

Tolucy Pty Ltd

Preliminary Flood Assessment: 25 Laitoki Road, Terrey Hills, NSW



ENVIRONMENTAL



WATER



WASTEWATER



GEOTECHNICAL



CIVIL



PROJECT
MANAGEMENT



P1806682JR05V01
January 2019

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All enquiries regarding this project are to be directed to the Project Manager.

Executive Summary

Martens & Associates Pty Ltd (MA) have prepared this preliminary flood assessment to assess the site capability for a proposed seniors living development at 25 Laitoki Road, Terrey Hills, NSW (the site). This report documents the procedures and findings of preliminary hydrologic and hydraulic modelling of the site in existing and proposed conditions.

Assessment concluded that:

1. The site is classified as a 'low flood risk planning precinct' by NBC.
2. The site in its existing conditions is flood affected during the 1% AEP and PMF events.
3. Flood waters back up at southern boundary due to a raised fill pad at adjacent southern property which acts as a retaining wall.
4. All of the proposed building's Finished Floor Levels (FFLs) comply with Council flood planning level requirements.
5. The proposed development has minor offsite impacts on adjacent southern and western properties.
6. Site evacuation is always available during the 1%AEP and PMF flood events via site egress.
7. A detailed flood assessment including additional survey data and proposed site earthworks is required at DA stage.

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1 Introduction

1.1 Overview

Martens & Associates Pty Ltd (MA) have prepared this preliminary flood assessment to assess the site capability for a proposed seniors living development at 25 Laitoki Road, Terrey Hills, NSW (the site).

1.2 Project Scope and Objectives

Project scope and objectives are:

1. Prepare a hydrologic model (ILSAX) for the site to determine the peak flow of the 1% annual exceedance probability (AEP) flood and probable maximum flood (PMF) events.
2. Prepare a hydraulic model (TUFLOW) for the site under existing and proposed conditions.
3. Prepare relevant flood maps including flood extents, depths, levels, velocities, hazards, hydraulic categories and impacts.
4. Comment on flood characteristics and model outcomes in existing and proposed conditions.

1.3 Relevant Guidelines

This report has been prepared in accordance with the following guidelines and policies:

1. Bureau of Meteorology (2003), *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*.
2. Commonwealth of Australia (Geoscience Australia) (2016), *Australian Rainfall and Runoff – A Guide to Flood Estimation*.
3. NSW Department of Infrastructure, Planning and Natural Resources (2005), *Floodplain Development Manual*.
4. Warringah Council (2011a), *Warringah Local Environmental Plan (LEP)*.
5. Warringah Council (2011b), *Warringah Development Control Plan (DCP)*.

1.4 Definitions

AEP	Annual exceedance probability: the probability of a flood event occurring within a year. A 1% AEP flood has a 1% chance of occurring in any given year.
ARI	Average recurrence interval: the average time between flood events occurring. A 100 year ARI flood occurs on average once every 100 years.
ARR	Australian Rainfall & Runoff
BOM	Bureau of Meteorology
Council	Northern Beaches Council (NBC)
DA	Development application
IFD	Intensity frequency duration – design rainfall data for frequent and infrequent storm events.
MA	Martens & Associates Pty Ltd
PMF	Probable maximum flood – the most extreme flood event possible for a certain location, with an approximate ARI of 100,000 to 10,000,000 years.
PMP	Probable maximum precipitation – design rainfall data for extreme storm events.

2 Site Description and Background Data

2.1 Location and Site Description

Existing site description summary is provided in Table 1.

Table 1: Existing site description summary.

Address	25 Laitoki Road, Terrey Hills, NSW 2084.
Lot / DP	Lot 261 DP 775299
Site Area	2.02 Ha
Local Government Area (LGA)	Northern Beaches Council (formerly Warringah Council)
Current Land Use	Rural residential and horse boarding / training establishment.
Current Zoning	RU4–Primary production small lots
Site Description	Neverfail Gully Creek flows through the site from north to southwest. The site is graded in direction of the creek and slopes toward the creek bed from eastern and western boundaries. The site is primarily vegetated with higher density vegetations along the creek and northern site boundary. There is a 2-storey dwelling with driveway and an inground swimming pool west of the dwelling. Site also includes horse stables and sheds and access is via Laitoki Road.
Surrounding Land Uses	Low density residential to the east and rural residential to the other sides,
Site Elevation	Approximately 192.2 mAHD at eastern site boundary and 187.2 mAHD at north-western site boundary falling to 177.7 mAHD upslope of an existing headwall along the southern boundary.
Site Grading & Aspect	Approximately 7% SSW aspect.
Site Drainage	Neverfail Gully Creek runs through the site from north to southwest.

2.2 Site Inspection

Site inspection was conducted on 18 July, 2018 and included:

- General walkover to identify land forms and site characteristics to understand local drainage behaviour.
- Identification and observation of existing site stormwater infrastructure and natural drainage lines.

2.3 Catchment Description

We note the following regarding the catchment upstream of the site:

- The site is located within the Neverfail Gully Creek catchment which is an upper tributary of Kierans Creek.

- Upstream catchment is urbanised to the west and north western of the site, and is rural residential to the north and east of the site.
- The total catchment area is 88.4 ha and is shown in Attachment C plan PS02-K000.

2.4 Site Flood Mechanisms

The site is likely affected by flood overbank flows from Neverfail Gully Creek.

2.5 Previous Flood Studies

A review of previous flood investigations was undertaken to assess likely local flood behaviour and characteristics for the site and the Neverfail Gully Creek catchment. Review did not identify any Council flood studies, but instead identified a previous flood study undertaken by MA which would be relevant to this assessment.

