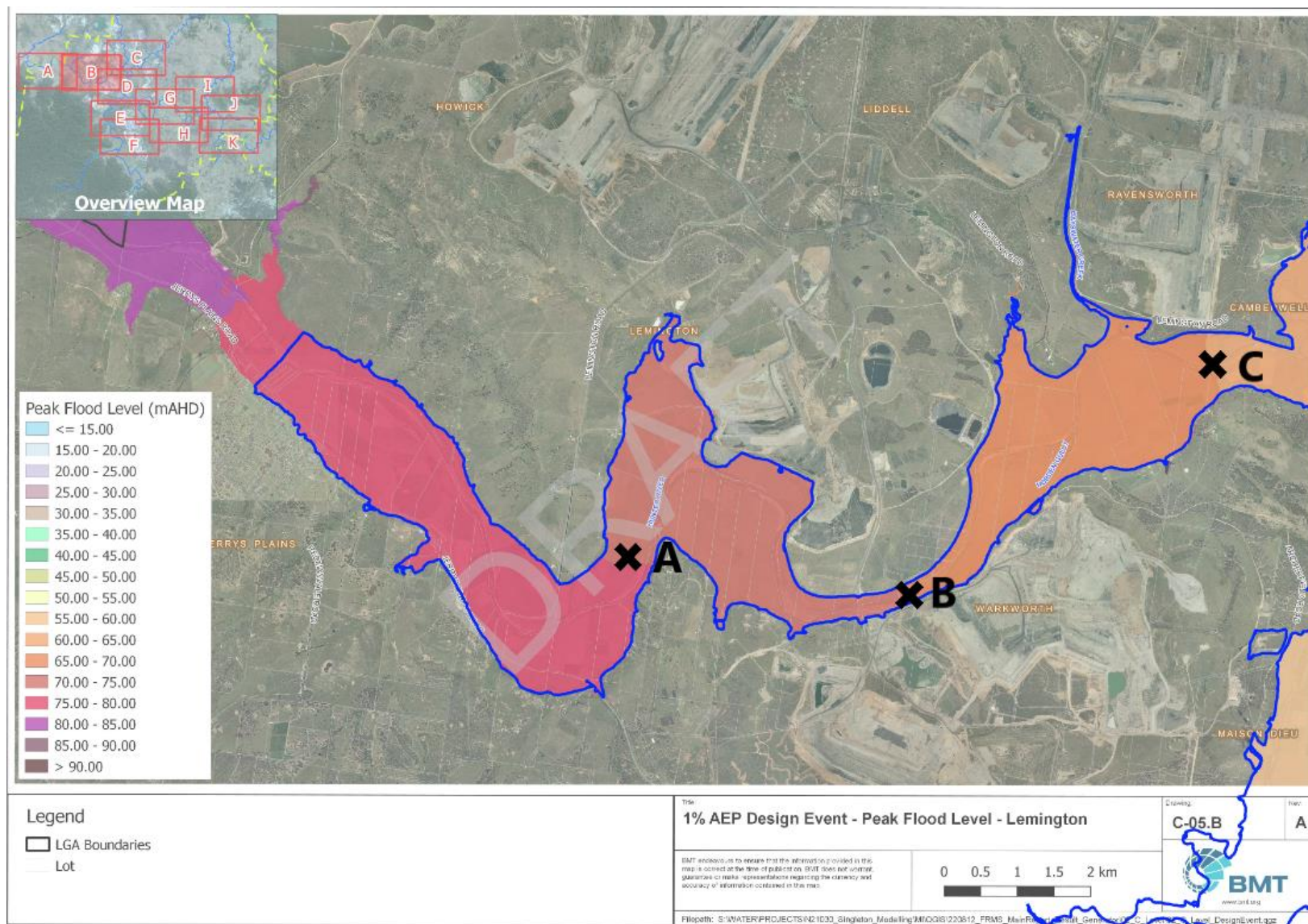


Figure 1: Comparison Points, HVO CP Flood Extent (Blue Outline) and Singleton Council Draft 1% (1:100) AEP Flood Map - Lemington

Author	Reviewer	Project Manager	Project Director
Sean Frazer	Andrew Vitale	Susan Shield	Sean Frazer

[BNTL00198_0001-LET-001-0-HVO CP Flood RFI Response](#)

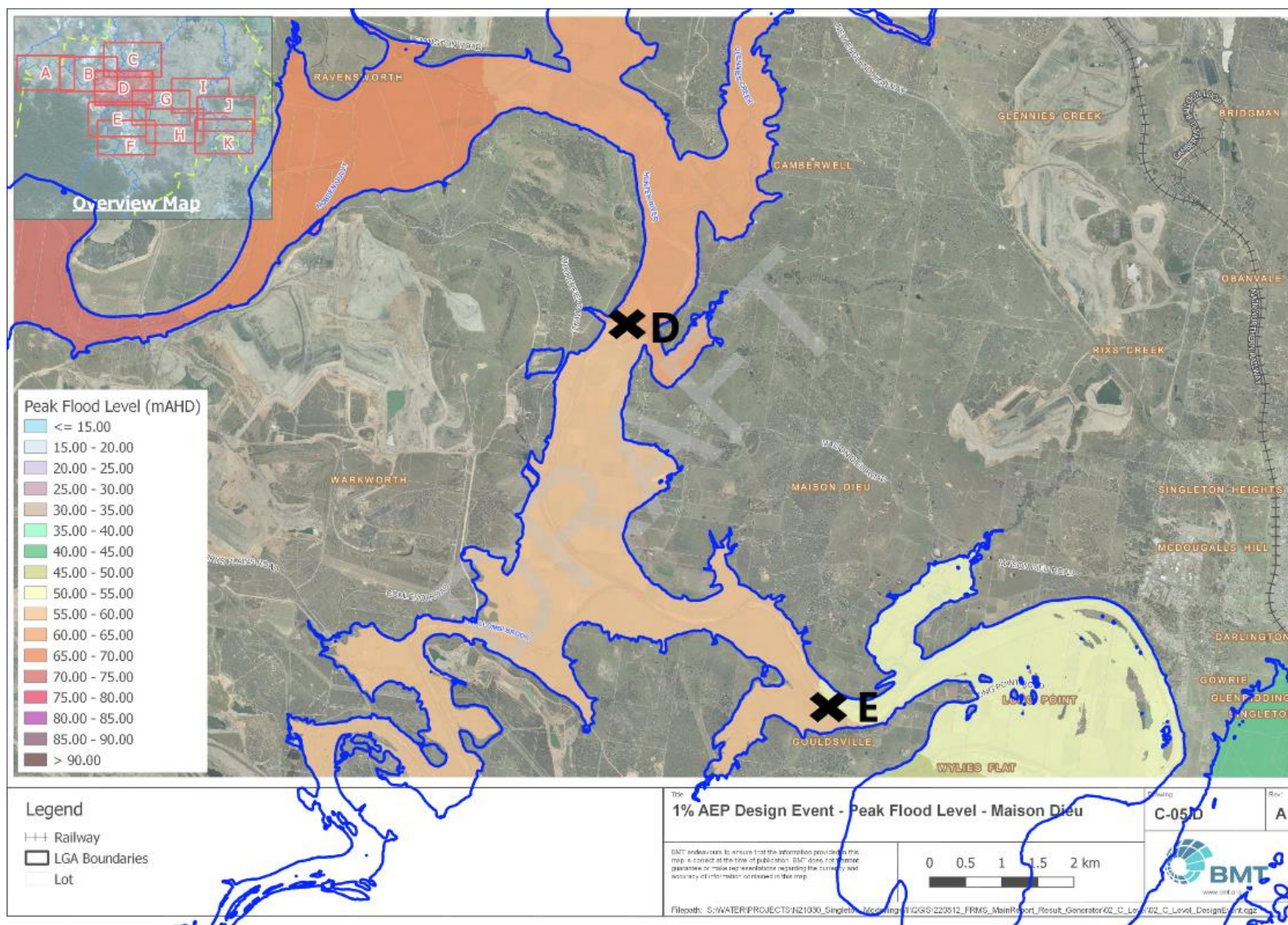


Figure 2: Comparison Points, HVO CP Flood Extent (Blue Outline) and Singleton Council Draft 1% (1:100) AEP Flood Map – Maison Dieu

Author	Reviewer	Project Manager	Project Director
Sean Frazer	Andrew Vitale	Susan Shield	Sean Frazer

BNTL00198_0001-LET-001-0-HVO CP Flood RFI Response

Limitation 2 - Topographic modifications

It is acknowledged that given the 8 m cell size of the TUFLOW model, direct import of design DEMs may have resulted in some underestimation of crest levels for certain HVO CP infrastructure (e.g. flood protection levees and the Lemington Road realignment). Further review has been undertaken to consider potential implications for the assessment.

General considerations

As noted by the peer review, "the adopted model grid resolution of 8 m may not explicitly define the contiguous crest levels of narrow linear features such as levees and road embankment where they are read into the model directly via a DEM surface (1 or 2 m resolution) and have not been reinforced by other 2d_zshape layers." This may result in the modelled terrain underestimating the design crest levels in places where the model cells do not fall directly on the crests of relevant infrastructure. By enforcing these elements, the crest of the modelled terrain would be increased. Consequently, enforcing levee and dam crests would improve modelled flood immunity for these Project elements and could only impact flood outcomes for events that are currently shown to overtop these topographic features.

Table 6-2 of the Surface Water Impact Assessment (SWIA, Engeny 2022) prepared for the Project summarises flood immunity for mine infrastructure and shows that the only modelled events with flood overtopping of Project levees or dams is the Extreme Event, which is shown to overtop the North Void Tailings Storage Facility (TSF) and North Pit. The North Void TSF is planned to be capped in approximately Year 17 of the Project (around 2040) and is incorporated into the capped final landform for the Project Operations flood assessment, which is representative of the mine plan in Year 21 of the Project (approximately 2044), as the worst case for potential impact on the floodplain. As part of a larger capped landform, this levee is not impacted by the limitation of the adopted flood modelling approach described above for narrow linear features. The Carrington West Wing Levee overtops in the Extreme Event and further consideration of the above-noted limitation for this levee on the flood assessment is provided below.

In addition to mine infrastructure, the realigned Lemington Road forms part of the Project infrastructure and passes through the Hunter River floodplain. Further consideration of the above-noted limitation for the realigned Lemington Road on the flood assessment is provided below.

Carrington West Wing Levee

Review of the model indicates that on average the as-modelled levee crest is approximately 300 mm lower than the design levee crest (design crest width of 4 m) due to the 8 m cell size. During Project operations, the design flood level in the Extreme Event is approximately 900 mm above the as-modelled levee crest (600 mm above the design crest). Further, it is estimated that approximately 140 GL of flood water spills into the pit in this scenario, which is approximately 5% of the total flood volume for the Extreme Event. As a result of these findings, it is evident that enforcing the levee crest in the flood model would reduce the volume of flood ingress to the Carrington West Wing Extension mining area but not achieve flood immunity in the Extreme Event.

Furthermore, the as-modelled results indicate a reduction in downstream flood levels and hazard under the Project Operation scenario as a result of flood ingress to the Carrington West Wing Extension mining area in the Extreme Event. By enforcing the Carrington West Wing Levee and reducing the flood ingress, there would be less reduction in flood levels and hazard relative to the Project Baseline. It is noted that the Project Closure scenario, which incorporates the final landform design (including a spoil dump landform providing flood immunity to North Pit void) and decommissioning of the Carrington West Wing Levee represents a worst-case flood behaviour for the Project. For the Extreme Event, maximum flood levels for the Project Closure scenario are up to 130 mm higher than the Baseline scenario; however, flood immunity of other nearby mine infrastructure (e.g. Riverview Levee) remains as documented in Table 6-2 of the SWIA.

Realigned Lemington Road

Review of model results indicates that the Lemington Road realignment interacts with the Hunter River flood plain at the Hunter River crossing and in some backwater areas on the edge of the flood extent along Wollombi Brook. Small changes in the road crest level within these backwater areas would not materially change flood behaviour and have not been considered further. The primary location of consideration has been the Hunter River crossing.

The Hunter River crossing is formed by two bridge structures with an intermediate section of elevated road causeway. Previous results indicate that the road is immune to flooding in the 10% (1:10) AEP event and results for the 10% (1:10) AEP would therefore not be impacted by enforcing the road crest.

Review of the design road cross section indicates that it has a 12 m wide crest with a one-way crossfall through the causeway. While an 8 m cell size may be sufficient to generally capture the road crest, it does not capture the variation in level due to the one-way crossfall. Further review of the model indicates that on average the as-modelled road crest is approximately 170 mm lower than the maximum design road crest as a result of the 8 m cell size.

The portion of the Hunter River flow that overtops the causeway is presented in Table 3 for events up to and including the 1% (1:100) AEP (i.e. the event adopted by Singleton Council for setting the Flood Planning Level). In addition, the estimated cross-sectional flow area over the as-modelled road crest and the design road crest (assuming no change in upstream water level) have been compared in Table 4. The tables indicates that most of the flow is conveyed through the bridge openings, particularly in smaller overtopping events. The potential impact of enforcing the road crest on the portion of flow over the causeway can be inferred by the reduction in cross-sectional flow area from the as-modelled road crest to the design crest. The results indicate that as the portion of flow over the causeway increases in progressively larger floods, the impact on flow area over the causeway becomes progressively smaller.

As a result of this finding, it is expected that enforcing the causeway crest would not materially change the flood impact assessment.

TABLE 3 FLOW OVER REALIGNED LEMINGTON ROAD COMPARED TO TOTAL FLOW

AEP	Total Flow (m ³ /s)	Flow over road (m ³ /s)	Flow over road (%)
5% (1:20)	3,498	48	1%
2% (1:50)	5,349	743	14%
1% (1:100)	7,016	1,809	26%

TABLE 4 CROSS SECTIONAL FLOW AREA FOR REASIGNED LEMINGTON ROAD OVERTOPPING FLOW

AEP	As-modelled flow area (m ²)	Design flow area (m ²)	Reduction
5% (1:20)	59	32	-47%
2% (1:50)	420	345	-18%
1% (1:100)	736	656	-11%

Conclusion

Based on the further consideration undertaken, it is concluded that while enforcing the crest level of narrow topographic features (levees, dams, roads) would provide a more accurate representation in the flood model, it is not expected to materially change the flood assessment results and findings. This is consistent with the findings of the peer review, which notes "any refinement in this regard is not expected to fundamentally change the flood assessment, but confirm local conditions."

RESPONSE TO BCS SUBMISSION

Additional mapping of flood level impacts was provided in Appendix F of the Submissions Report (EMM, 2023). Seven zoomed-in maps were produced showing the 1% (1:100) AEP event flood level changes overlaying an aerial image and property boundaries. To further address Recommendation 1 of the BCS submission dated 25 June 2024, further mapping and assessment has been prepared incorporating the following:

- Sets of 15 maps focused on each of the 15 contiguous land holdings that have 1% (1:100) AEP flood level impacts greater than 20 mm. This captures all 31 properties previously described in the SWIA (Engeny, 2022) as multiple land parcels have the same owner. One map has been prepared for each contiguous landholding such that each landholder can clearly visualise the assessment results.
- Inclusion of property boundaries and aerial imagery to illustrate the land use and built infrastructure (e.g. dwellings).
- Map sets have been produced showing the change in flood level, velocity and hazard for the 1% (1:100) AEP event, which is the event used by Singleton Council in defining the Flood Planning Level.

- Tabular summaries have been included to provide a simple numerical summary of the map data. These tables summarise the maximum flood characteristics (level, velocity and hazard) across the relevant landholding in the Project Baseline scenario and the Project Operations scenario, and the maximum flood impacts (changes to flood characteristic) for each landholding.
- An assessment of the change in time of inundation has been undertaken by extracting flow hydrographs at discrete locations in the vicinity of the relevant properties. These have been extracted using the Plot Output (PO) functionality of TUFLOW and use a 0.5 hr reporting increment. The duration of flows above various thresholds has been extracted and compared for the Project Baseline and Project Operations scenarios. These results are summarised in Figure 3 for the locations shown in Figure 4 and indicate negligible change in the duration of flood flows (average change across all locations and flow thresholds is less than 1% while the maximum change is generally less than 5%). Consequently, it is evident that there is minimal change in time of inundation on these properties.

The additional mapping and flood impact results are provided as an attachment to this letter.

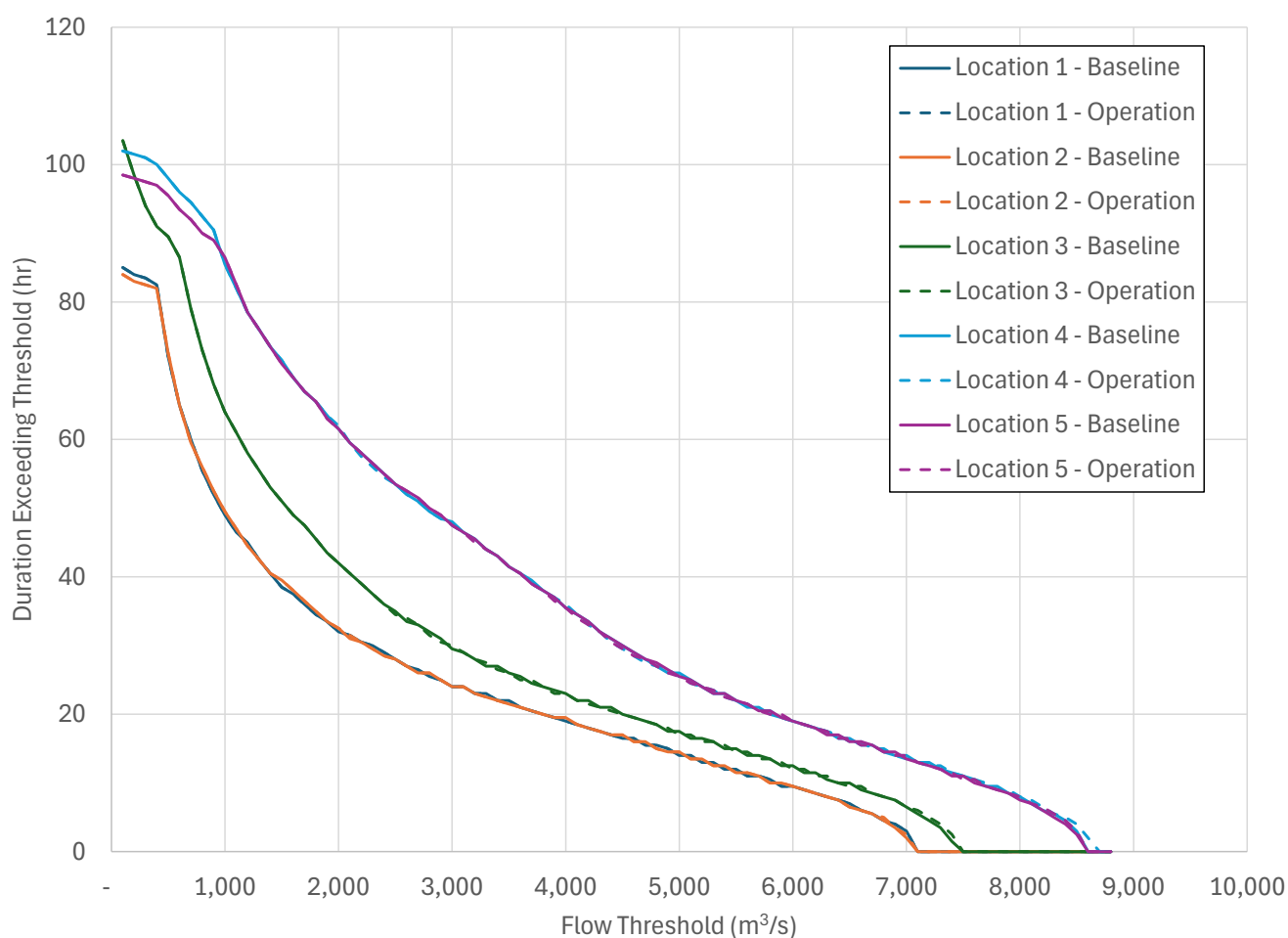


Figure 3: Time of Inundation Comparison

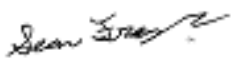


Figure 4: Reporting Locations

CLOSING

We trust that this response addresses the flooding submissions from the peer review (Torrent Consulting) and BCS. For further information or clarification please contact the undersigned.

