Appendix 7a_Water Cycle Management Study

LAND REZONING PROPOSAL

'ALLFARTHING'

LOTS 61 TO 64 & 71 TO 77 DP976708 AND LOT 60 DP1090981

2 BRISBANE GROVE ROAD

BRISBANE GROVE. NSW. 2580

WATER CYCLE MANAGEMENT STUDY

Prepared by SOWDES
19 October 2021

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Water Cycle Management Study

Executive Summary.

This *Water Cycle Management Study* has been prepared in support of a submission to the Goulburn Mulwaree Council for the rezoning of a parcel of land identified as Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 – 2 Brisbane Grove Road, Brisbane Grove from its current status of 'RU6 – Transition' to 'R5 Large Lot Residential'. The land rezoning opportunity has been identified in the recently commissioned *Urban and Fringe Housing Strategy* undertaken on behalf of the Goulburn Mulwaree Council by Elton Consulting which was adopted by Council in July 2020.

The development site falls within the boundaries of the defined Sydney Drinking Water Catchment hence this submission has been undertaken in accordance with the information requirements of both the Goulburn Mulwaree Council and Water NSW best practice publications titled '*Water Sensitive Design Guide for Rural Residential Subdivisions*' (May 2021), '*Using MUSIC in Sydney's Drinking Water Catchment*' (June 2019), and '*Developments in the Drinking Water Catchment – Water Quality Information Requirements*' (June 2018). Where practical and appropriate, the recommendations, constraints and conditions from the above listed documents have taken precedence in the modelling and design process such that any water quality issues, environmental concerns, and matters pertaining to public amenity have been addressed. The proponents have been involved throughout the modelling and design process by contributing to the information source and providing general commentary on the overall recommendations and findings. The submission of a *Water Cycle Management Study* to Water NSW for assessment of the land rezoning proposal also satisfies the Ministerial Directions obligations under the Section 9.1 of the Environmental Planning and Assessment Act (1979) – Direction 5.2 Sydney Drinking Water Catchments.

The subject site is located at the intersection of the Braidwood Road and Brisbane Grove Roads which is just on the southern outskirts of the city of Goulburn, approximately 400 metres south of where the Mulwaree River crosses under Thorns Bridge. The site is bordered by three separate formed roads; the Braidwood Road traffic corridor along the western boundary which is a Traffic for NSW (TfNSW) classified road, Brisbane Grove Road along the northern boundary, and Johnsons Lane along the southern boundary. The property covers a total area of 34.863 hectares which is comprised of twelve separate registered portions totalling 33.981 hectares plus a separate 8,828m² portion of freehold land still held in the name of a former landowner that was subdivided for possible future road allocation but has never been dedicated as such. The property which is set to open paddocks of improved pastures and native grasslands with a discontinuous row of old radiata pine trees along the western roadside boundary has historically been used for grazing by stock, however the past 5 or so years has seen only light grazing and minor silage production.

The site has a *locally significant* heritage listed homestead (Goulburn Mulwaree LEP – Schedule 5, Part 1 – Heritage Items – Item # 1009) that is located at the crest of a hillock within the southern half of the holding. A conceptual subdivision design for the property has been prepared which allows for the existing homestead to be the focal point of the development and provides for proposed future residential dwellings to be established in a manner that is sympathetic to the heritage values of the area. The conceptual subdivision design will create a total of sixteen allotments, of which fifteen will be seeking new residential dwelling permissibility whilst the remaining Lot will house the existing homestead. All proposed Lots will have a minimum land area of 2 hectares, and each will have separate access from either Johnsons Lane along the southern boundary of the current holding or via a proposed new internal access road.

This Water Cycle Management Study is divided into four sections; the first being an overview and the triggers for the rezoning submission, and a detailed description of the development property and surrounding landscape; the second section is a stormwater quality assessment for the civil works associated with a proposed future subdivision of the land and satisfying the Neutral or Beneficial Effect requirements; the third section is an assessment of the potential or likelihood for overland stormwater drainage and flood impacts to affect the proposed future subdivision of the land; and the forth section is a wastewater management assessment for each of the proposed Lots created by a future subdivision of the land.

Within the Water Cycle Management Study assessment a 'potential building envelope' having a nominal area of 600m² has been identified within each of the proposed Lots seeking residential permissibility which is based on a raft of subdivision design elements including but not limited bush fire protection measures and water quality impacts as recommended in the publication titled '*Water Sensitive Design Guide for Rural Residential Subdivisions*' (May 2021).