2.5.1 MA (2013) Flood Assessment: 83 Booralie Road, Terrey Hills, NSW

MA has undertaken a flood assessment for a property approximately 190 m upstream of the site at 83 Booralie Road, Terrey Hills. The study was prepared to support a development application for a seniors living development at the site (DA 2013/0796). This flood assessment has been accepted by Warringah Council, and construction of buildings at the above address has been completed. Full details of the flood study are provided in MA report (2013) P1203558JR09V01.

2.6 Proposed Development

Architectural drawings prepared by Playoust Churcher Architects (Attachment B) indicate that the proposed development will include:

- Demolition of existing structures on site.
- Construction of 12 residential houses and a community centre on the western side of Neverfail Gully Creek.
- Construction of two residential blocks comprising 10 terrace houses and five residential apartments on the eastern side of Neverfail Gully Creek. Proposed buildings east of the Creek include basement and underground carparking areas.
- Construction of internal driveways including a bridge or box culvert across Neverfail Gully Creek as well as multiple footpaths across the site.

We note that no proposed site grading details or design earthworks were provided at this stage of the development.

3 Hydrology Modelling

3.1 Overview

For this assessment the previously NBC approved DRAINS model developed for the flood assessment at the upstream site (83 Booralie Road) was used. The catchment area and times of concentration were updated to represent the increased catchment areas arriving at 25 Laitoki Road.

The DRAINS software package (version 2018.06 – 17 July, 2018) was used with the ILSAX hydrological engine to assess the 1% AEP flood and PMF peak flow rates for a range of storm durations between 5 minutes and 6 hours.

3.2 Model Setup

Parameters used for the updated DRAINS model are consistent with the flood assessment for 83 Booralie Road and are provided in Table 2 and Table 3. Model inputs are as follows:

1. Sub-catchment delineations and flow paths were updated using LIDAR data provided by Land and Property Information NSW (LPI 2013) and site survey provided by Bee & Lethbridge Pty Ltd. Refer to Attachment C PS02-K000 for site catchment plan.
2. Sub-catchment impervious areas were adopted based on recent catchment aerals obtained from Nearmaps (2018).
3. Sub-catchment times of concentration were calculated based on individual catchment properties and reach flow paths (kerb / overland / channel / pipe flow etc).
4. Intensity Frequency Duration (IFD) data, rainfall temporal patterns and Probable Maximum Precipitation (PMP) data were based on the previous MA flood assessment at 83 Booralie Road. Data was based on Australian Rainfall & Runoff (1987) and BOM (2003). Refer to P1203558JR09V01 for details.
5. ILSAX parameters have been adopted from the previous MA flood assessment and are based on the suggested values in the DRAINS (2018) user's manual.
6. DRAINS model layout is provided in Attachment C PS02-K010.

Table 2: Details of sub-catchments used in ILSAX modelling.

Sub-catchment ¹	Area (ha) ¹	Impervious (%) ²	Pervious (%) ²	Time of Concentration (min) ³	
				Impervious	Pervious
Catchment 1	26.5	60	40	22.5	28.1
Catchment 2	24.8	62	38	14.5	21.5
Catchment 3	15.4	18	82	14.5	20.3
Catchment 4	7.9	21	79	15.9	13.1
Catchment 5	4.2	20	80	8.8	17.1
Catchment 6	9.5	29	71	9.6	19.3
Total	88.4				

Notes

- 1. Obtained based on LIDAR data provided by LPI (2013). Refer to Attachment C plan PS02-K000 for site catchment plan.
- 2. Adopted based on recent catchment aerials obtained from Nearmaps (2018).
- 3. Calculated based on individual catchment properties and reach flow paths (kerb / overland / channel / pipe flow etc).

Table 3: Probable maximum precipitation data used in DRAINS modelling.

PMP Data ¹	Unit	Value
PMP 15 min rainfall intensity	mm/hr	650.0
PMP 30 min rainfall intensity	mm/hr	450.2
PMP 45 min rainfall intensity	mm/hr	379.7
PMP 1 hour rainfall intensity	mm/hr	330.3
PMP 1.5 hour rainfall intensity	mm/hr	275.9
PMP 2 hour rainfall intensity	mm/hr	239.5
PMP 3 hour rainfall intensity	mm/hr	190.3
PMP 6 hour rainfall intensity	mm/hr	125.0

Notes

- 1. Adopted based on the previously approved DRAINS model using the BOM (2003) Generalised Short Duration Method.

3.3 Results

Results of peak flow rates for sub-catchments arriving at the site for the critical duration 1% AEP flood event and PMF event are summarised in Table 4. The critical storm duration was determined to be 2 hours for the 1% AEP flood event and 30 minutes for the PMF event. DRAINS model results for critical storm durations are provided in Attachment C PS02-K015.

Table 4: Peak 1% AEP and PMF flow rates for critical duration storms estimated by DRAINS modelling for sub-catchments arriving at the site.

Sub-catchment	Peak Catchment Flow Rates (m³/s)	
	1% AEP (2 hrs)	PMF (30 mins)
1	10.5	34.5
2	11.2	38.5
3	6.3	21.8
4	3.7	13.7
5	1.9	6.1
6	4.4	13.7
Total	37.4 ¹	119.1 ¹

Notes

1. The offset of the timing of each catchment's hydrograph means the total flow rate is not always equal to the sum of all catchment peak flow rates.

4 Hydraulic Modelling

4.1 Overview

The TUFLOW hydraulic model was used to determine flood characteristics including flood extents, levels, depths, velocities, hydraulic hazard, water level impacts for the critical 1% AEP flood and PMF events for existing and proposed conditions.

4.2 Scenarios

The hydraulic model was setup to represent the following flood condition scenarios:

1. Existing condition: The catchment and site are in their current state as described in Sections 2.1, 2.3 and 2.4.
2. proposed condition: the catchment in its current state and the site was changed to represent the proposed development as described in Section 2.6.

The hydraulic model was used to assess flood behaviour for the following events:

3. 1% AEP 2 hours (critical duration) event.
4. PMF 30 minutes (critical duration) event.