Regards,



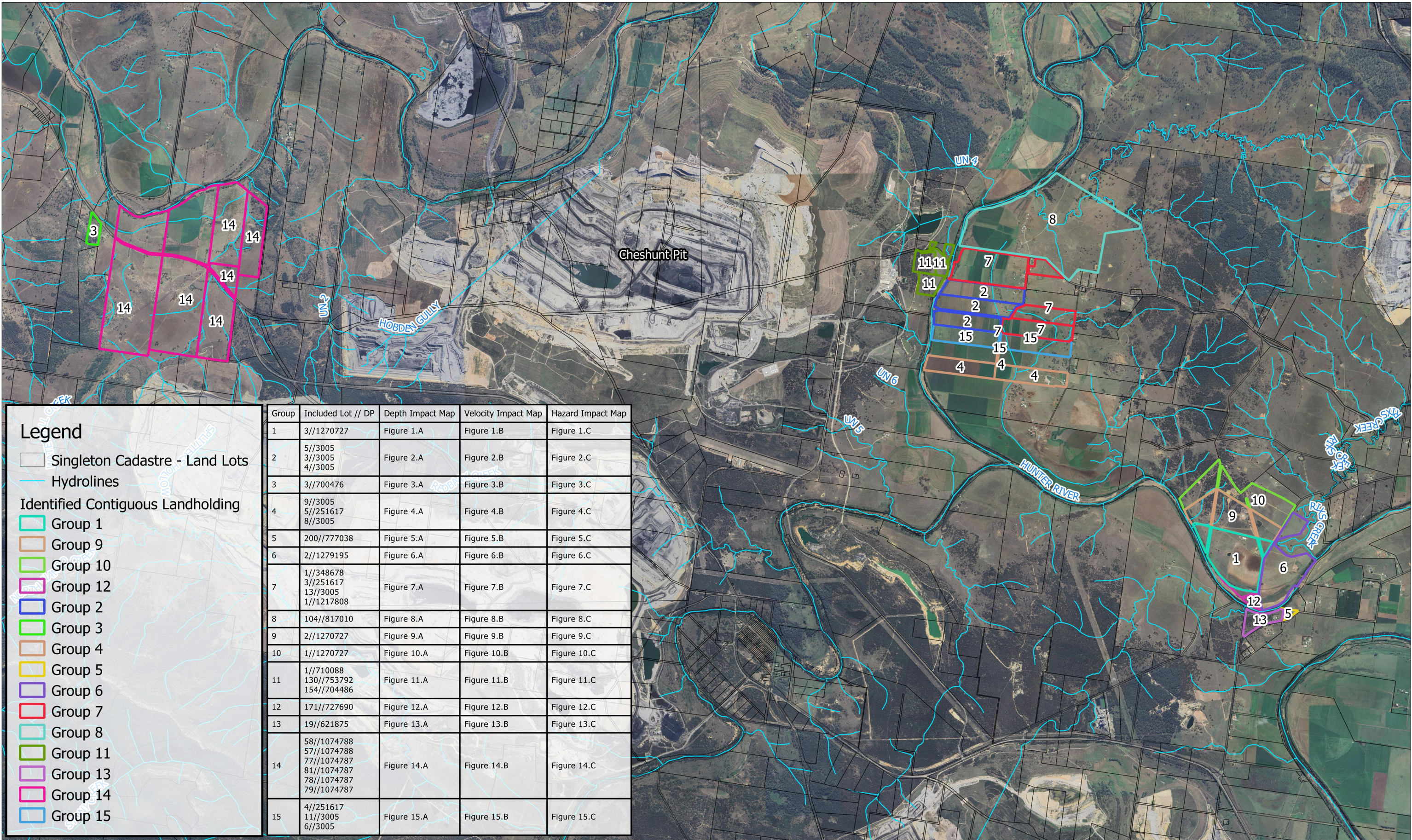
Sean Frazer
Principal Engineer

Enc. Private Land Impact Maps

DISCLAIMER

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Legend

Singleton Cadastre - Land Lots

Hydrolines

Identified Contiguous Landholding

- Group 1
- Group 9
- Group 10
- Group 12
- Group 2
- Group 3
- Group 4
- Group 5
- Group 6
- Group 7
- Group 8
- Group 11
- Group 13
- Group 14
- Group 15

Group	Included Lot // DP	Depth Impact Map	Velocity Impact Map	Hazard Impact Map
1	3//1270727	Figure 1.A	Figure 1.B	Figure 1.C
2	5//3005 3//3005 4//3005	Figure 2.A	Figure 2.B	Figure 2.C
3	3//700476	Figure 3.A	Figure 3.B	Figure 3.C
4	9//3005 5//251617 8//3005	Figure 4.A	Figure 4.B	Figure 4.C
5	200//777038	Figure 5.A	Figure 5.B	Figure 5.C
6	2//1279195	Figure 6.A	Figure 6.B	Figure 6.C
7	1//348678 3//251617 13//3005 1//1217808	Figure 7.A	Figure 7.B	Figure 7.C
8	104//817010	Figure 8.A	Figure 8.B	Figure 8.C
9	2//1270727	Figure 9.A	Figure 9.B	Figure 9.C
10	1//1270727	Figure 10.A	Figure 10.B	Figure 10.C
11	1//710088 130//753792 154//704486	Figure 11.A	Figure 11.B	Figure 11.C
12	171//727690	Figure 12.A	Figure 12.B	Figure 12.C
13	19//621875	Figure 13.A	Figure 13.B	Figure 13.C
14	58//1074788 57//1074788 77//1074787 81//1074787 78//1074787 79//1074787	Figure 14.A	Figure 14.B	Figure 14.C
15	4//251617 11//3005 6//3005	Figure 15.A	Figure 15.B	Figure 15.C

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PO Box 787 Newcastle

www.engeny.com.au

P: 02 4926 1225



1,000 0 1,000 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 0: Private Land Impacts - Overview

Job Number: N1013_001

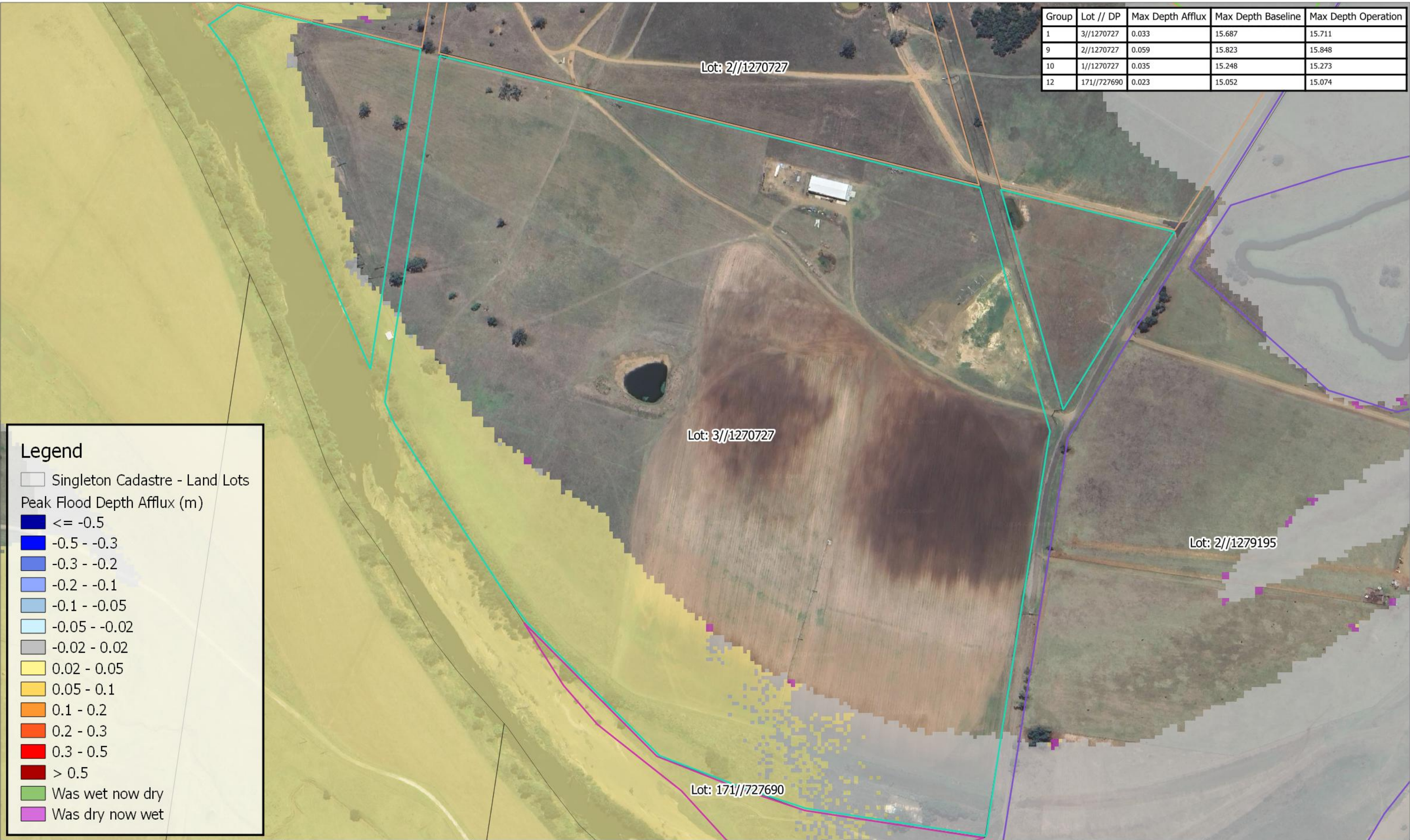
Revision: 0

Drawn: AH

Checked: LV

Date: 13/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
9	2//1270727	0.059	15.823	15.848
10	1//1270727	0.035	15.248	15.273
12	171//727690	0.023	15.052	15.074

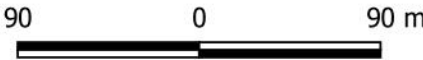


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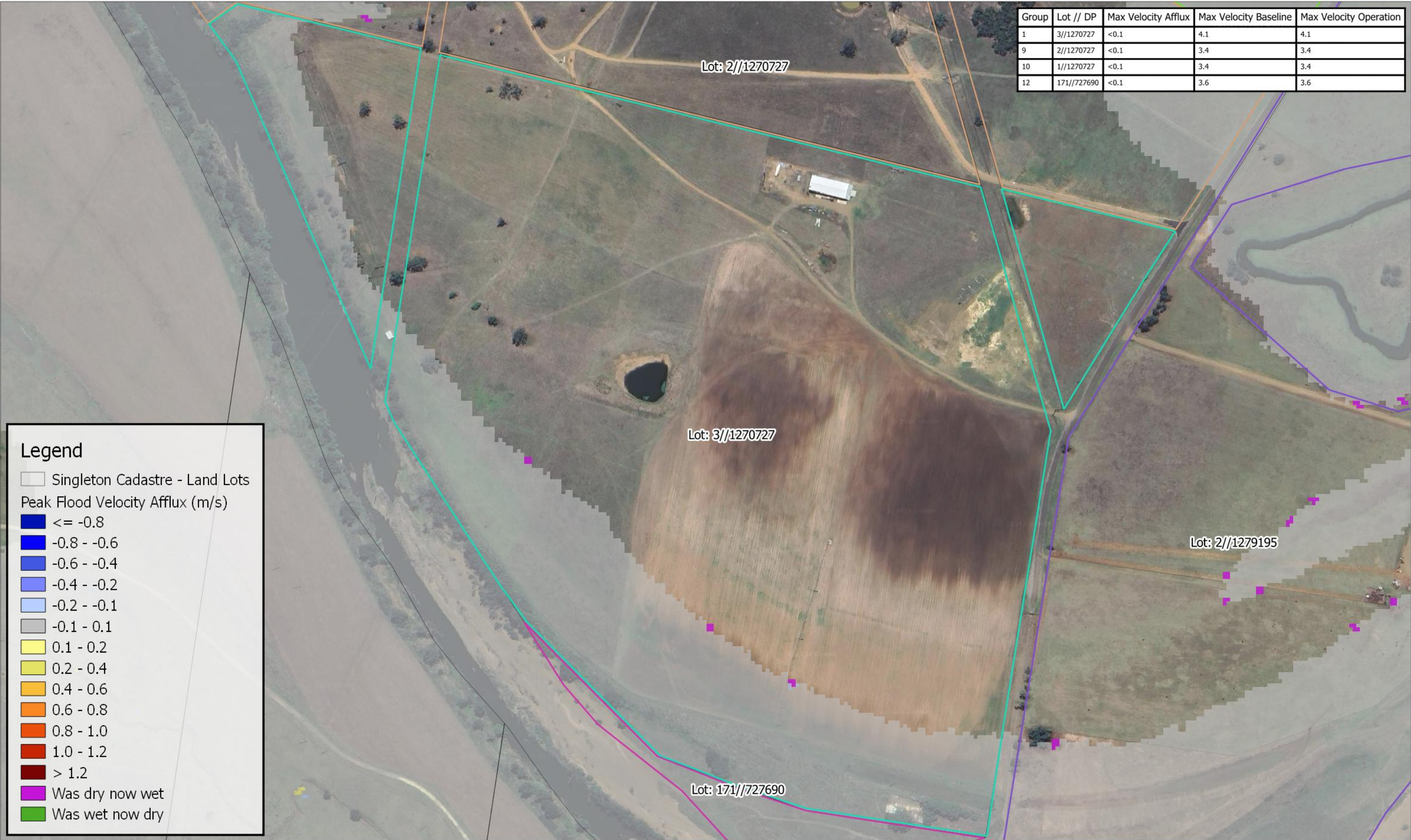


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 1.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 3 DP 1270727 (Group 1)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

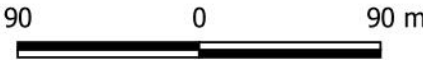


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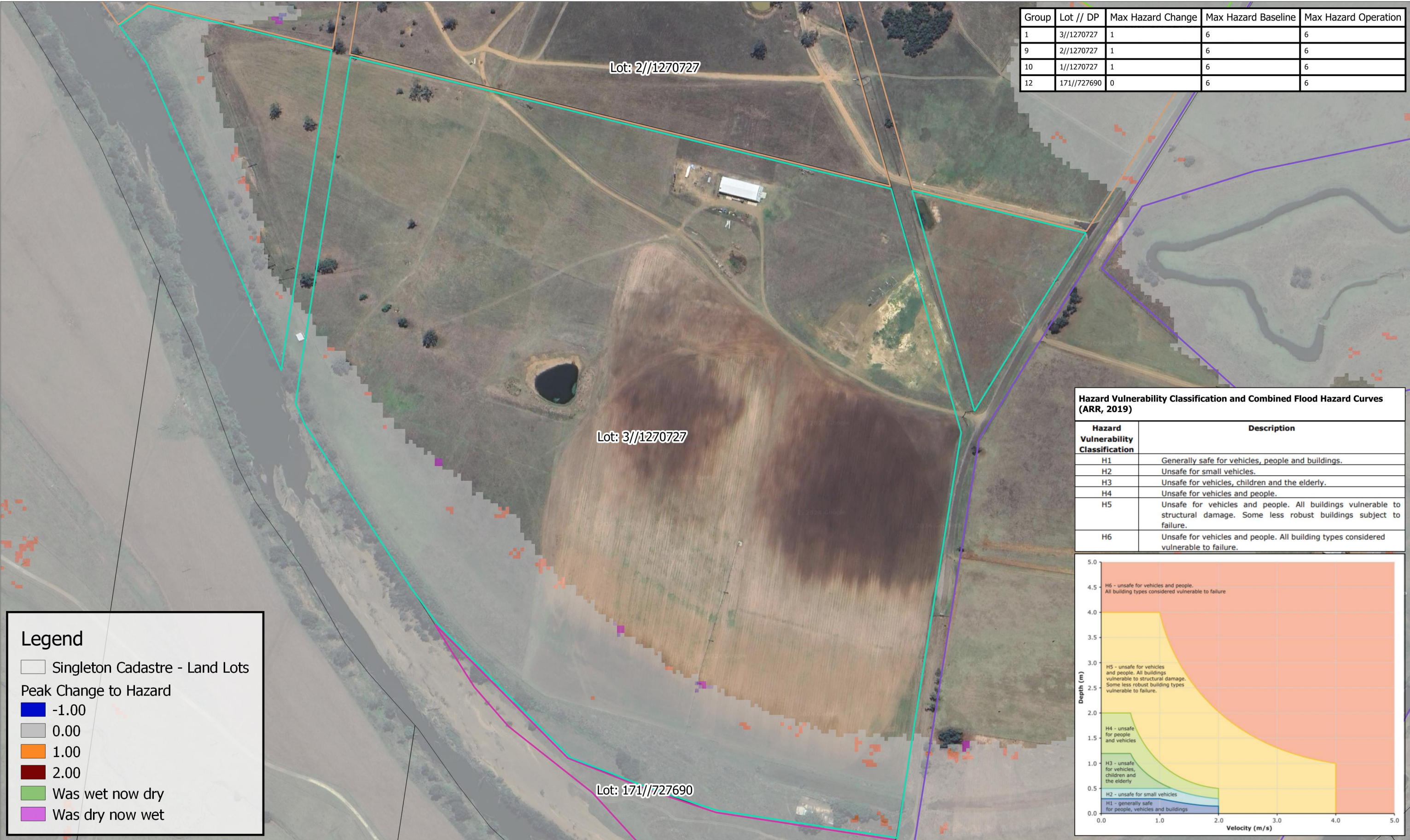


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 1.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 3 DP 1270727 (Group 1)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