In summary, a total of 4 scenarios were modelled as part of this assessment (2 flood condition scenarios and 2 flood events each).

4.3 Terrain Data

A 3D surface for the existing catchment site and local floodplain environment was prepared for the TUFLOW model using:

1. LIDAR data provided by LPI (2013).
2. Site survey data provided by Bee & Lethbridge Pty Ltd (November 2017) (Attachment A).
3. Survey data for 85 Booralie Road provided by Bee & Lethbridge Pty Ltd and works as executed Neverfail Gully Creek channel survey downstream of Laitoki Road (May 2016).
4. Survey data for 58 Laitoki Road provided by Bee & Lethbridge Pty Ltd (May 2015).

5. Survey data for 83 Booralie Road provided by Bee & Lethbridge Pty Ltd (September 2012).

4.4 Model Setup

4.4.1 Existing Conditions

TUFLOW model construction for existing conditions consisted of:

1. A 1.0 m topographic grid based on the data listed in Section 4.3.
2. The model domain was defined from a point downstream of the Laitoki Road culvert (122 m upstream of the site) to a point 240 m downstream of Cooyong Road. Model boundary extents were generally placed along Neverfail Gully Creek ridgelines and connecting high points surrounding the study area.
3. Inflow boundary conditions based on the critical duration 1% AEP and PMF hydrographs from DRAINS for each of the six sub-catchments discharging to the study area.
4. Computed water slopes for downstream model extent boundary conditions based on the slopes from available LIDAR data.
5. Manning's zones based on Nearmaps (2018) aerial photography of the study area with roughness coefficients adopted from the MA flood assessment as per Table 5.
6. Existing buildings obstructions were represented as elevated cells in the model.
7. A 1050 mm pipe at southern property collecting stormwater from downstream of the site was modelled as a 1D element based on the Bee & Lethbridge Pty Ltd survey and LIDAR data, and a 25% blockage was adopted based on the assessment procedure in Australian Rainfall and Runoff (Weeks & Rigby, 2016).
8. The three 1050 mm pipes below Cooyong Road were modelled as a 1D element based on the Bee & Lethbridge Pty Ltd survey data, and a 25% blockage was adopted based on the assessment procedure in Australian Rainfall and Runoff (Weeks & Rigby, 2016). All other pits and pipes in the study area have conservatively been assumed to be 100% blocked.

Table 5: Manning's roughness values for TUFLOW modelling.

Catchment Material Type	Manning's Roughness Coefficient ¹
Low Density Vegetation	0.035
High Density Vegetation	0.080
Developed Creek bed	0.045
Roads / Concrete	0.0150

Notes

1. Based on the previous MA flood assessment (83 Booralie Road).

4.4.2 Proposed Conditions

The existing conditions model was modified as follows to simulate proposed conditions:

1. Existing site buildings were removed and replaced with proposed buildings to model as flow obstructions.
2. Proposed site driveways were represented as elevated cells with elevations based on the architectural plan details.
3. Existing model surface was raised at the proposed bridge's abutments to model flow obstructions. Model surface beneath the bridge's deck was remained as existing to let flood waters flow through. No additional blockage was assumed for the proposed bridge.
4. Site manning's zones were updated to represent the proposed surfaces as detailed in Section 2.6.

All other model construction elements remained consistent with the existing conditions model.

4.5 Results

4.5.1 Flood Results

Flood mapping results (flood levels, depths, velocities and provisional hazard categories) for the critical duration 1% AEP flood event and PMF events in addition to hydraulic categories map in existing and proposed conditions are provided in Attachment C, with drawing references summarised in Table 6.

Table 6: Flood map drawing references in Attachment C (MA planset P1806682PS02).

Flood Condition Scenario	Critical Duration Flood Event	Water Level & Depth	Water Velocity	Provisional Hydraulic Hazard ¹	Hydraulic Categories ²	Water Level Afflux
Existing Conditions	1% AEP	K100	K101	K102	K103	–
	PMF	K110	K111	K112	—	–
Proposed Conditions	1% AEP	K200	K201	K202	K203	K300
	PMF	K210	K211	K212	—	K310

Notes

- 1. Provisional hydraulic hazard categories are based on NSW Floodplain Development Manual (2005) definitions and are shown in Figure 1.
- 2. Floodway is defined as areas where the VD product (Velocity × Depth) is greater than 0.25 m²/s or velocity is greater than 1.0 m/s and peak depth is greater than 0.15 m. Flood storage is defined as areas outside the floodway where peak depth is greater or equal 1.0 m. Flood fringe is defined as areas outside the floodway where peak depth is smaller than 1.0 m.

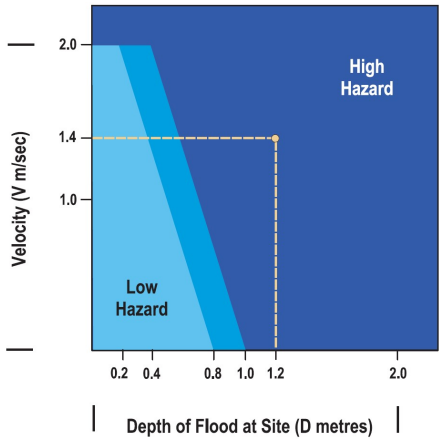


Figure 1: Provisional hydraulic hazard categories (NSW Floodplain Development Manual, 2005).

4.6 Discussion

We note the following regarding modelled flood behaviour:

4.6.1 Existing Conditions

- 1. The primary source of site flooding is overbank flows from Neverfail Gully Creek.
- 2. Flood waters primarily flow across the site from north to southwest in the flow direction of Neverfail Gully Creek.
- 3. Flood waters reach the existing headwall downslope of southern boundary. A portion of water is conveyed via a drainage pipe easement (single 1050 mm) through the southern property and eventually discharged into Neverfail Gully Creek at downstream of the southern property.

4. Excess flood waters back up at southern boundary due to a raised fill pad at downstream property which acts as a dam. Flood waters are dammed up along south-western boundary before discharging via overland flow onto the southern and eastern properties.
5. Flood water depth typically raises up to 1 m in the 1%AEP and 1.2 m in the PMF events upslope of the existing fill pad, just before it overtops onto the downstream properties.
6. Maximum water depth on the site occurs upslope of the existing easment headwall along the southern boundary to 3.5 m in the 1%AEP event and 3.8 m in the PMF event.
7. Provisional flood hazard is high through the drainage line as well as upslope of the fill pad at the southern property. Provisional flood hazard is low to intermediate for the rest of flood affected areas on site.

4.6.2 Proposed Conditions

1. Proposed flooding conditions are largely unchanged from existing conditions.
2. Entirety of the proposed internal driveways are flood free in the 1% AEP and PMF events.
3. Entirety of the proposed buildings at eastern side of the creek are flood free in the 1% AEP and PMF events.
4. Six of the proposed buildings on the western side of the creek including the community centre, House 1, House 8, House 9, House 11 and House 12 are flood affected in the 1% AEP and PMF events.
5. Flood affection for the proposed buildings in the south-western area of the site is aggravated due to an existing raised fill pad at southern property which detains flood waters at southern boundary and causes flood waters to back up onto the site.
6. The proposed bridge's top of deck is at 183.9 mAHD which is 400 mm above the 1% AEP flood level of 183.5 mAHD and 200 mm above the PMF level of 183.7 mAHD at the bridge.
7. Floor level compliance:
 - a. NBC classify the site as a low flood risk planning precinct, and require minimum habitable level for the development to be 'set at the PMF level or the 1% AEP level plus 500 mm freeboard whichever is greater' (Warringah DCP 2011).

- b. Table 7 demonstrates that proposed habitable finished floor level (FFL) for the proposed development is above NBC's minimum acceptable floor level and indicates that the proposed development achieves compliance with NBC requirements.
8. All site habitable floor levels are above their corresponding peak PMF levels. All internal driveways are flood free during the PMF events. Hence, evacuation from site egress to Laitoki Road is always available during flood events up to and including the PMF.

Table 7: Minimum accepted habitable floor levels for the proposed development.

Building	Building RL (mAHD)	1%AEP Water Level (mAHD)	PMF Water Level (mAHD)	1% AEP Water Level + 500mm (mAHD)	Complies
Community Centre	183.90	182.24	182.54	182.74	Yes
House 1	182.35	180.56	180.78	181.06	Yes
House 2	182.35	180.92	181.13	181.42	Yes
House 3	182.80	182.12	182.16	182.62	Yes
House 4	183.60	182.24	182.54	182.74	Yes
House 5	184.00	183.13	183.45	183.63	Yes
House 6	184.00	183.13	183.45	183.63	Yes
House 7	184.00	183.13	183.45	183.63	Yes
House 8	184.00	183.13	183.45	183.63	Yes
House 9	183.90	182.12	182.16	182.62	Yes
House 10	183.90	182.12	182.16	182.62	Yes
House 11	182.40	180.92	181.13	181.42	Yes
House 12	182.40	180.57	181.13	181.07	Yes
Block A	190.00	183.21	183.33	183.71	Yes
Block B	190.50	184.85	185.29	185.35	Yes
Block C	186.00	183.21	183.33	183.71	Yes
Block D	188.00	184.85	185.29	185.35	Yes
Block E	186.00	184.85	185.29	185.35	Yes
Block F	184.00	183.21	183.33	183.71	Yes
Block G	183.00	181.33	181.53	181.83	Yes

Notes

1. Refer Attachment C PS01-K200 for modelled proposed 1% AEP flood levels.
2. Refer Attachment C PS01-K210 for modelled proposed PMF flood levels.
3. NBC requires the minimum habitable floor level to be set at the PMF level or the 1% AEP level plus 500 mm freeboard whichever is greater.
4. Refer architectural drawings (Attachment B).

4.6.3 Offsite Flood Impacts

1. The proposed development has minor offsite impacts above 20 mm in the 1% AEP flood event which affects approximately 19 m² of the southern property (Lot 262 DP 775299) and 22 m² of the western property (Lot 47 DP 752017).
2. The proposed development has minor offsite impacts above 50 mm in the PMF event which affects approximately 22 m² of the southern property and 84 m² of the western property.

5 Summary and Recommendations

A detailed hydrologic and hydraulic model has been developed for the site using previously accepted MA flood assessment for 83 Booralie Road (refer to MA report P1203558JR09V01). Detailed site survey in addition to survey data for 85 & 83 Booralie Road and 58 Laitoki Road and proposed design elements for 83 Booralie Road were used to assess local flood characteristics.

The model was used to determine the existing and proposed flood conditions in the 1% AEP and PMF flood events. Modelling concluded that:

1. An area at the centre of the site along the existing drainage line and an area southwest of the site are affected by flood waters in the 1% AEP and PMF events.
2. Flood affection of the proposed buildings in the southwest of the site is aggravated due to an existing fill pad on the southern property which detains flood waters at site's southern boundary and causes flood waters to back up onto the site.
3. Entirety of the proposed buildings on eastern side of the creek are flood free in the 1% AEP and PMF events.
4. Six of the proposed buildings on western side of the creek are flood affected in the 1% AEP and PMF events.
5. All of the proposed building's Finished Floor Levels (FFLs) comply with Council flood planning level requirements.
6. The proposed bridge's top of deck is 400 mm above the 1% AEP flood level and 200 mm above the PMF level.
7. Proposed internal driveways remain flood free during all flood events up to and including the PMF.
8. The proposed development has minor offsite impacts on southern and western properties.
9. Site evacuation is always available during the 1%AEP and PMF flood events via site egress.