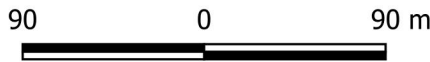


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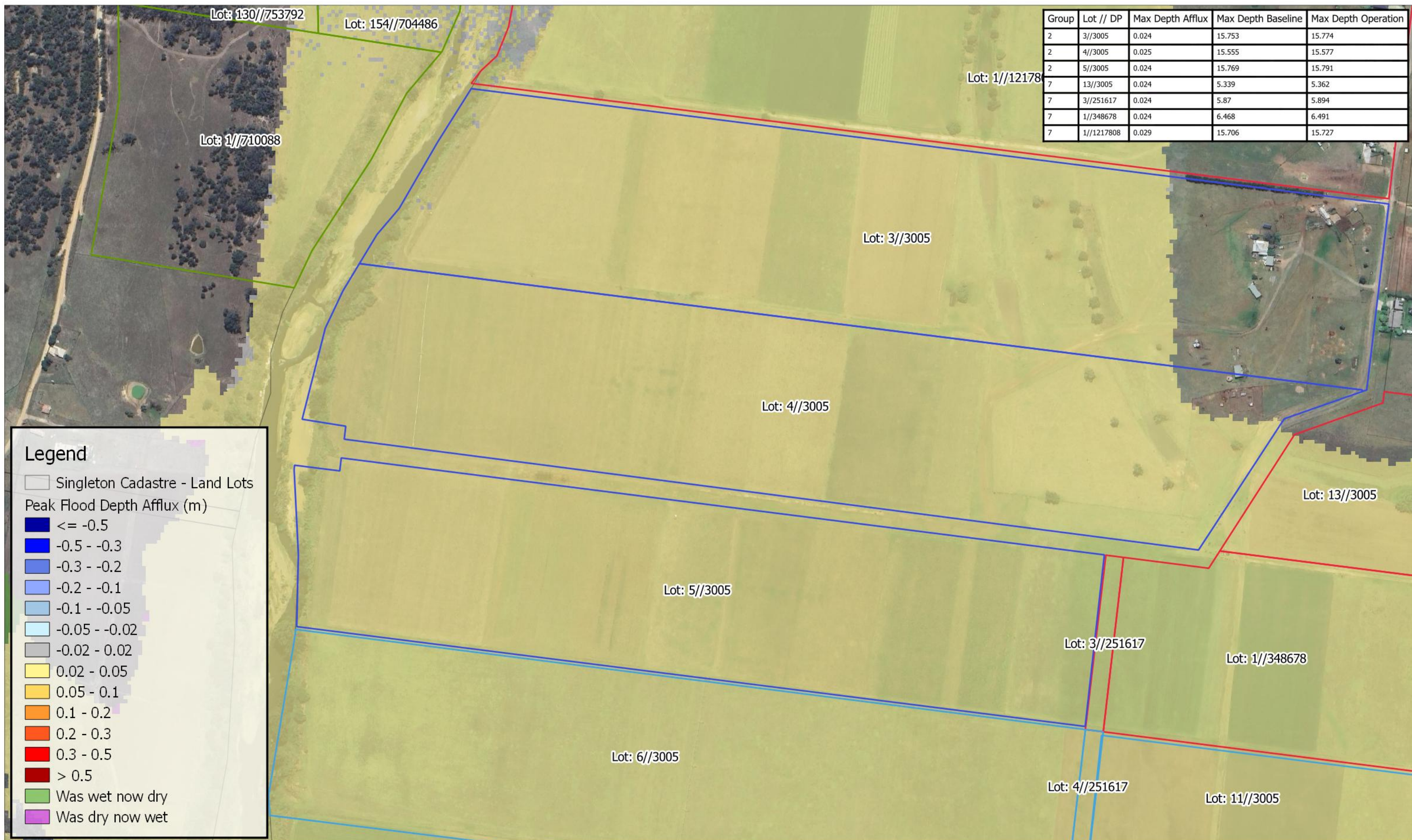


Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 1.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 3 DP 1270727 (Group 1)

Job Number: NC1013_001
Revision: 0
Drawn: AH
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Date: 13/8/2024



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90 0 90 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 2.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lots 3, 4 and 5 DP 3005 (Group 2)

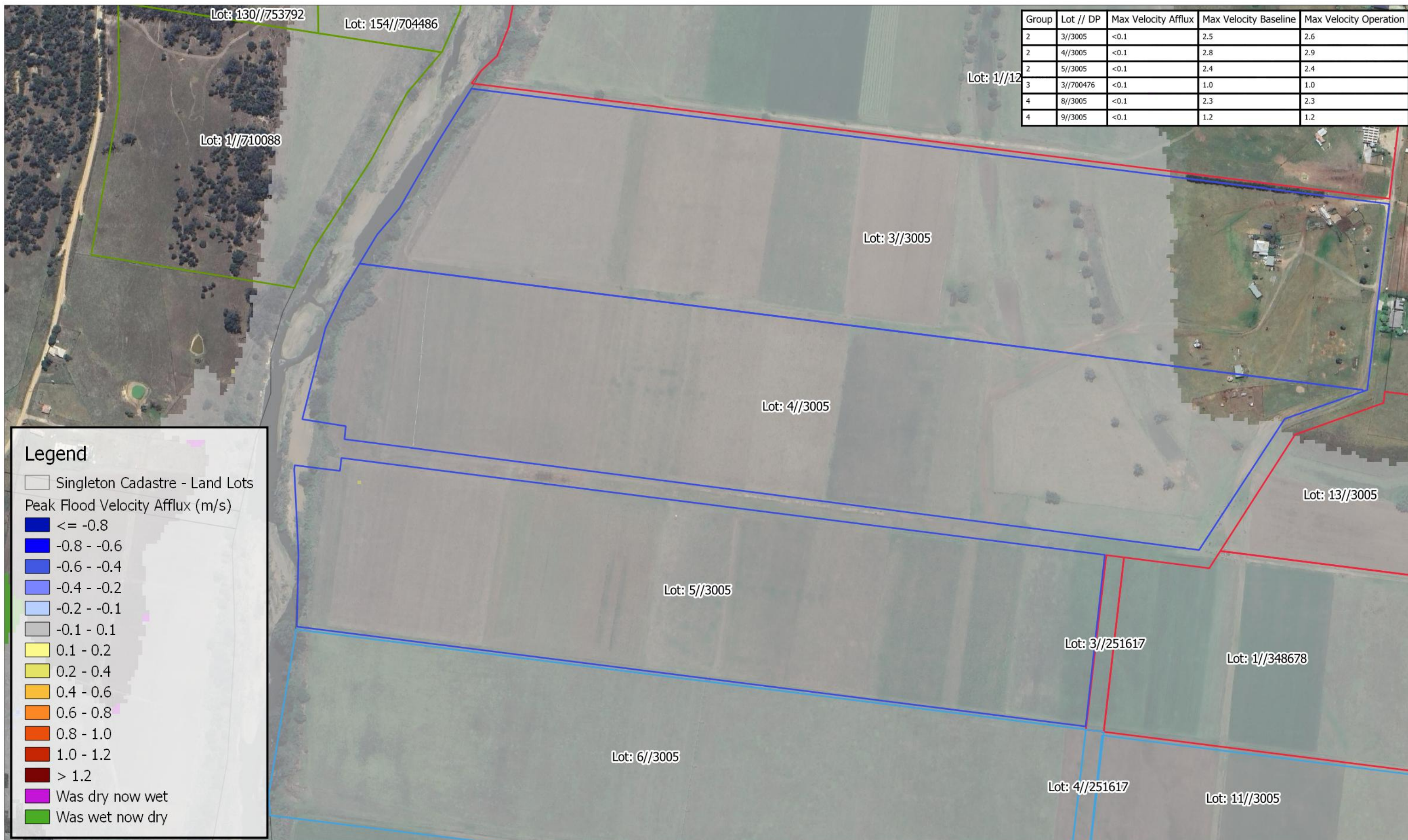
Job Number: NC1013_001

Revision: 0

Drawn: AH

Checked: LV

Date: 8/8/2024



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90 0 90 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 2.B: 1% AEP Velocity Afflux - Private Land Impacts
Lots 3, 4 and 5 DP 3005 (Group 2)

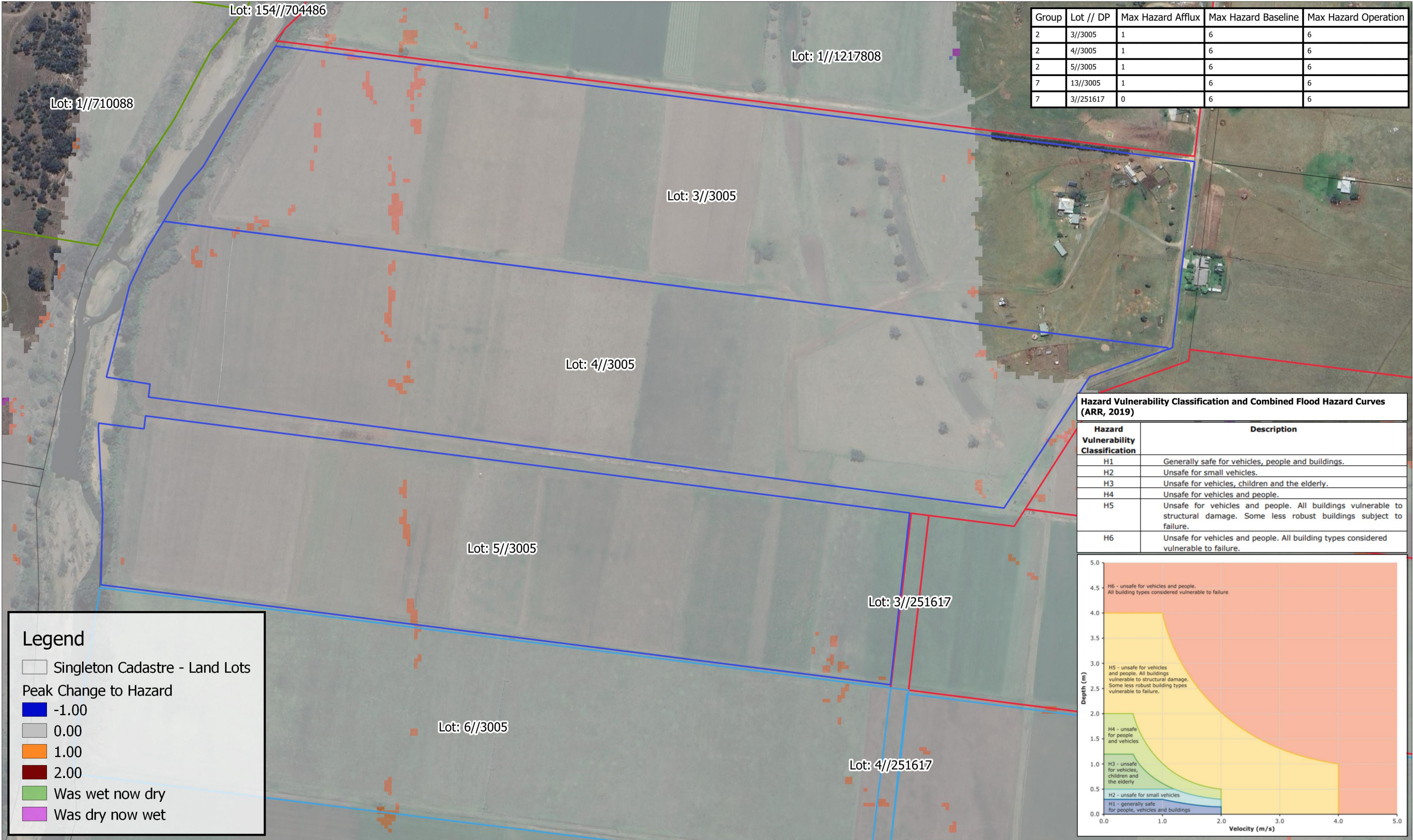
Job Number: NC1013_001

Revision: 0

Drawn: AH

Checked: LV

Date: 9/8/2024



Group	Lot // DP	Max Hazard Afflux	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
2	4//3005	1	6	6
2	5//3005	1	6	6
7	13//3005	1	6	6
7	3//251617	0	6	6

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NSW 2300

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www.engeny.com.au

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90 0 90 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 2.C: 1% AEP Hazard Afflux - Private Land Impacts
Lots 3, 4 and 5 DP 3005 (Group 2)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
3	3//700476	0.023	2.771	2.793
14	58//1074788	0.029	15.299	15.325



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NSW 2300

PO Box 787 Newcastle

www.engeny.com.au

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40 0 40 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 3.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 3 DP 700476 (Group 3)

Job Number: NC1013_001

Revision: 0

Drawn: AH

Checked: LV

Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
3	3//700476	<0.1	1.0	1.0
14	58//1074788	<0.1	2.9	2.9



Legend

Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

- <= -0.8
- 0.8 - -0.6
- 0.6 - -0.4
- 0.4 - -0.2
- 0.2 - -0.1
- 0.1 - 0.1
- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2
- Was dry now wet
- Was wet now dry

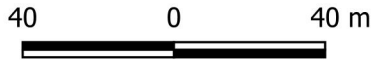


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Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 3.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 3 DP 700476 (Group 3)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024



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100 0 100 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 4.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 5 DP 251617 and Lots 8 and 9 DP 3005 (Group 4)

Job Number: NC1013_001

Revision: 0

Drawn: AH

Checked: LV

Date: 8/8/2024



Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	5//3005	<0.1	2.4	2.4
4	8//3005	<0.1	2.3	2.3
4	9//3005	<0.1	1.2	1.2
4	5//251617	<0.1	1.0	1.0
7	3//251617	<0.1	1.4	1.4
7	1//348678	<0.1	1.5	1.5
15	6//3005	<0.1	2.5	2.5
15	4//251617	<0.1	1.0	1.0
15	11//3005	<0.1	1.7	1.7

Legend

- Singleton Cadastre - Land Lots
- Peak Flood Velocity Afflux (m/s)
 - <= -0.8
 - 0.8 - -0.6
 - 0.6 - -0.4
 - 0.4 - -0.2
 - 0.2 - -0.1
 - 0.1 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.4
 - 0.4 - 0.6
 - 0.6 - 0.8
 - 0.8 - 1.0
 - 1.0 - 1.2
 - > 1.2
- Was dry now wet
- Was wet now dry

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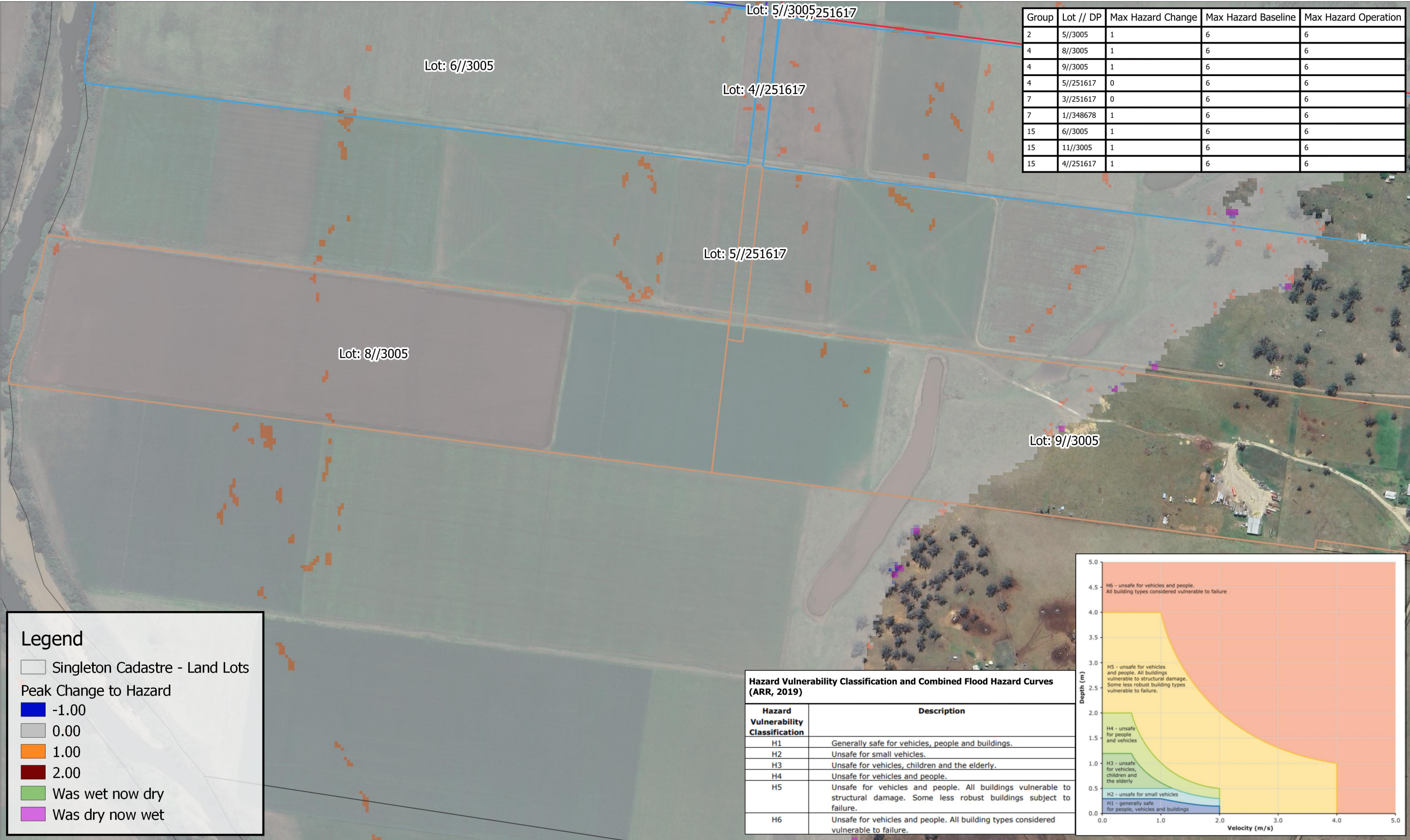
100 0 100 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 4.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 5 DP 251617 and Lots 8 and 9 DP 3005 (Group 4)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

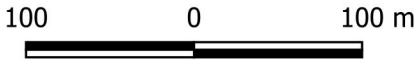


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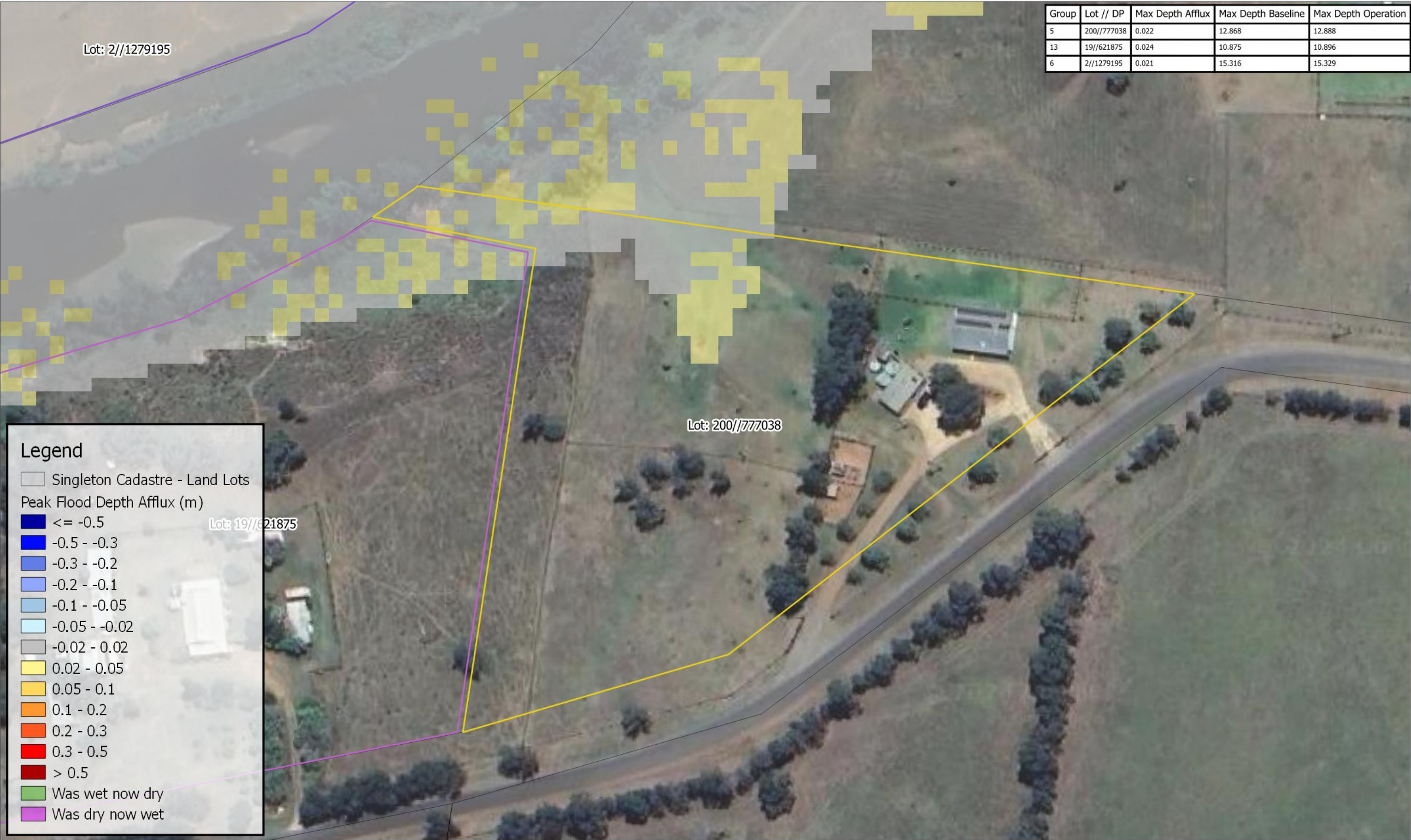


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 4.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 5 DP 251617 and Lots 8 and 9 DP 3005 (Group 4)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024



Legend

Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- 0.5 - -0.3
- 0.3 - -0.2
- 0.2 - -0.1
- 0.1 - -0.05
- 0.05 - -0.02
- 0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

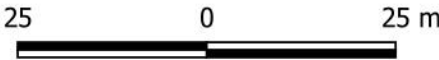


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Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 5.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 200 DP 777038
(Group 5)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

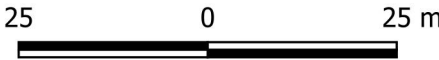


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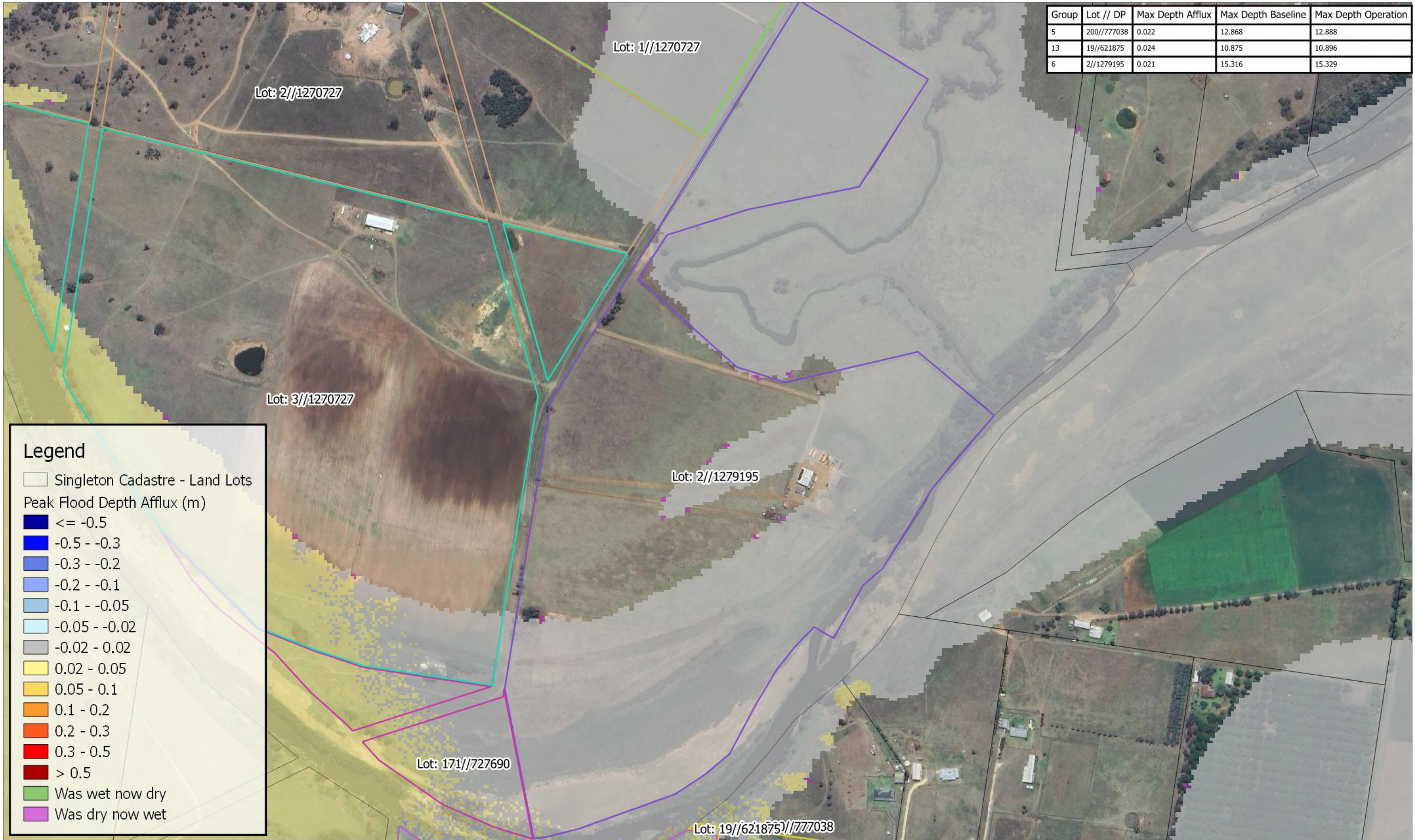


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 5.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 200 DP 777038
(Group 5)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024



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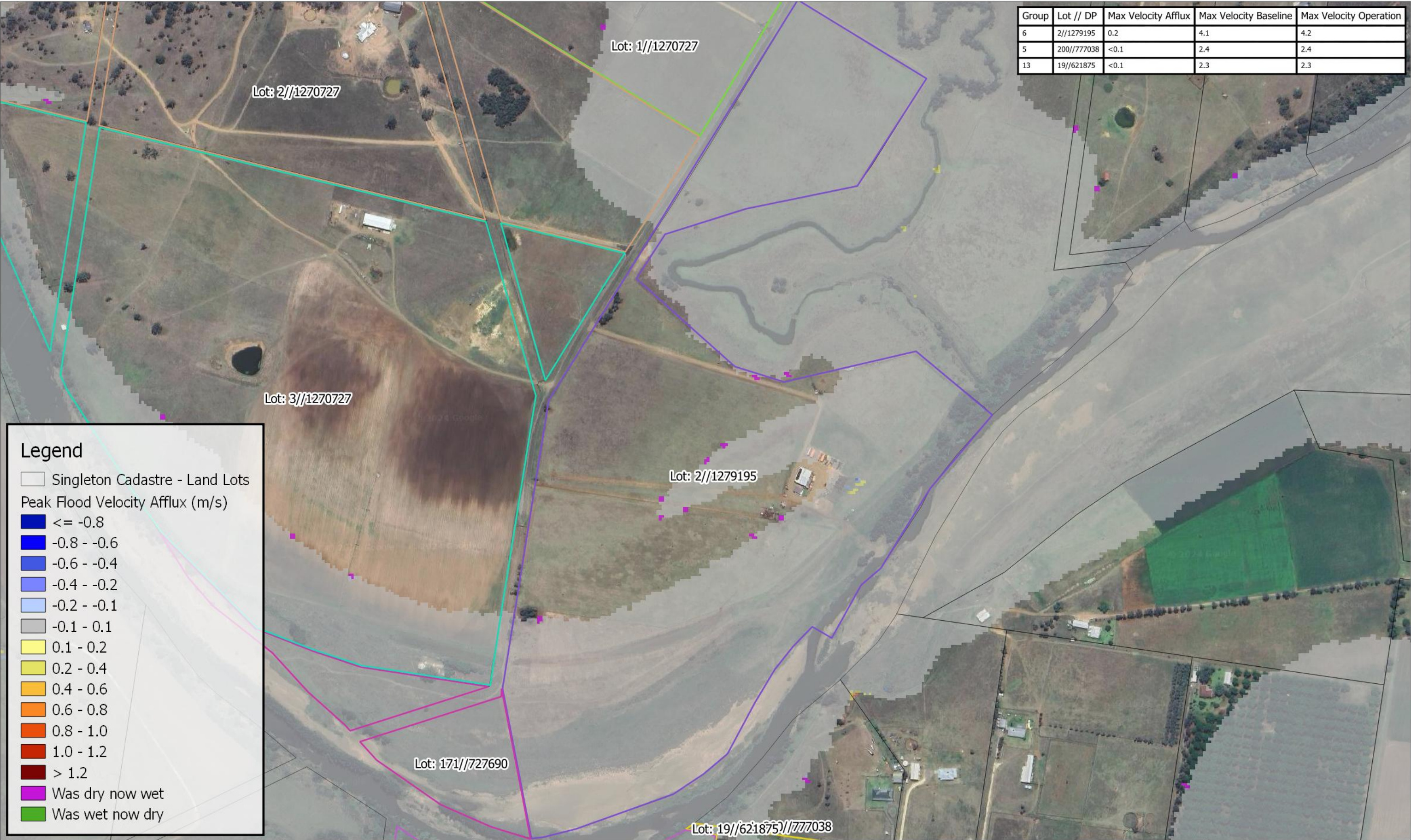
130 0 130 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 6.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 2 DP 1279195 (Group 6)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

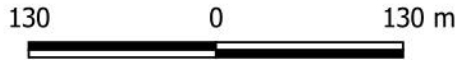


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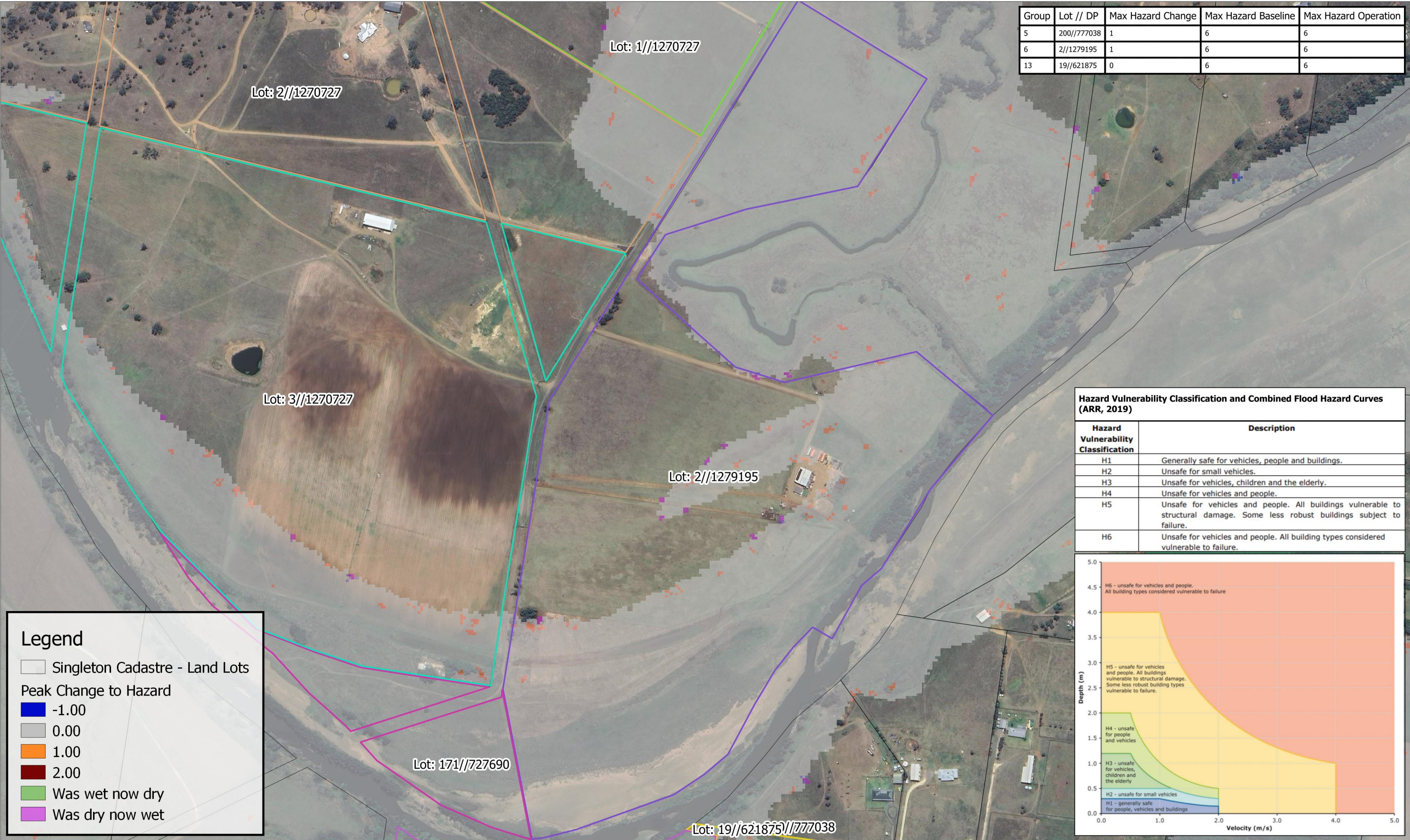


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 6.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 2 DP 1279195 (Group 6)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

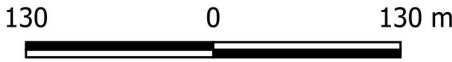


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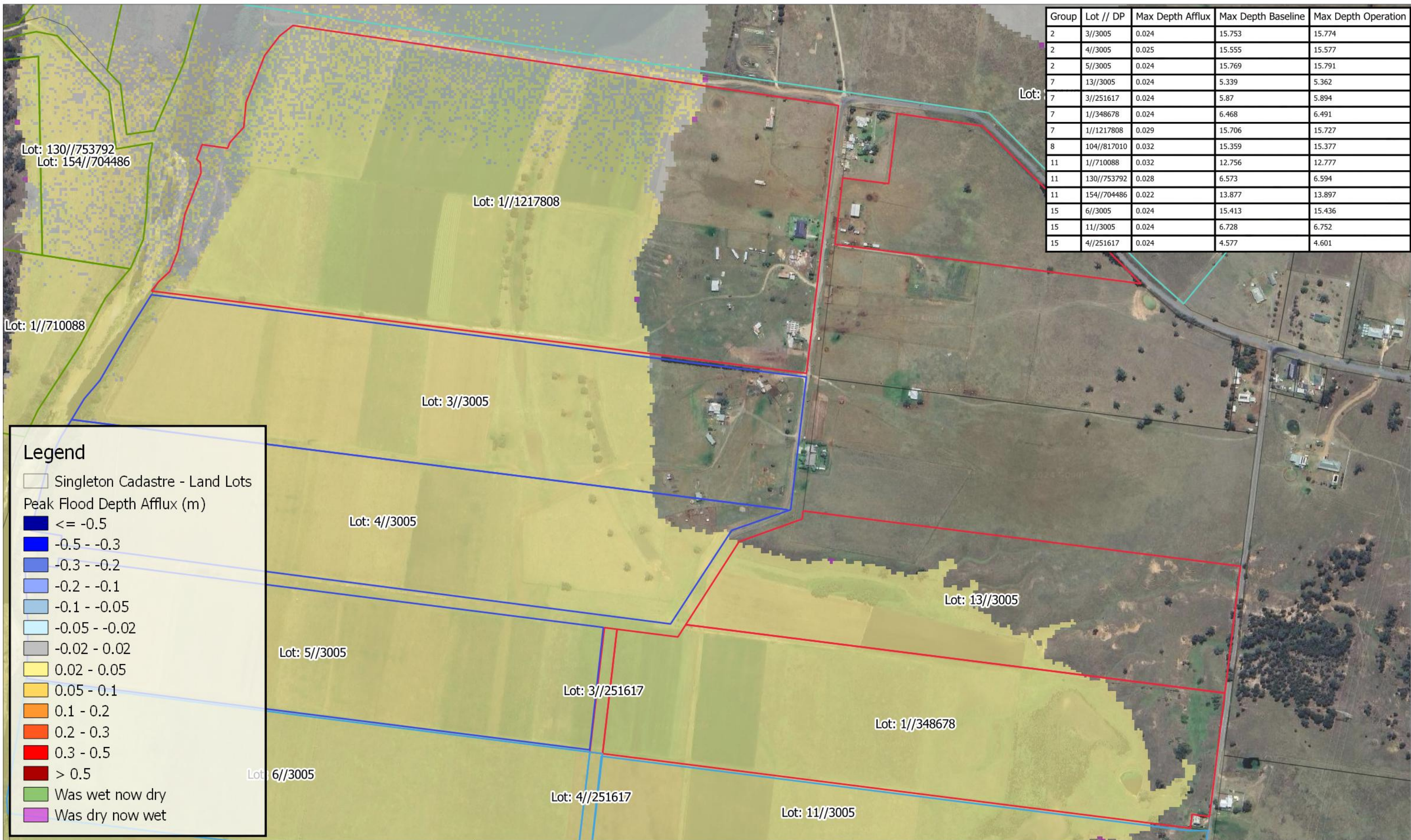


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 6.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 2 DP 1279195 (Group 6)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024



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130 0 130 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 7.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 1 DP 348678, Lot 3 DP 251617, Lot 13 DP 3005 and Lot
1 DP 1217808 (Group 7)

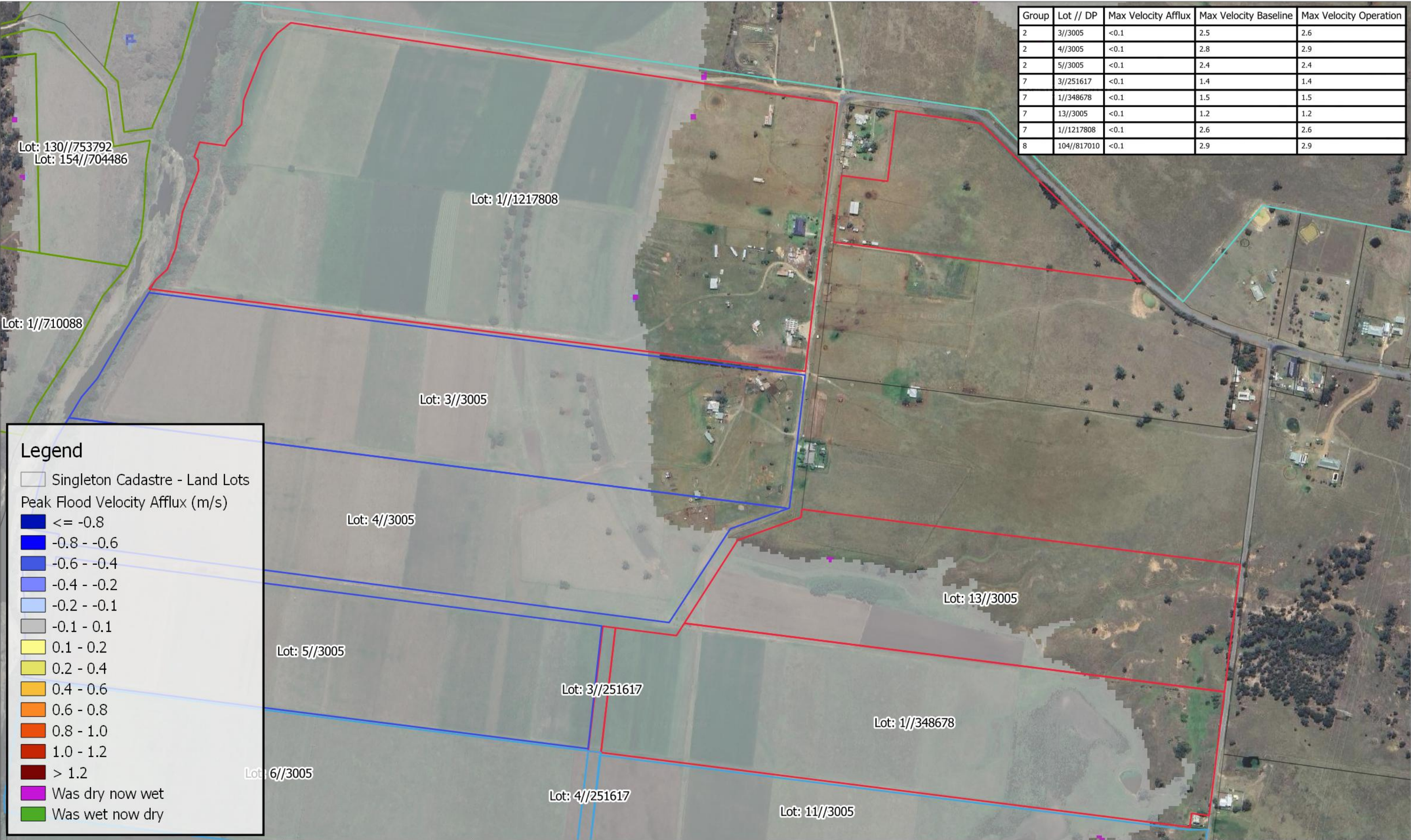
Job Number: NC1013_001

Revision: 0

Drawn: AH

Checked: LV

Date: 8/8/2024



Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	3//3005	<0.1	2.5	2.6
2	4//3005	<0.1	2.8	2.9
2	5//3005	<0.1	2.4	2.4
7	3//251617	<0.1	1.4	1.4
7	1//348678	<0.1	1.5	1.5
7	13//3005	<0.1	1.2	1.2
7	1//1217808	<0.1	2.6	2.6
8	104//817010	<0.1	2.9	2.9