The following recommendations are made:

1. Detailed survey data for the existing fill pad on the southern property to be included in flood models.
2. Detailed survey data for the existing drainage easement through the southern property to be included in flood models.
3. Minor earthworks are recommended at the site to address the unacceptable offsite flood impacts in the 1% AEP and PMF events.
4. A detailed flood assessment including additional survey data and proposed site earthworks is to be undertaken at DA stage.

6 References

Bureau of Meteorology (2003), *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*.

Commonwealth of Australia (Geoscience Australia) (2016), *Australian Rainfall and Runoff – A Guide to Flood Estimation*.

DRAINS (2017), *DRAINS Content Menu*.

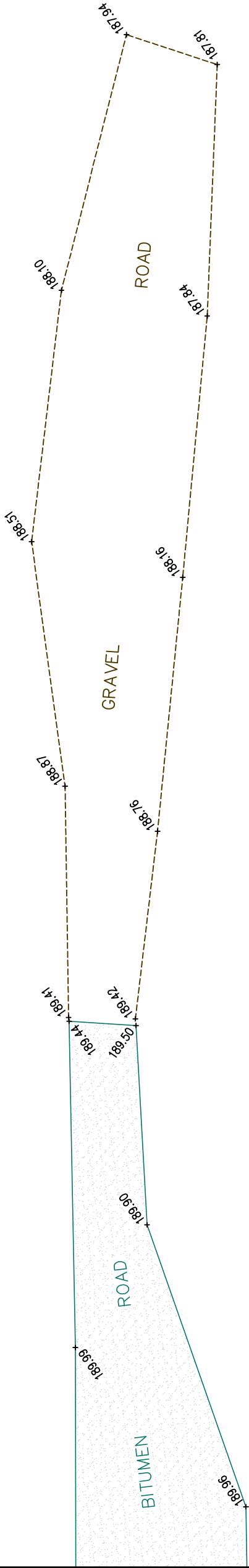
Martens & Associates (August 2017) *Flood Assessment: Proposed Seniors Living Development, 85 Booralie Road, Terrey Hills, NSW, (REF: P1705808JR07V02, August 2017)*.

Martens & Associates (June 2012) *Flooding Assessment, 83 Booralie Road, Terrey Hills, NSW, (REF: P1203558JR09V01, June 2013)*.

NSW Department of Infrastructure, Planning and Natural Resources (2005), *Floodplain Development Manual*.

Warringah Council (2011a), *Warringah Local Environmental Plan (LEP)*.

Warringah Council (2011b), *Warringah Development Control Plan (DCP)*.



NOTES:

- 1) CAUTION: SHOULD ANY DEVELOPMENT OR CONSTRUCTION BE PLANNED ON OR NEAR THE BOUNDARIES, THE BOUNDARIES SHOULD BE CLEARLY MARKED ON SITE.
- 2) ALL AREAS AND DIMENSIONS HAVE BEEN COMPILED FROM PLANS MADE AVAILABLE AT THE LAND TITLES OFFICE.
- 3) ORIGIN OF LEVELS ON A.H.D. IS TAKEN FROM S.S.M. 35455 RL 197.327 A.H.D.
- 4) CONTOUR INTERVAL 0.5 METRE.
- 5) CONTOURS ARE INDICATIVE OF GROUND FORM ONLY. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION.
- 6) TREE SPREADS ARE DIAGRAMMATIC ONLY AND ARE NOT SYMMETRICAL.
- 7) UNDERGROUND (NON VISIBLE) SERVICE LINES HAVE BEEN SHOWN FROM "DIAL BEFORE YOU DIG" SERVICE AUTHORITY RECORDS & ARE DIAGRAMMATIC ONLY IN REGARD TO THEIR POSITION & WIDTH UNLESS STATED OTHERWISE.
- 8) SPOT LEVELS ARE ACCURATE.

INVESTIGATION OF "DIAL BEFORE YOU DIG" UNDERGROUND SERVICES HAS BEEN MADE. DETECTION OF UNDERGROUND SERVICES IS NOT AN INTEGRAL PART OF THIS SURVEY. ALL RELEVANT AUTHORITIES SHOULD BE NOTIFIED PRIOR TO ANY EXCAVATION ON OR NEAR THE SITE

DEVELOPERS & EXCAVATORS MAY BE HELD FINANCIALLY RESPONSIBLE BY THE ASSET OWNER SHOULD THEY DAMAGE UNDERGROUND NETWORKS.

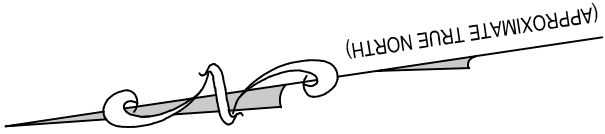
CARELESS DIGGING CAN:
- CAUSE DEATH OR SERIOUS INJURY TO WORKERS AND THE GENERAL PUBLIC
- INCONVENIENCE USERS OF ELECTRICITY, GAS, WATER AND COMMUNICATIONS
- LEAD TO CRIMINAL PROSECUTION AND DAMAGES CLAIMS
- CAUSE EXPENSIVE FINANCIAL LOSSES TO BUSINESS
- CUT OFF EMERGENCY SERVICES
- DELAY PROJECT COMPLETION TIMES WHILE THE DAMAGE IS REPAIRED

MINIMISE YOUR RISK AND DIAL BEFORE YOU DIG.
TEL. 1100

www.dialbeforeyoudig.com.au

+ 190.22

M.G.A.
(MAP GRID of AUSTRALIA.)