Legend

Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

<= -0.8

-0.8 - -0.6

-0.6 - -0.4

-0.4 - -0.2

-0.2 - -0.1

-0.1 - 0.1

0.1 - 0.2

0.2 - 0.4

0.4 - 0.6

0.6 - 0.8

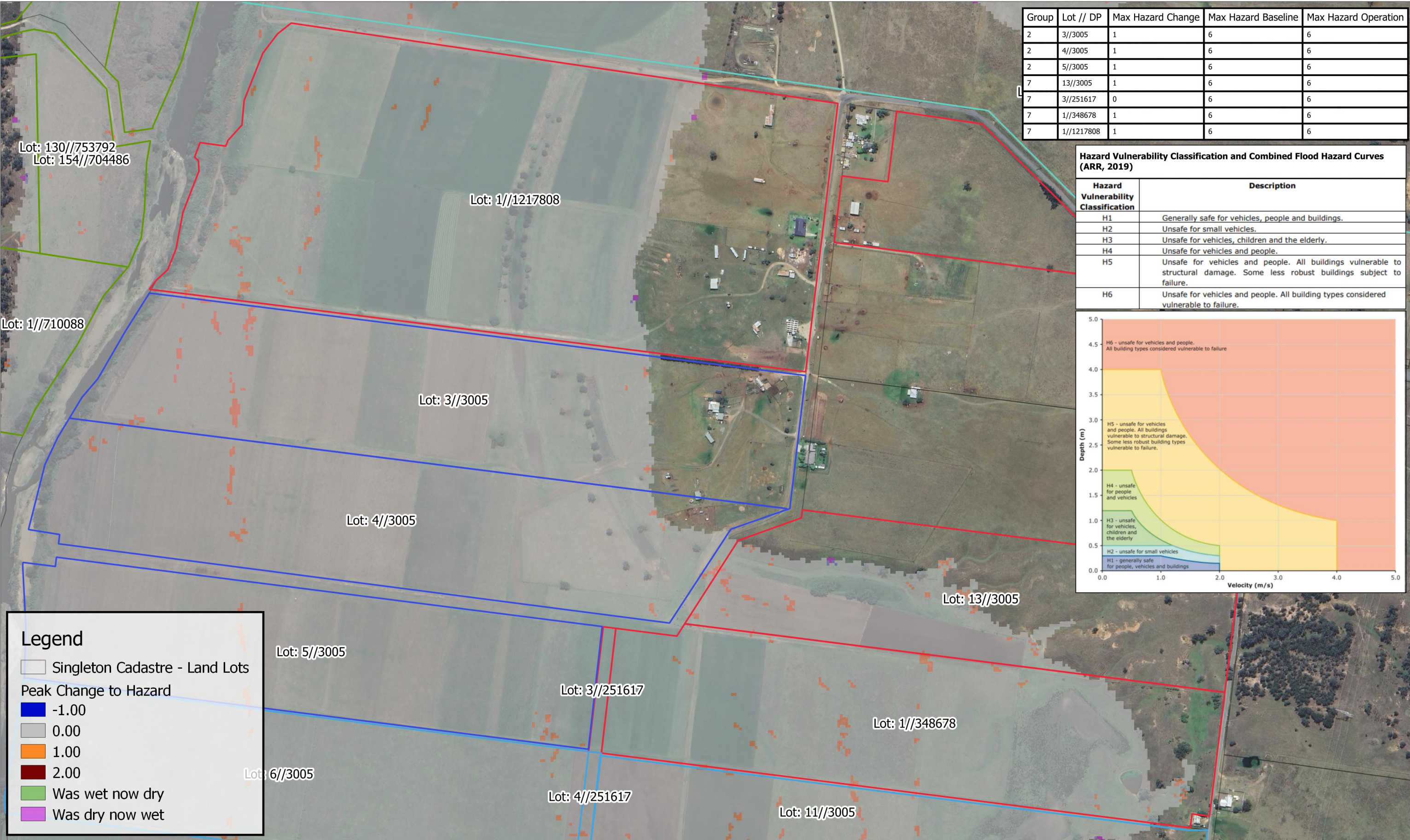
0.8 - 1.0

1.0 - 1.2

> 1.2

Was dry now wet

Was wet now dry



Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
2	4//3005	1	6	6
2	5//3005	1	6	6
7	13//3005	1	6	6
7	3//251617	0	6	6
7	1//348678	1	6	6
7	1//1217808	1	6	6

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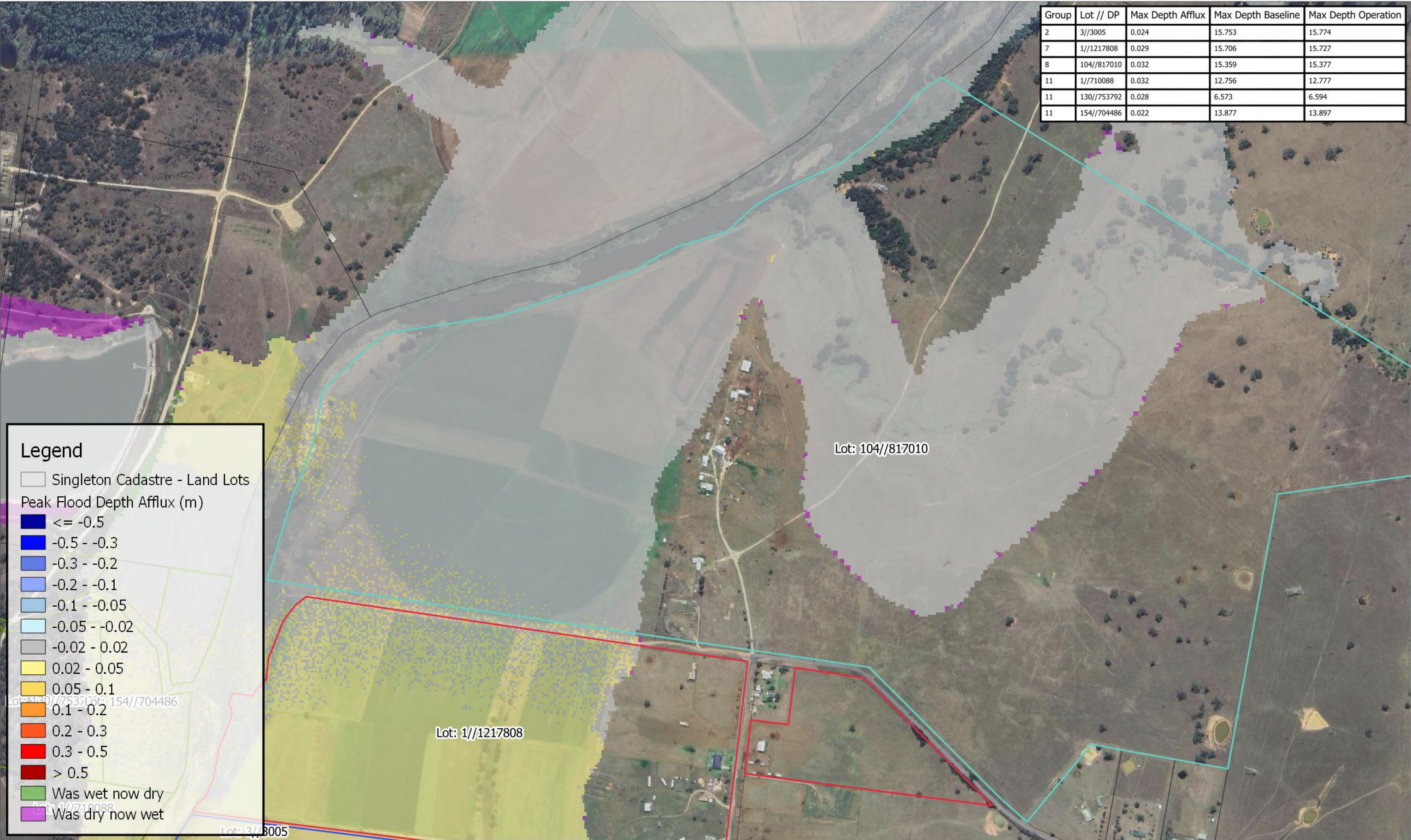
130 0 130 m

Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 7.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 1 DP 348678, Lot 3 DP 251617, Lot 13 DP 3005 and Lot
1 DP 1217808
(Group 7)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024



Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	3//3005	0.024	15.753	15.774
7	1//1217808	0.029	15.706	15.727
8	104//817010	0.032	15.359	15.377
11	1//710088	0.032	12.756	12.777
11	130//753792	0.028	6.573	6.594
11	154//704486	0.022	13.877	13.897

Legend

- Singleton Cadastre - Land Lots
- Peak Flood Depth Afflux (m)
- <= -0.5
- 0.5 - -0.3
- 0.3 - -0.2
- 0.2 - -0.1
- 0.1 - -0.05
- 0.05 - -0.02
- 0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet

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160 0 160 m

Map Projection: Tranverse Mercator
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Figure 8.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 104 DP 817010 (Group 8)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

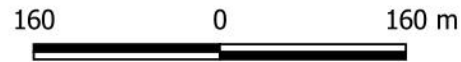


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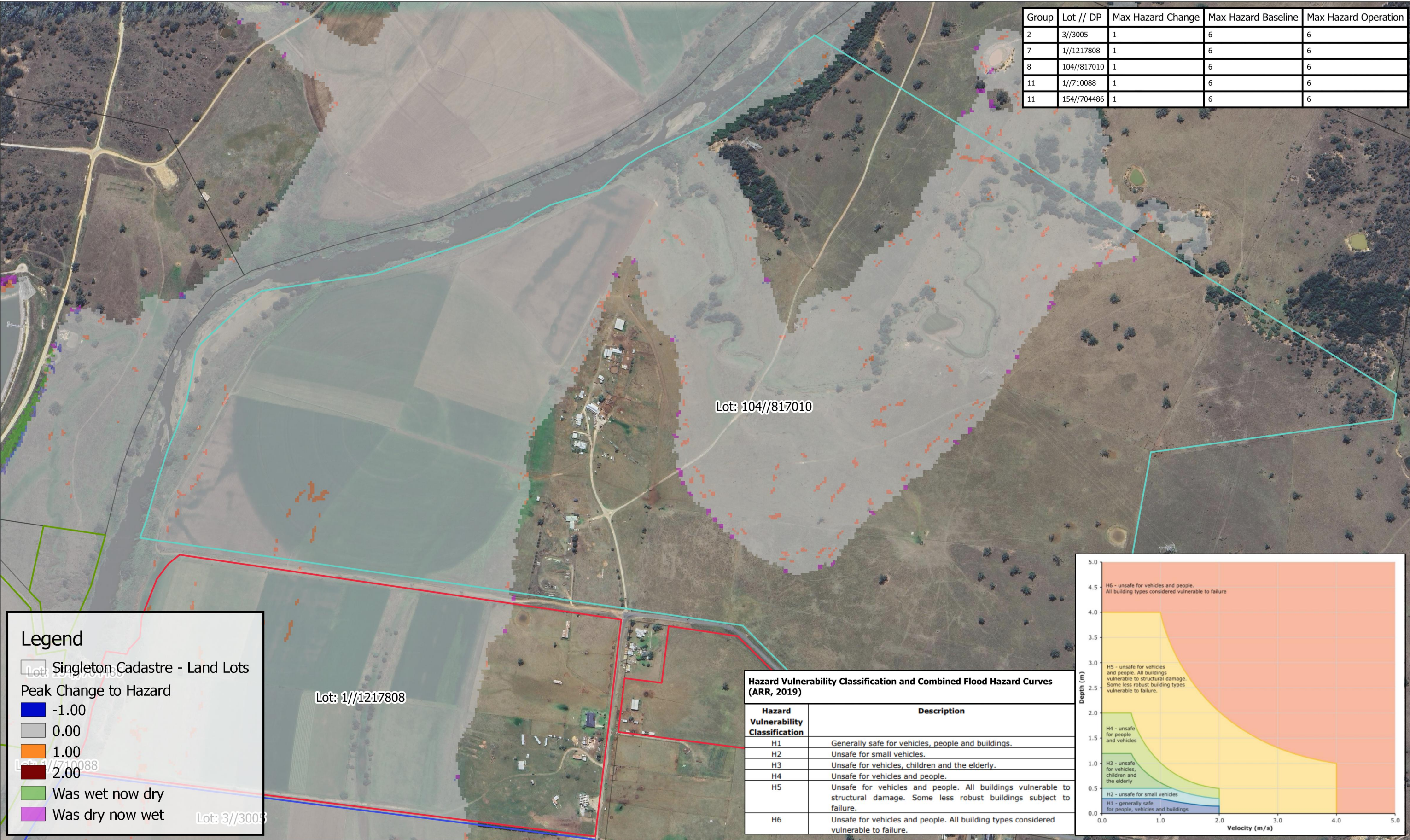


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 8.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 104 DP 817010 (Group 8)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024



Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
2	3//3005	1	6	6
7	1//1217808	1	6	6
8	104//817010	1	6	6
11	1//710088	1	6	6
11	154//704486	1	6	6

Legend

Singleton Cadastre - Land Lots

Peak Change to Hazard

-1.00

0.00

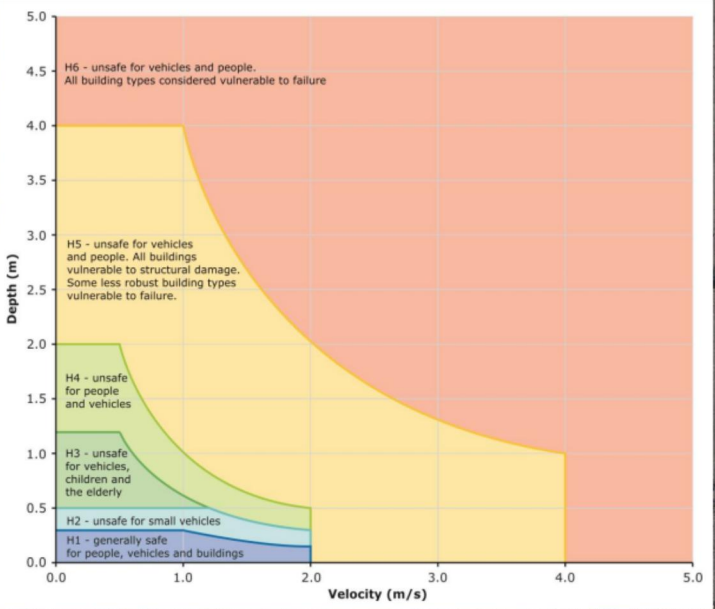
1.00

2.00

Was wet now dry

Was dry now wet

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)	
Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

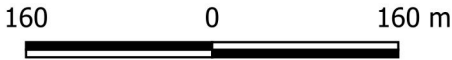


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Horizontal Datum: Geocentric Datum of Australia
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Figure 8.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 104 DP 817010 (Group 8)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
9	2//1270727	0.059	15.823	15.848
10	1//1270727	0.035	15.248	15.273



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80 0 80 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 9.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 2 DP 1270727 (Group 9)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
1	3//1270727	<0.1	4.1	4.1
9	2//1270727	<0.1	3.4	3.4
10	1//1270727	<0.1	3.4	3.4



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80 0 80 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 9.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 2 DP 1270727 (Group 9)

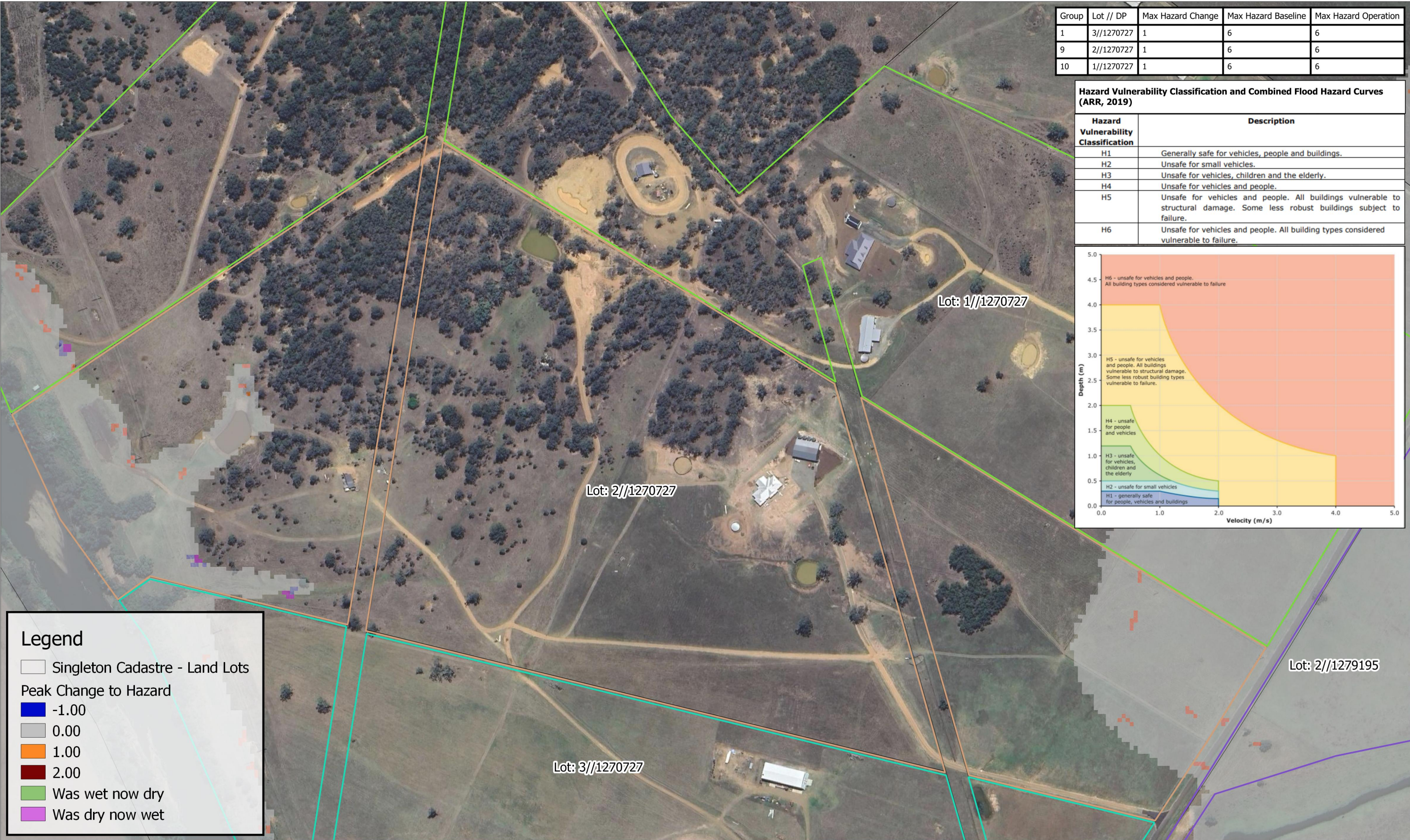
Job Number: NC1013_001

Revision: 0

Drawn: AH

Checked: LV

Date: 14/8/2024



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Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 9.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 2 DP 1270727 (Group 9)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
9	2//1270727	0.059	15.823	15.848
10	1//1270727	0.035	15.248	15.273



Legend

Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

≤ -0.5

-0.5 - -0.3

-0.3 - -0.2

-0.2 - -0.1

-0.1 - -0.05

-0.05 - -0.02

-0.02 - 0.02

0.02 - 0.05

0.05 - 0.1

0.1 - 0.2

0.2 - 0.3

0.3 - 0.5

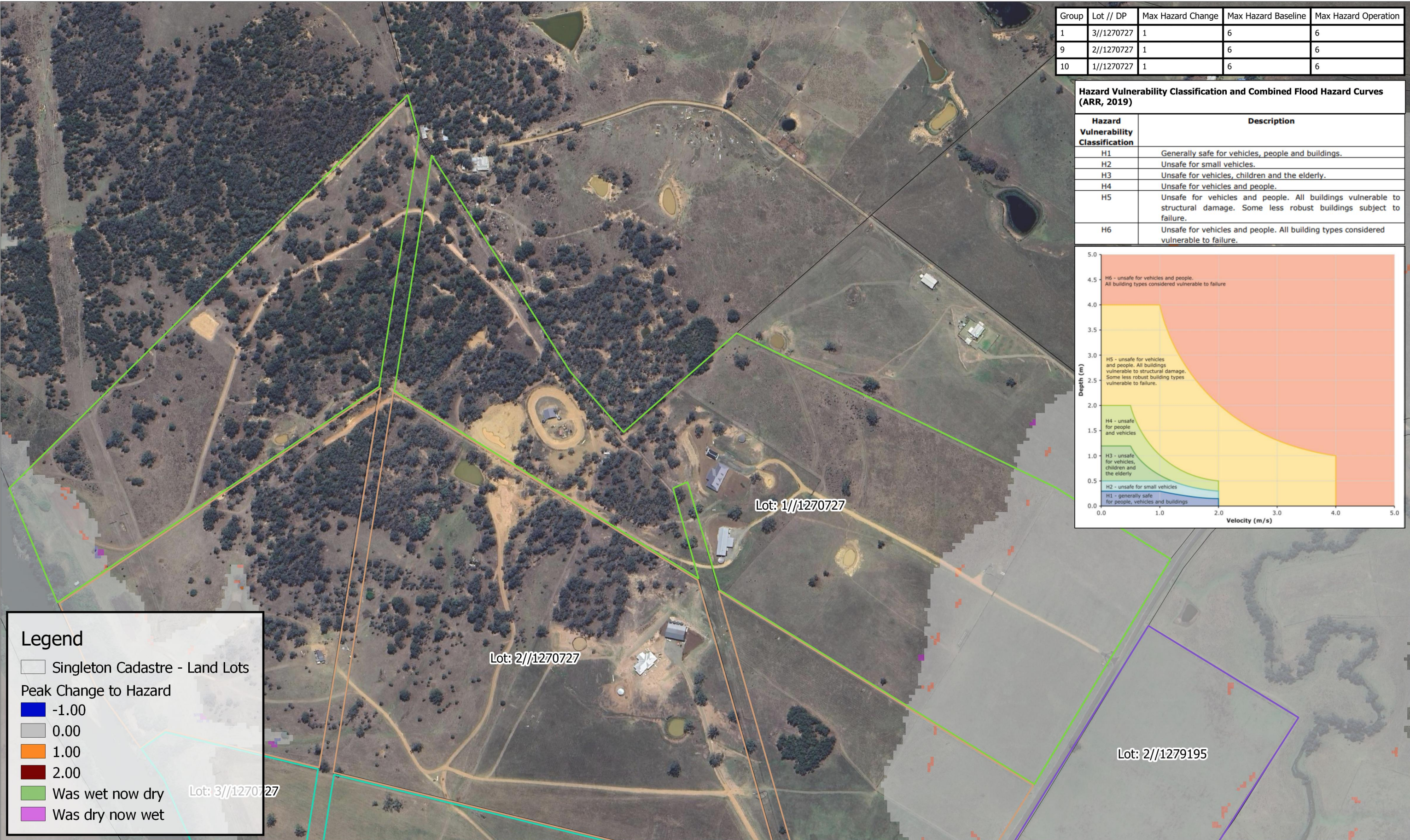
> 0.5

Was wet now dry

Was dry now wet

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
1	3//1270727	<0.1	4.1	4.1
9	2//1270727	<0.1	3.4	3.4
10	1//1270727	<0.1	3.4	3.4



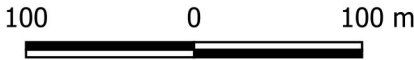


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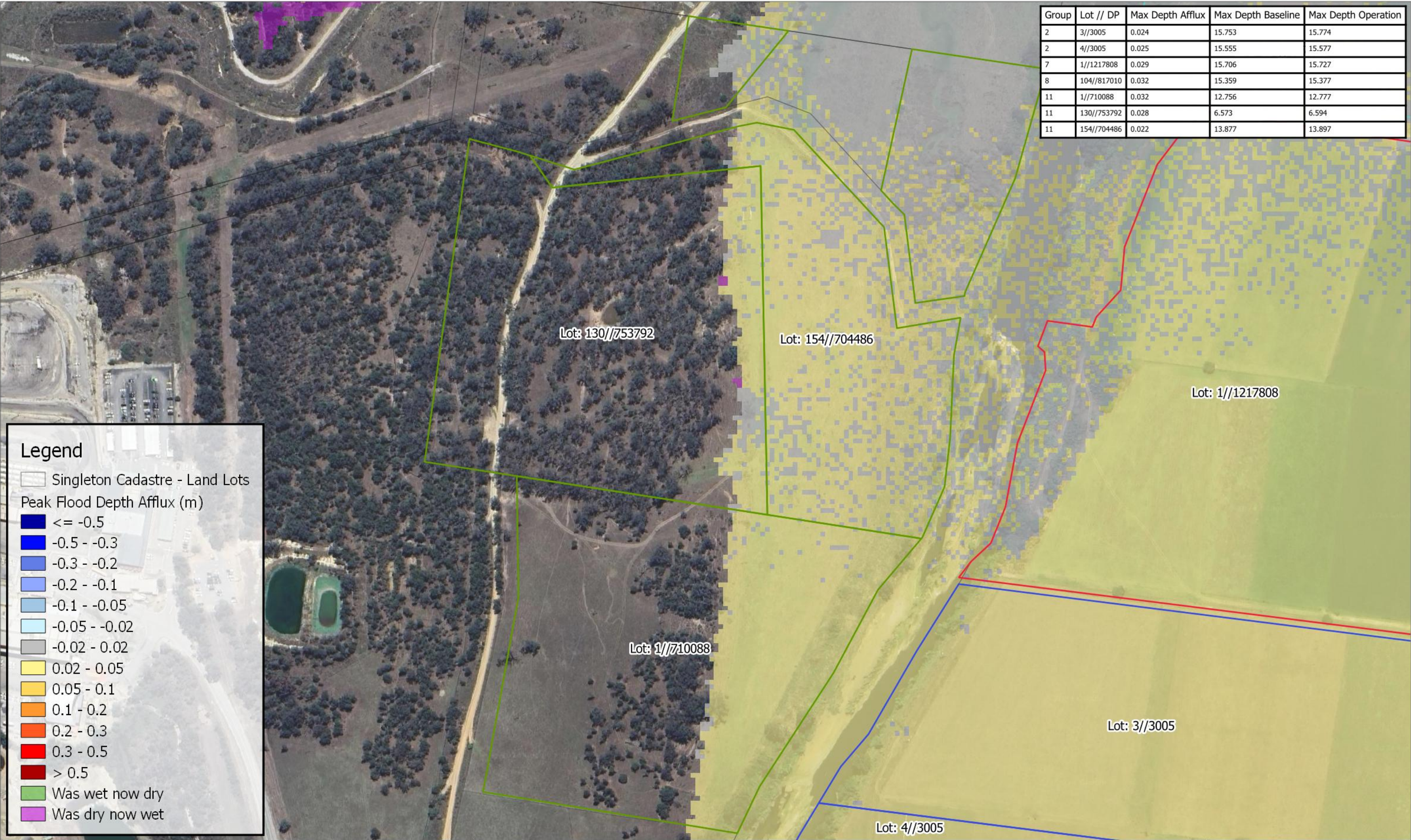


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 10.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 1 DP 1270727 (Group 10)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

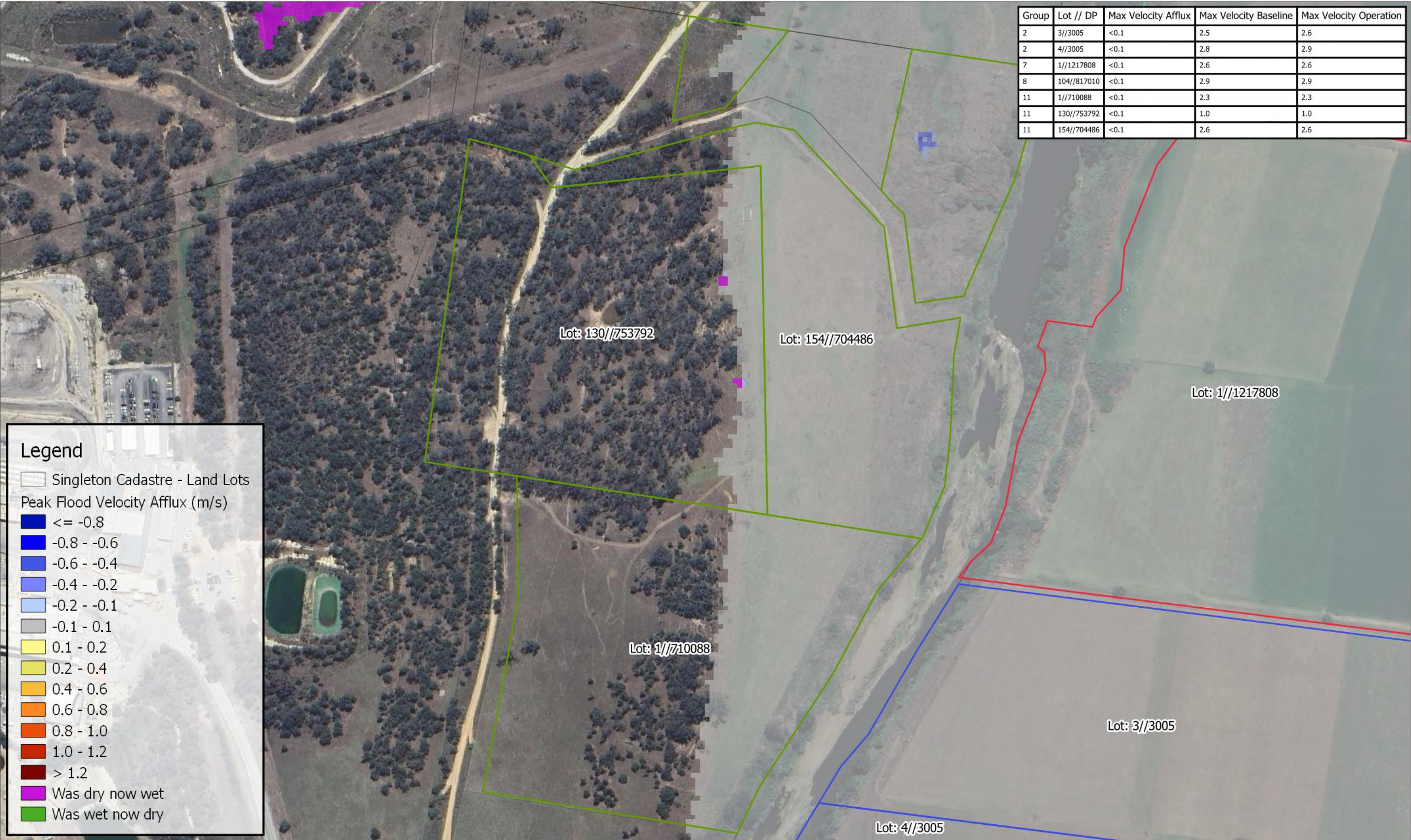


Legend

Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

- <= -0.5
- 0.5 - -0.3
- 0.3 - -0.2
- 0.2 - -0.1
- 0.1 - -0.05
- 0.05 - -0.02
- 0.02 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- > 0.5
- Was wet now dry
- Was dry now wet



Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
2	3//3005	<0.1	2.5	2.6
2	4//3005	<0.1	2.8	2.9
7	1//1217808	<0.1	2.6	2.6
8	104//817010	<0.1	2.9	2.9
11	1//710088	<0.1	2.3	2.3
11	130//753792	<0.1	1.0	1.0
11	154//704486	<0.1	2.6	2.6

Legend

- Singleton Cadastre - Land Lots
- Peak Flood Velocity Afflux (m/s)
- <= -0.8
 - 0.8 - -0.6
 - 0.6 - -0.4
 - 0.4 - -0.2
 - 0.2 - -0.1
 - 0.1 - 0.1
 - 0.1 - 0.2
 - 0.2 - 0.4
 - 0.4 - 0.6
 - 0.6 - 0.8
 - 0.8 - 1.0
 - 1.0 - 1.2
 - > 1.2
 - Was dry now wet
 - Was wet now dry

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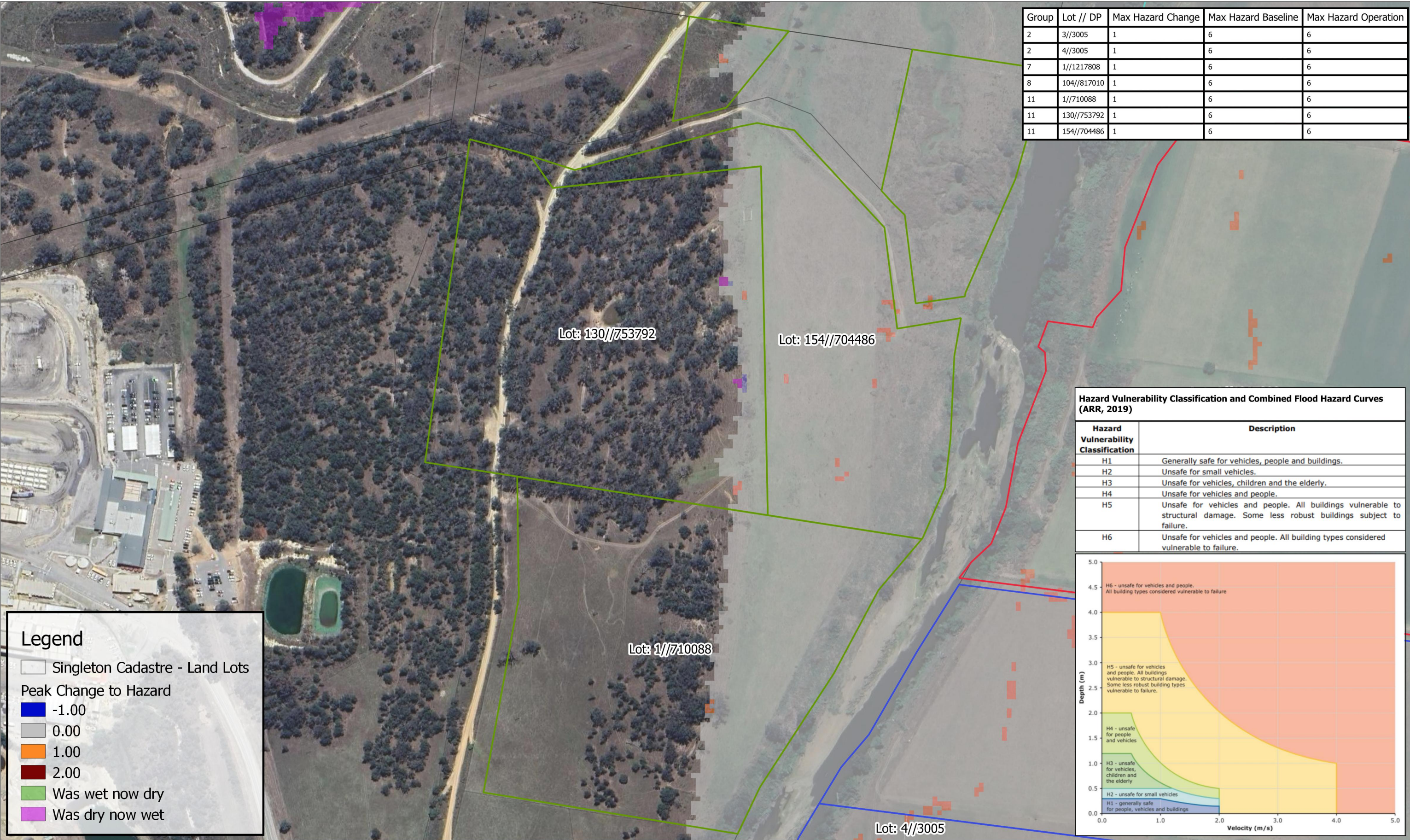
70 0 70 m

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 11.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 1 DP 710088, Lot 130 DP 753792 and Lot 154 DP
704486 (Group 11)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

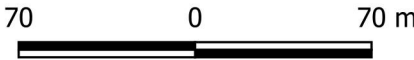


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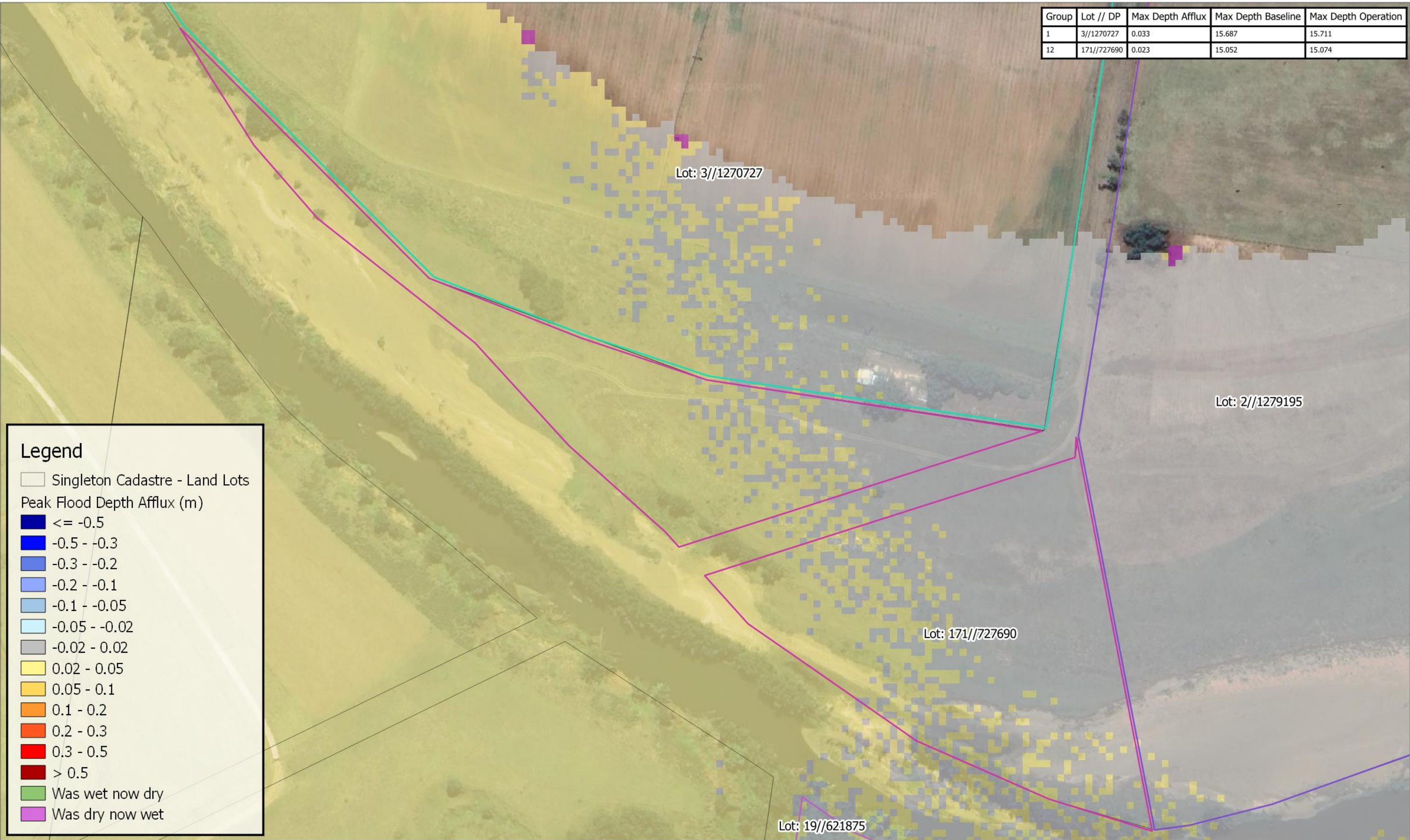
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 11.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 1 DP 710088, Lot 130 DP 753792 and Lot 154 DP 704486 (Group 11)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
1	3//1270727	0.033	15.687	15.711
12	171//727690	0.023	15.052	15.074