TOORONGA



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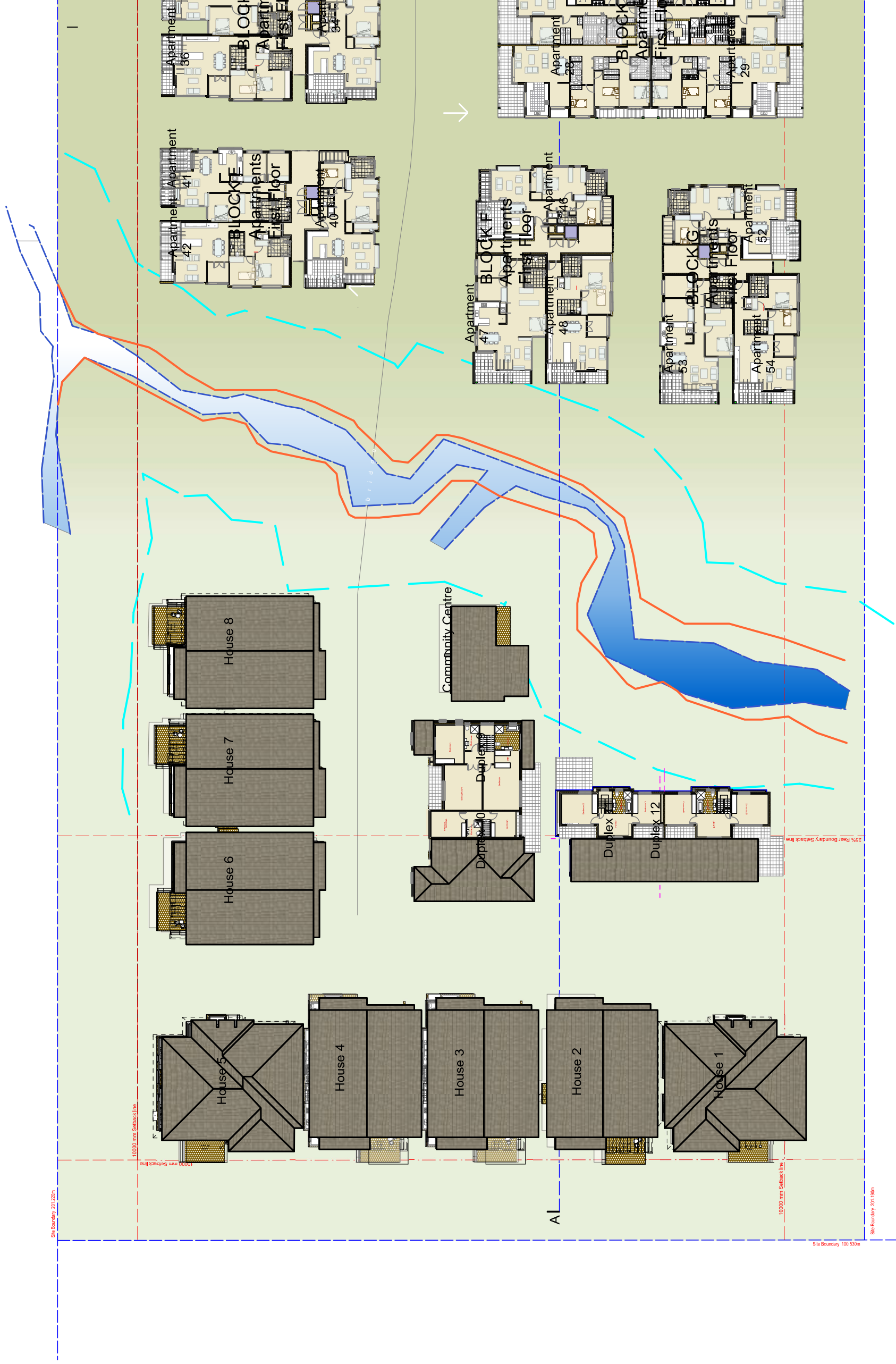
SITE AREA