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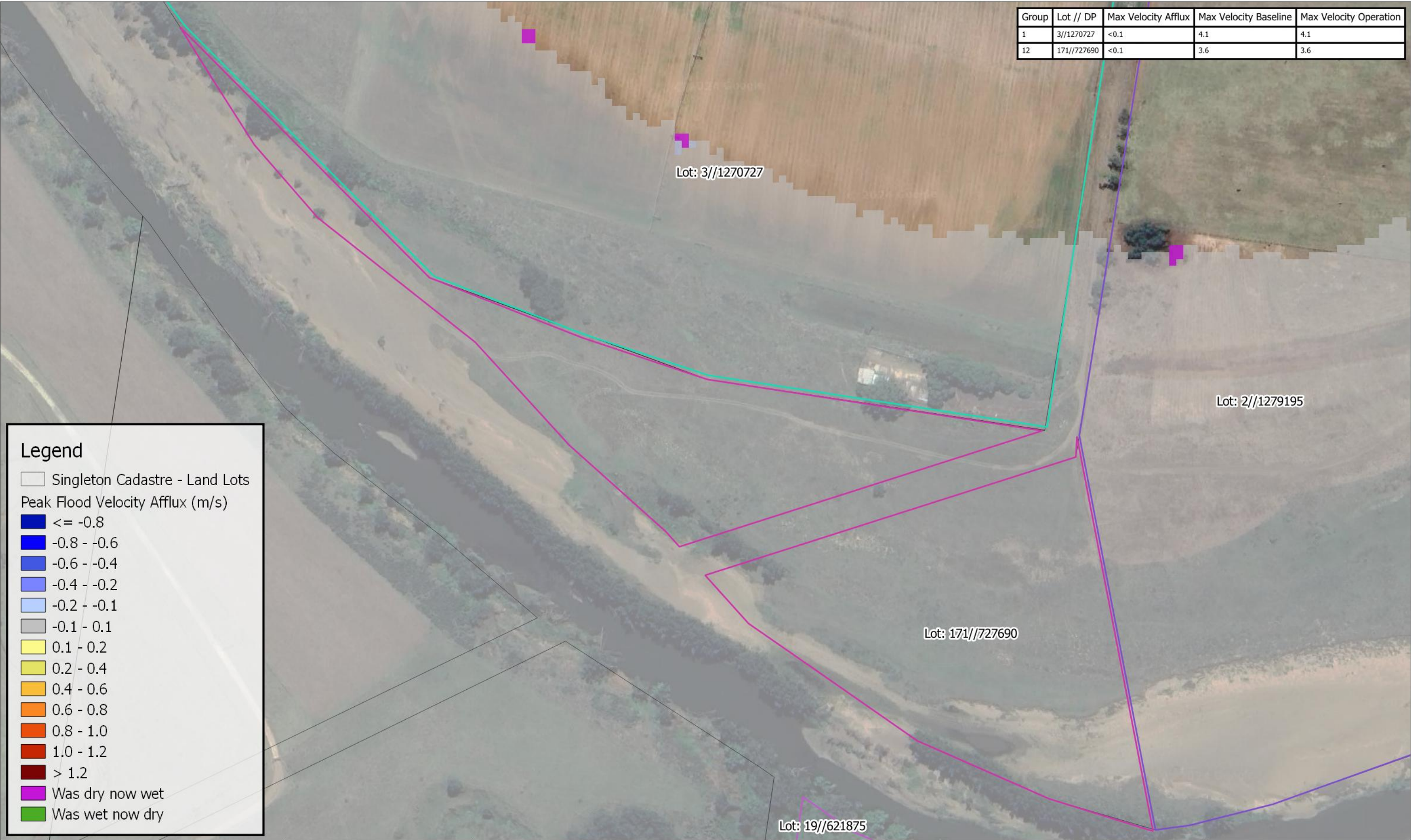
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

HVO Continuation Project

Figure 12.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 171 DP 727690 (Group 12)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
1	3//1270727	<0.1	4.1	4.1
12	171//727690	<0.1	3.6	3.6

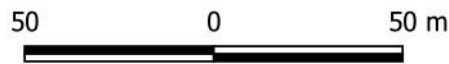


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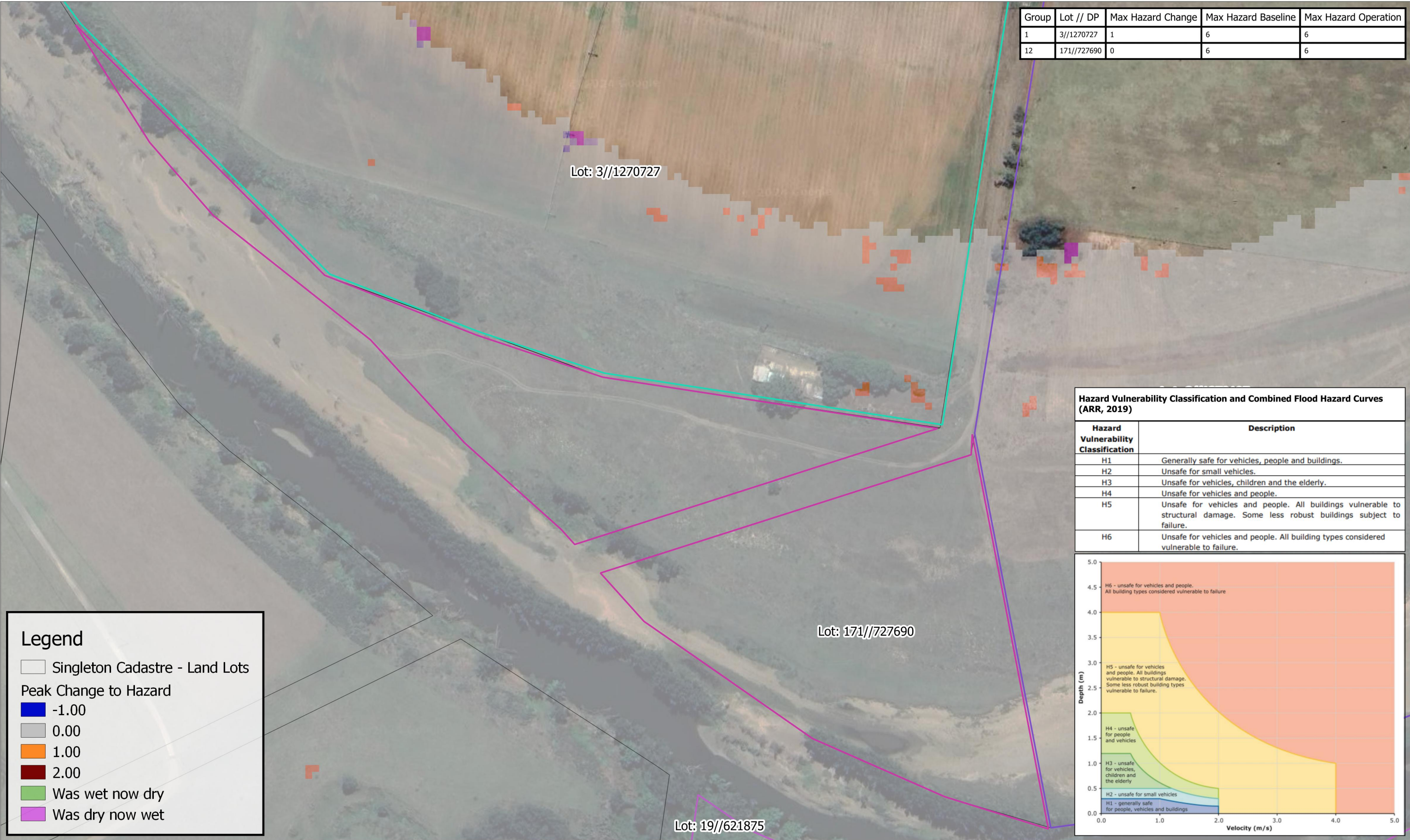


Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 12.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 171 DP 727690 (Group 12)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 13/8/2024



Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
1	3//1270727	1	6	6
12	171//727690	0	6	6

Legend

Singleton Cadastre - Land Lots

Peak Change to Hazard

-1.00

0.00

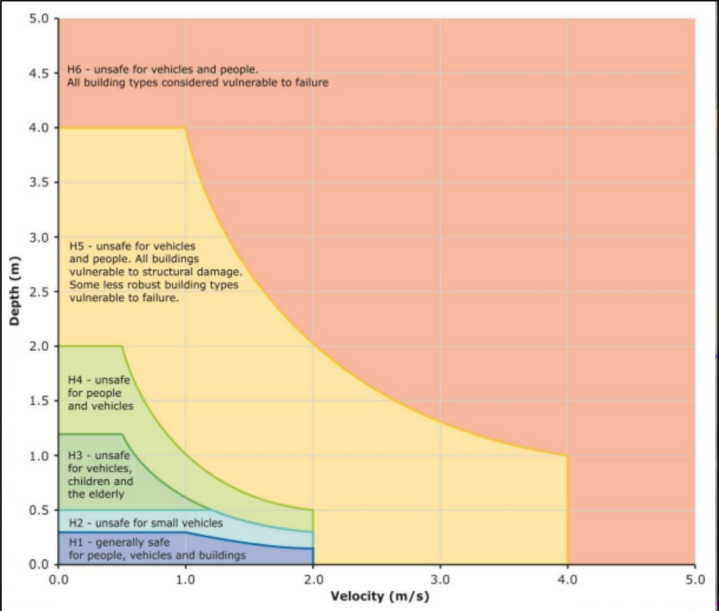
1.00

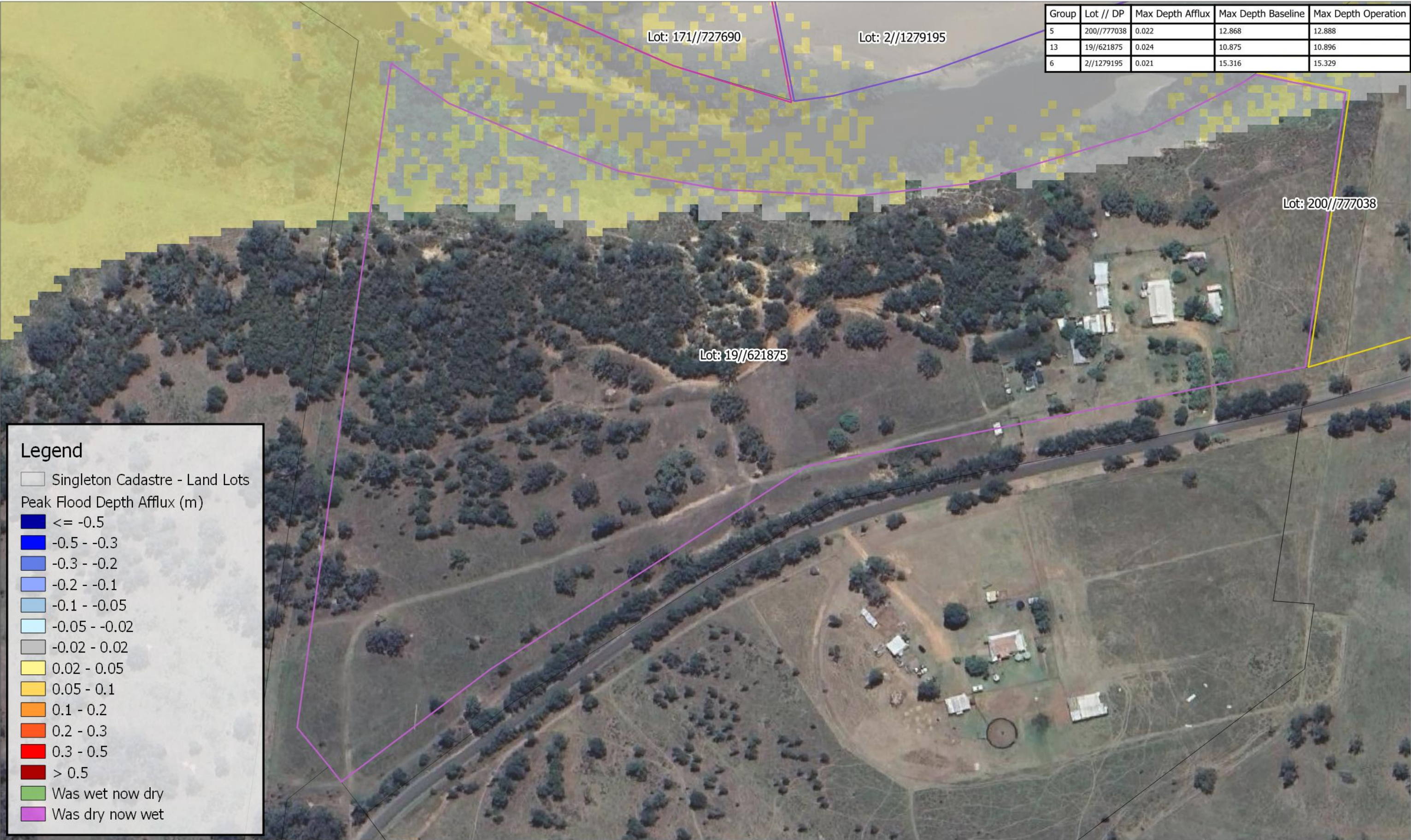
2.00

Was wet now dry

Was dry now wet

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)	
Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.





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40 0 40 m

Map Projection: Transverse Mercator
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Grid: Map Grid of Australia, Zone 56

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Figure 13.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 19 DP 621875 (Group 13)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

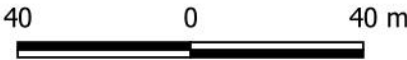


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Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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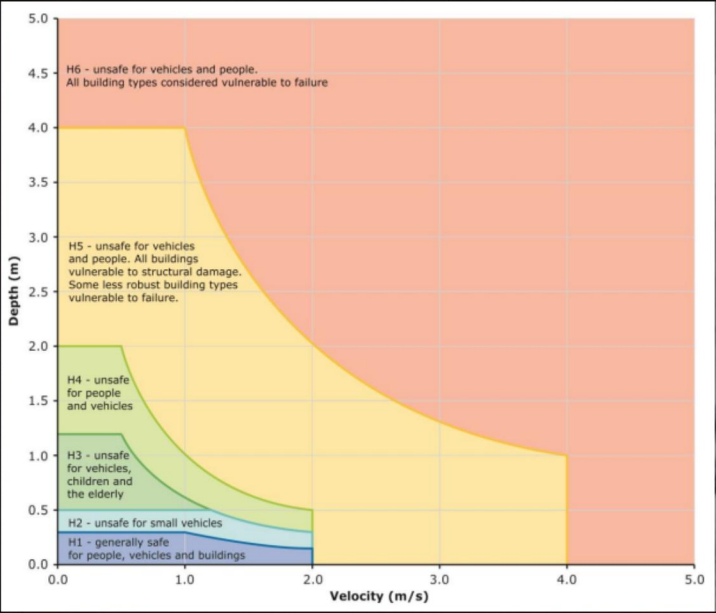
Figure 13.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 19 DP 621875 (Group 13)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024



Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
5	200//777038	1	6	6
13	19//621875	0	6	6

Hazard Vulnerability Classification and Combined Flood Hazard Curves (ARR, 2019)	
Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

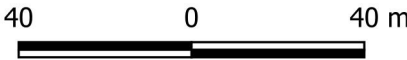


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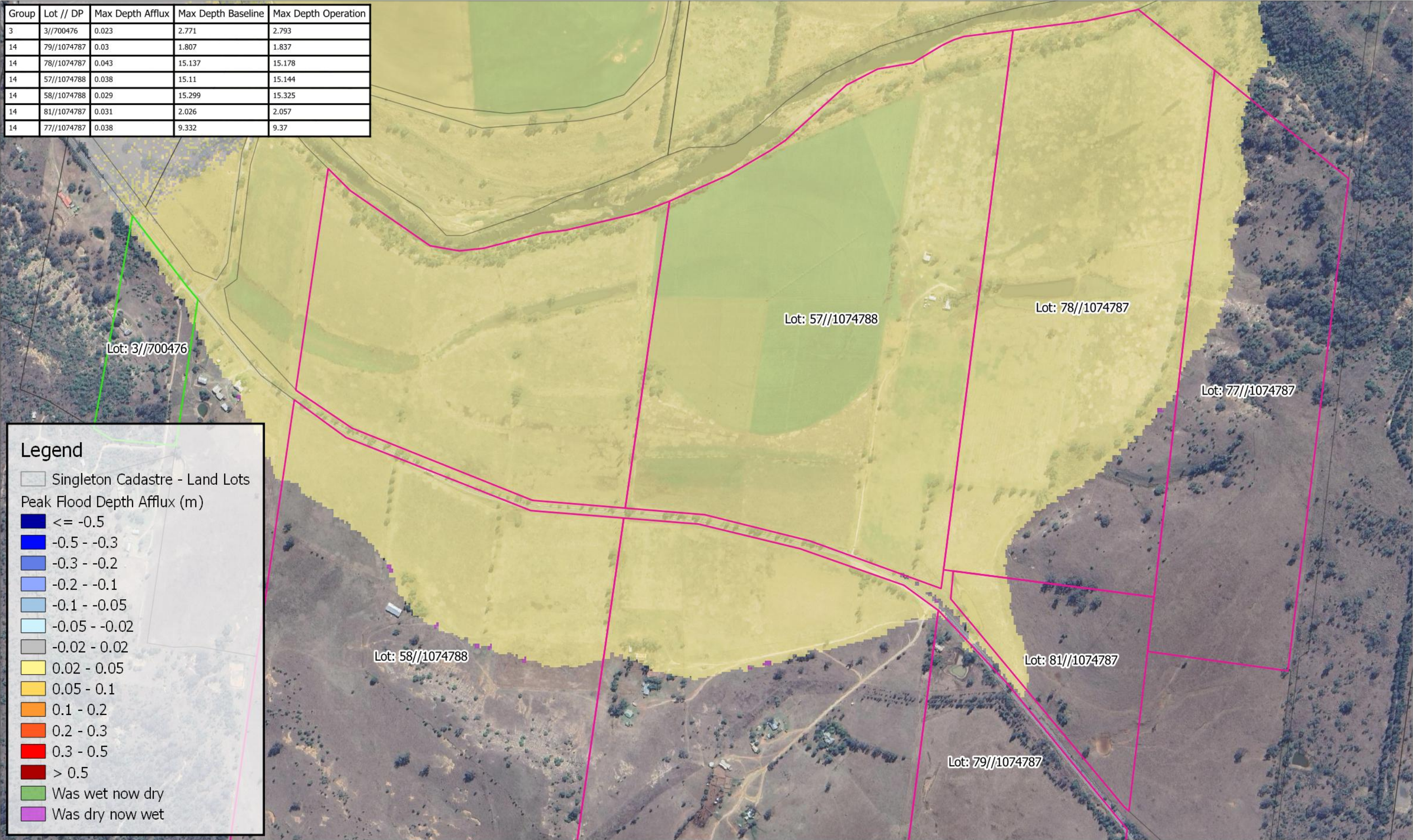
Map Projection: Tranverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