2.023ha

WATER COURSE

NATURAL

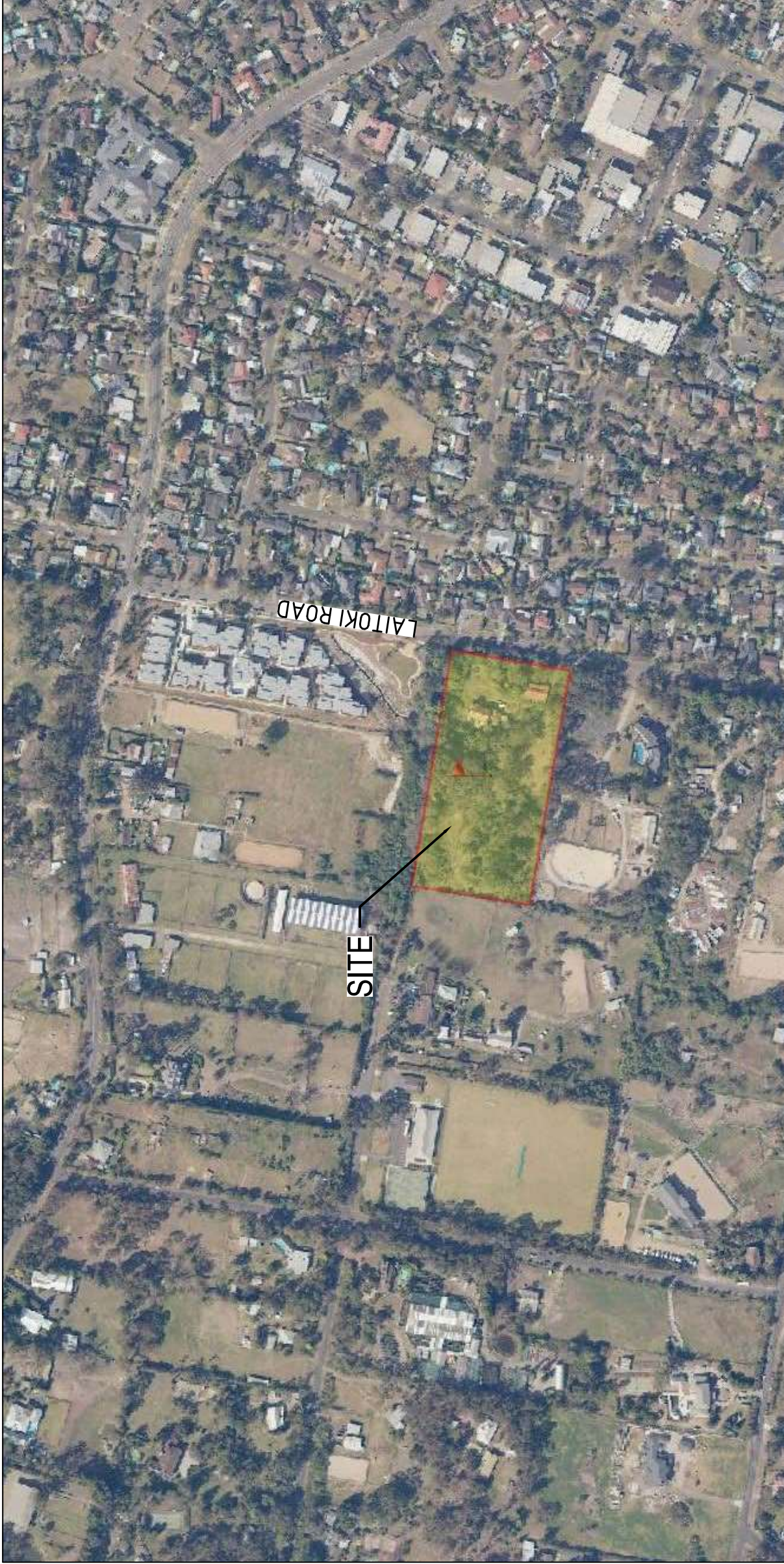
SCATTERED TREES, SHRUBS & GRASSY AREAS

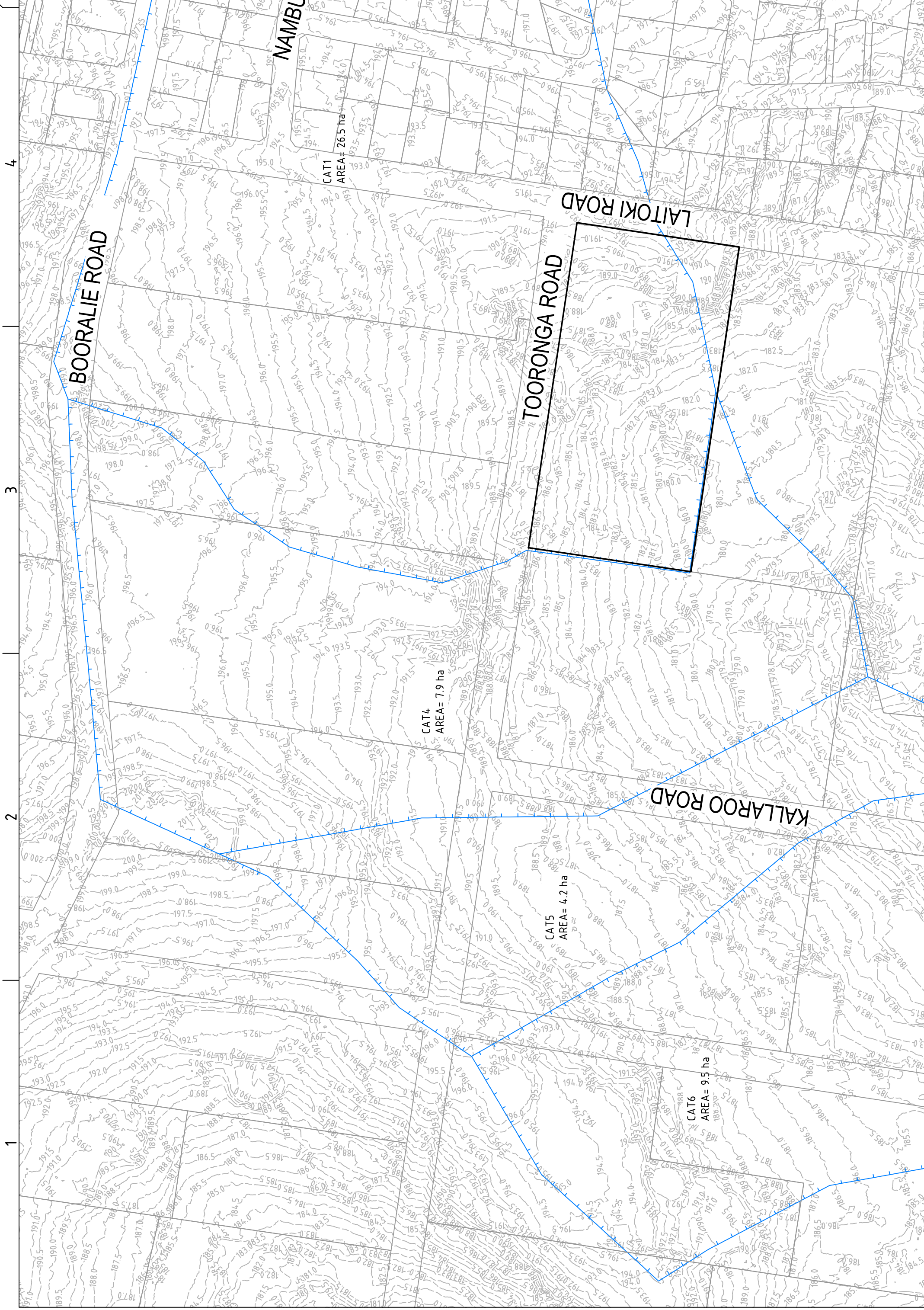


PROJECT: SITE CAPABILITY ASSESSMENT

PLANSET: PRELIMINARY FLOOD ASSESSMENT

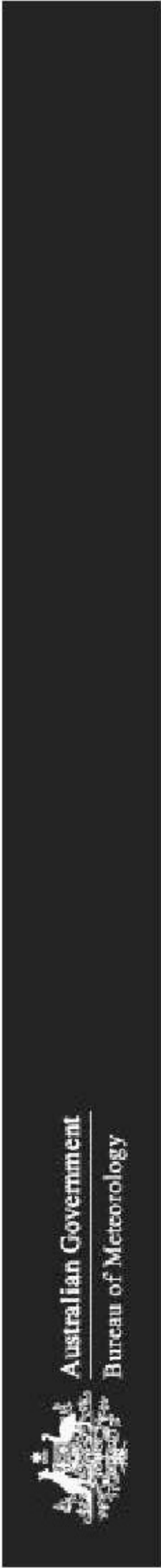
CLIENT: TOLUCY PTY LTD





24/07/2017

Rainfall IFD Data System: Water Information: Bureau of Meteorology



Location

Label: 85 Booralle Rd, Terrey Hills

Latitude: -33.679627 [Nearest grid cell: 33.6875 (S)]

Longitude: 151.219172 [Nearest grid cell: 151.2125 (E)]

IFD Design Rainfall Intensity (mm/h)

Issued: 24 July 2017

Rainfall Intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
[FAQ for New ARR probability terminology](#)

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	142	160	219	261	305	366	416
2 min	118	132	178	211	245	296	338
3 min	109	122	165	196	229	276	315
4 min	103	115	156	186	217	261	298
5 min	97.0	109	148	177	207	249	283
10 min	76.7	86.5	119	142	166	199	226
15 min	63.8	72.0	99.0	118	138	166	188
20 min	55.0	62.0	85.2	102	119	143	162
25 min	48.5	54.7	75.1	89.8	105	126	143

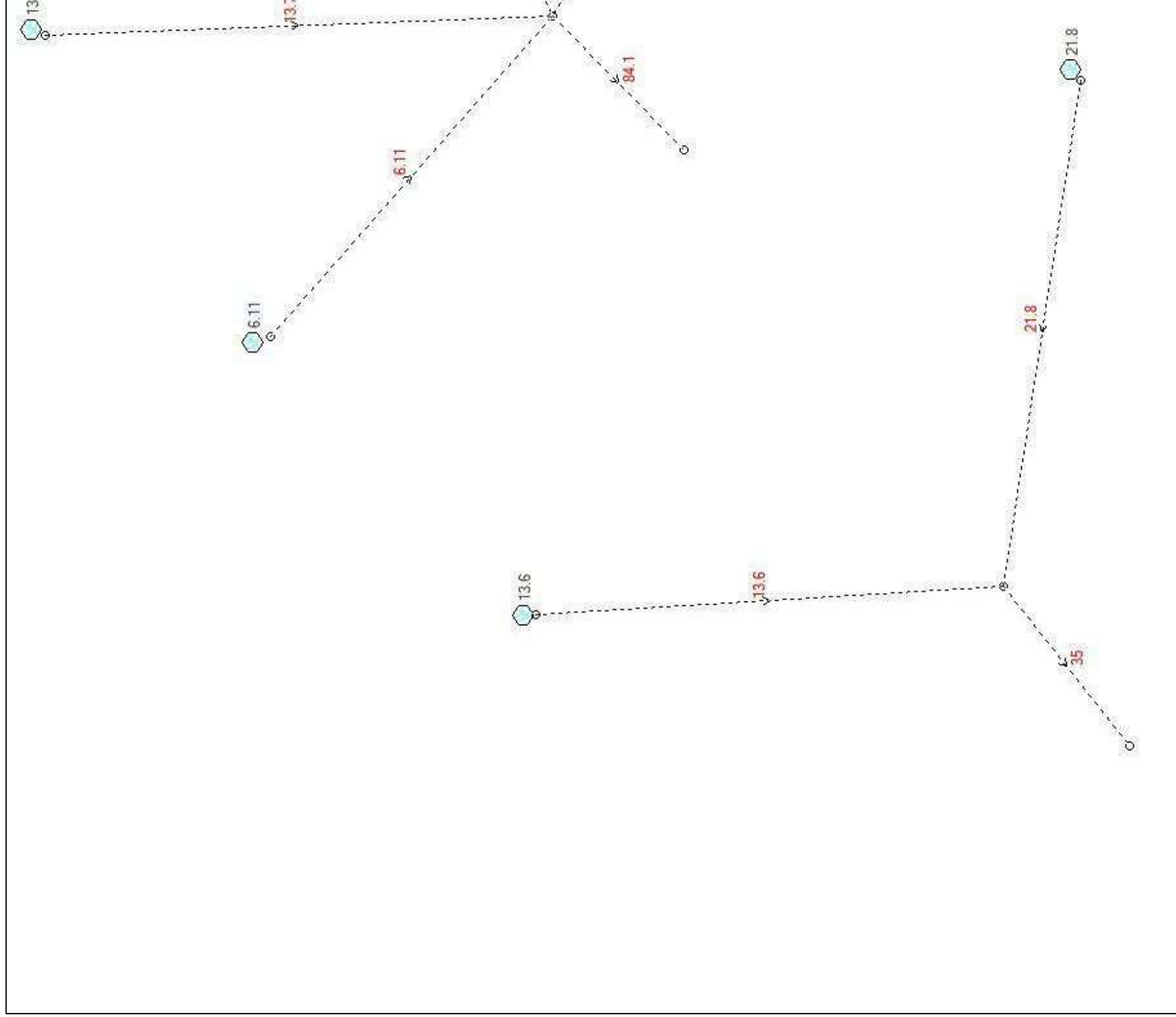


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PMF CRITICAL S⁺





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