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Figure 13.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 19 DP 621875 (Group 13)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 14/8/2024

Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
3	3//700476	0.023	2.771	2.793
14	79//1074787	0.03	1.807	1.837
14	78//1074787	0.043	15.137	15.178
14	57//1074788	0.038	15.11	15.144
14	58//1074788	0.029	15.299	15.325
14	81//1074787	0.031	2.026	2.057
14	77//1074787	0.038	9.332	9.37



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160 0 160 m

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Grid: Map Grid of Australia, Zone 56

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Figure 14.A: 1% AEP Flood Depth Afflux - Private Land
Impacts
Lot 58 and 57 DP 1074788, Lot 77, 78, 79 and 81 DP
1074787 (Group 14)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024

Group	Lot // DP	Max Velocity Afflux	Max Velocity Baseline	Max Velocity Operation
3	3//700476	<0.1	1.0	1.0
14	78//1074787	<0.1	2.4	2.4
14	58//1074788	<0.1	2.9	2.9
14	81//1074787	<0.1	0.6	0.6
14	77//1074787	<0.1	1.6	1.6
14	79//1074787	<0.1	0.4	0.4
14	57//1074788	<0.1	2.6	2.6



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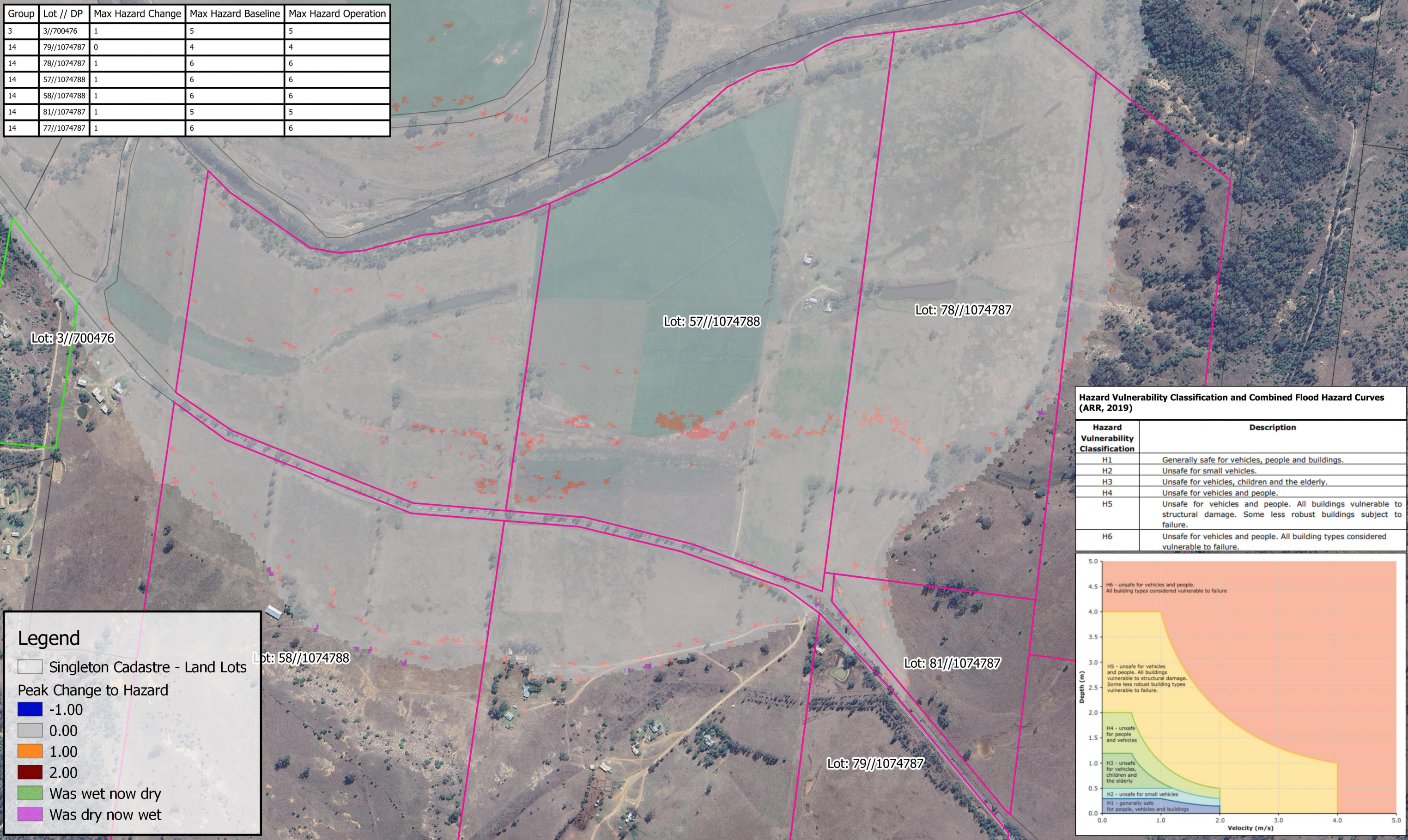
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Vertical Datum: Australia Height Datum
Grid: Map Grid of Australia, Zone 56

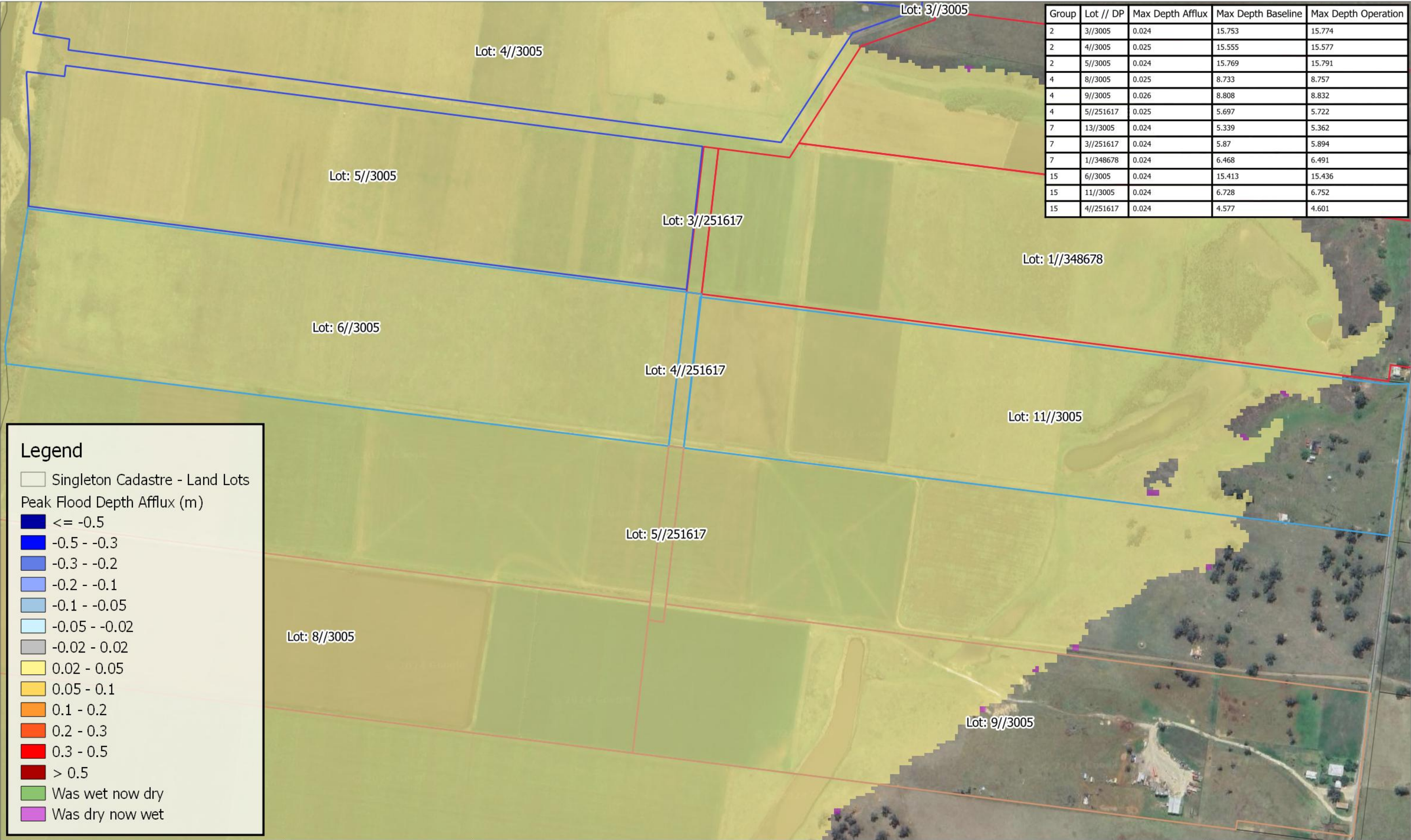
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Figure 14.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 58 and 57 DP 1074788, Lot 77, 78, 79 and 81 DP
1074787 (Group 14)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 9/8/2024

Group	Lot // DP	Max Hazard Change	Max Hazard Baseline	Max Hazard Operation
3	3//700476	1	5	5
14	79//1074787	0	4	4
14	78//1074787	1	6	6
14	57//1074788	1	6	6
14	58//1074788	1	6	6
14	81//1074787	1	5	5
14	77//1074787	1	6	6





Group	Lot // DP	Max Depth Afflux	Max Depth Baseline	Max Depth Operation
2	3//3005	0.024	15.753	15.774
2	4//3005	0.025	15.555	15.577
2	5//3005	0.024	15.769	15.791
4	8//3005	0.025	8.733	8.757
4	9//3005	0.026	8.808	8.832
4	5//251617	0.025	5.697	5.722
7	13//3005	0.024	5.339	5.362
7	3//251617	0.024	5.87	5.894
7	1//348678	0.024	6.468	6.491
15	6//3005	0.024	15.413	15.436
15	11//3005	0.024	6.728	6.752
15	4//251617	0.024	4.577	4.601

Legend

Singleton Cadastre - Land Lots

Peak Flood Depth Afflux (m)

<= -0.5

-0.5 - -0.3

-0.3 - -0.2

-0.2 - -0.1

-0.1 - -0.05

-0.05 - -0.02

-0.02 - 0.02

0.02 - 0.05

0.05 - 0.1

0.1 - 0.2

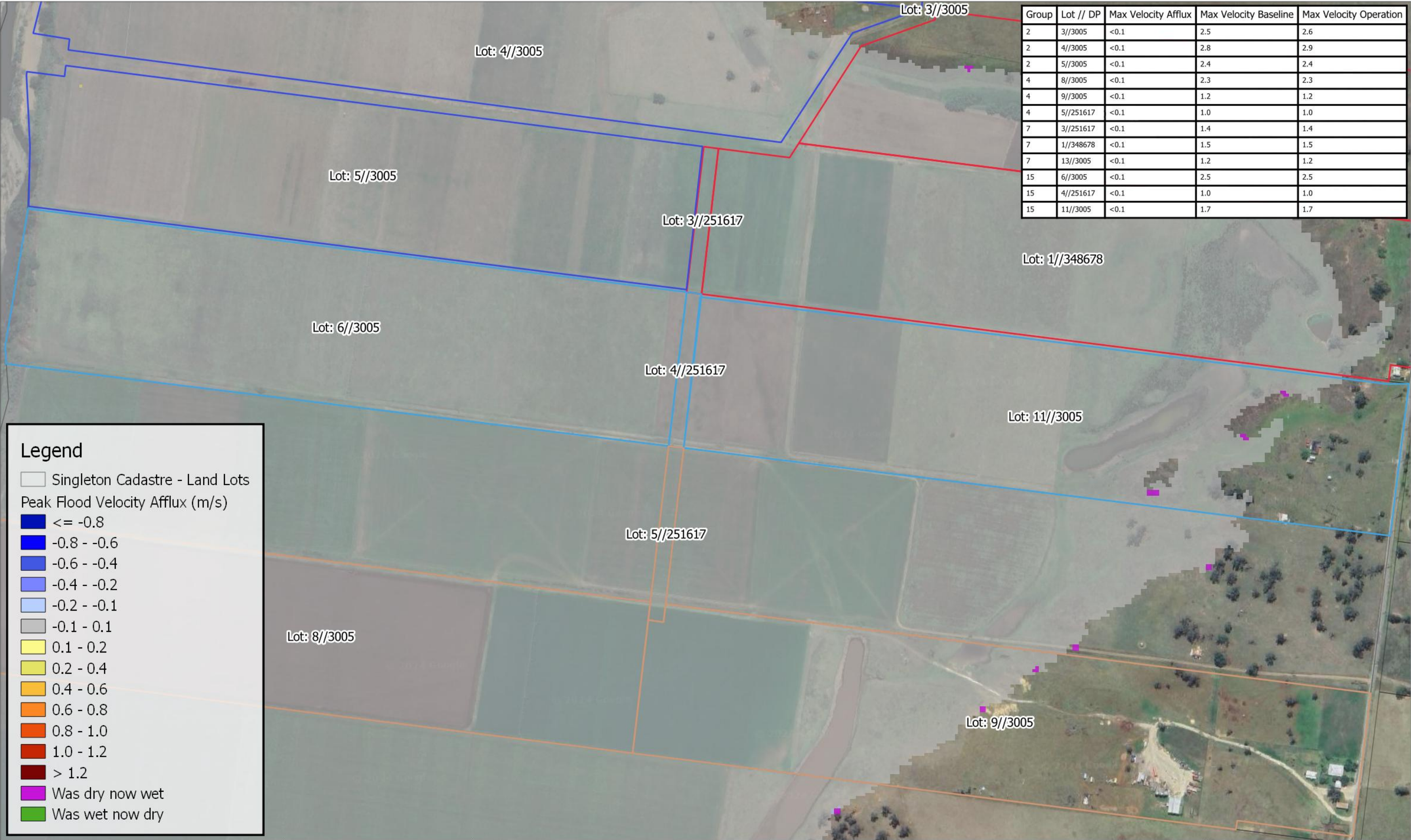
0.2 - 0.3

0.3 - 0.5

> 0.5

Was wet now dry

Was dry now wet



Legend

Singleton Cadastre - Land Lots

Peak Flood Velocity Afflux (m/s)

<= -0.8

-0.8 - -0.6

-0.6 - -0.4

-0.4 - -0.2

-0.2 - -0.1

-0.1 - 0.1

0.1 - 0.2

0.2 - 0.4

0.4 - 0.6

0.6 - 0.8

0.8 - 1.0

1.0 - 1.2

> 1.2

Was dry now wet

Was wet now dry

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N

100000000

0

100 m

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Figure 15.B: 1% AEP Velocity Afflux - Private Land Impacts
Lot 4 DP 251617 and Lots 6 and 11 DP 3005 (Group 15)

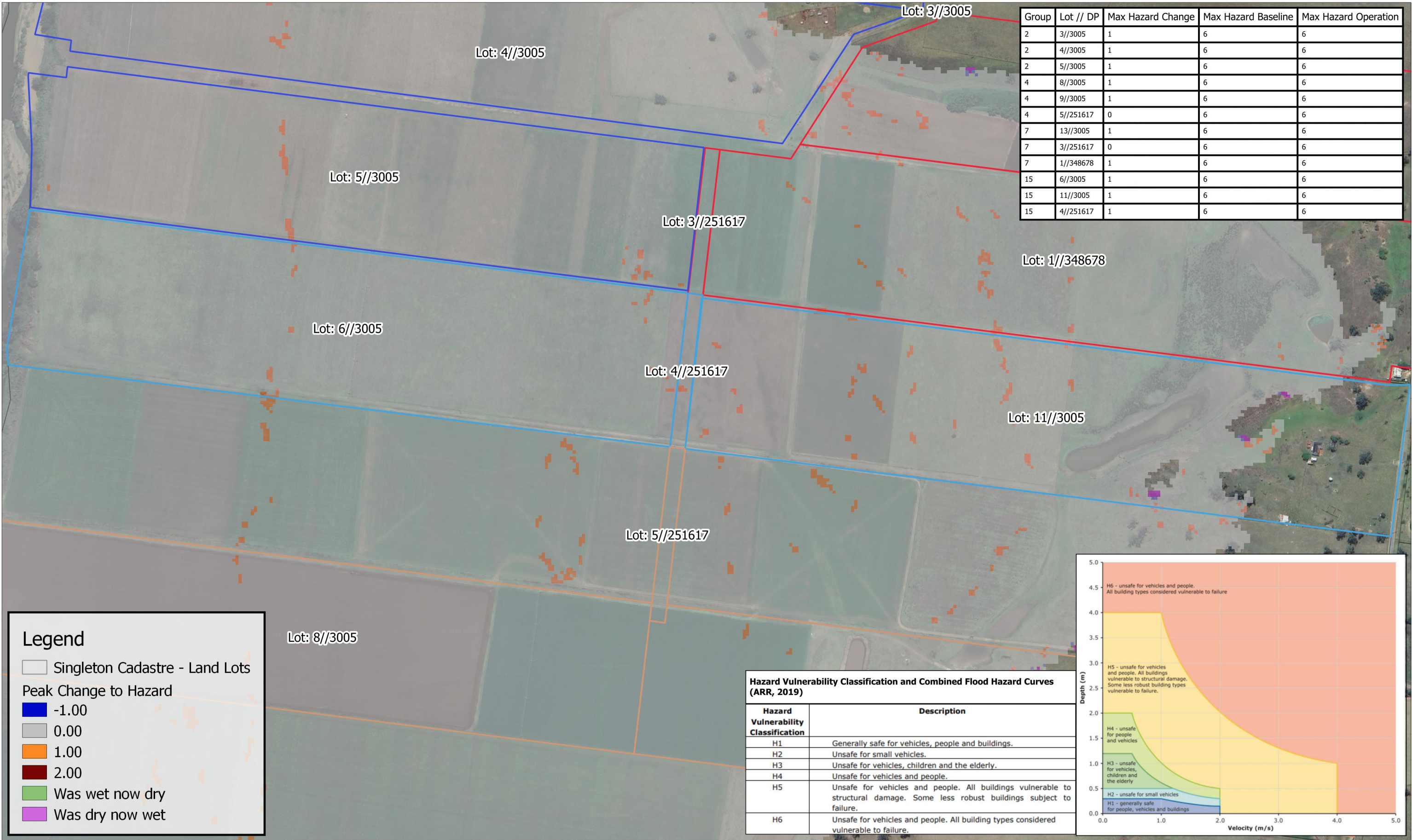
Job Number: NC1013_001

Revision: 0

Drawn: AH

Checked: LV

Date: 9/8/2024

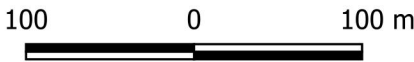


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Figure 15.C: 1% AEP Hazard Afflux - Private Land Impacts
Lot 4 DP 251617 and Lots 6 and 11 DP 3005 (Group 15)

Job Number: NC1013_001
Revision: 0
Drawn: AH
Checked: LV
Date: 8/8/2024