The following key summaries apply to the development and are detailed in the following pages:

- The proponent is seeking to rezone the land in accordance with Section 4.4.1 of the *Urban and Fringe Housing Strategy* study and in doing so establish the basis upon which to undertake a subdivision of the land that will create a total of sixteen allotments each with a minimum Lot size of 2 hectares
- The subject development property has an existing 'locally significant' heritage listed homestead that must be considered within the context of any future subdivision of the property.
- The proposed new internal access roadway will create a hardstand surface that will invariably have a detrimental effect on water quality and therefore will need to be treated within the scope of the subdivision civil works to achieve a neutral or beneficial effect on water quality in accordance with Water NSW 'NorBE' guidelines.

- The development property is not directly burdened by any mapped drainage depressions as defined in topographical mapping instruments however the lower southern and western portions of the property are subject to periodic inundation during large rain and storm events, particularly the southern aspect where external sources of water enter the site.
- Whilst the site is not directly burdened by any defined drainage depressions it is located approximately 400 metres south of the banks of the Mulwaree River which is subject to frequent flooding of varying magnitudes however it is acknowledged that surface water runoff from the site and surrounding area forms part of the drainage and overland flow network that contributes to the flooding of the river system during these events.
- The conceptual subdivision as proposed in the accompanying plans meets the Neutral or Beneficial Effect (NorBE) criteria, and each of the new Lots seeking new residential building entitlements are deemed suitable to support a residential development incorporating an on-site wastewater management facility. Future dwellings within the proposed subdivision will be required to submit individual development applications to Council which will include a detailed assessment of the proposed onsite wastewater management system relative to the size of the daily effluent loading being generated by the proposed dwelling.

Whilst this report has based its determinations and recommendations on a conceptual subdivision design that is subject to a raft of considerations and approvals, and on the location of a 'potential building envelope' within the proposed new Lots it is recognised that any future development application for the construction of a residential dwelling within the Lots will be required to submit an independent stormwater quality and wastewater management assessment in support of any such development at the time of lodging a formal development application to Council which is based on a specific dwelling and site design.

It is considered that the proposed rezoning of the land from RU6 – '*Transition*' to R5 – *Large Lot Residential'* and a subsequent subdivision of the land to create a total of sixteen allotments plus internal access road will be able to satisfy the requirements of the Neutral or Beneficial Effect on water quality as required under the Sydney Drinking Water SEPP (2011).

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Figure 1. Recent aerial view of the development property showing the nature of the vegetation formations within and surrounding the site.

1/. Overview of the Rezoning Submission, Description of the Land and Proposed Subdivision.

The Goulburn Mulwaree Council commissioned *Elton Consulting* to undertake an *Urban and Fringe Housing Strategy* study for the urban centres of both Goulburn and Marulan which was completed and adopted by Council in July 2020. To gain an appreciation of how the aforementioned study triggers the submission of the land rezoning application being the subject of this assessment the following extracts have been taken directly from the completed report to provide context;

"This Urban and Fringe Housing Strategy (Strategy) investigates and identifies areas suitable for the provision of additional housing to assist Goulburn Mulwaree Council (Council) meet the housing demands generated by expected continued population growth.

The Strategy has been prepared in response to both the limited supply of residential land available to meet the short and medium term needs of the community and the directions of the South East and Tablelands Regional Plan 2036.

The scope of the Strategy includes looking at the urban areas of Goulburn and Marulan and identifying opportunities for an additional recommended 3,500 dwellings over the next 18 years to 2036. The Strategy also considers land for large lot residential development (typically greater than 2ha and often referred to as rural residential development) particularly on the urban fringe of Goulburn.

Growth across the LGA has been strong over the past decade increasing by 14 percent. In Marulan population growth has been significant with an increase in population between 2006 and 2016 of 27 percent.

With the Goulburn Mulwaree LGA expected to reach between 33,350 and 37,202 residents by 2036, approximately 5,000 to 7,000 additional residents are expected. Given the drivers of growth include proximity to economically viable regions and affordable housing, these growth rates may increase over time if prices in Sydney and the ACT continue to rise. Advances in technology and improvements in transport, for example higher speed rail, may further stimulate growth.

The majority of recent growth has been through residential subdivisions in Goulburn and Marulan. These new subdivisions have typically provided R2 Low Density Residential zoned land with a minimum lot size of 700sqm. The market responded well to these releases driving demand for additional land as the currently zoned land nears full utilisation.

Anecdotal evidence gained through the initial community and stakeholder engagement process indicated demand for large lot residential blocks (2ha). This was corroborated by Council analysis of rural residential lot uptake on the western and south western Goulburn fringes over the past decade. Council found that 200 of the 290 lots registered had a dwelling approved, or a development application lodged. Most of which were within 2 years of lot registration. The relatively low subdivision costs associated with creating these lots has resulted in this form of development being the preference of proponents looking to rezone land. These products offer diversity in lifestyle choice. Given the current and expected demand for residential land in Goulburn and Marulan it would be anticipated that small volumes of large lot residential land will be absorbed by the market, however, the actual annual demand is difficult to determine."

The development property is located on the southern outskirts of the city of Goulburn and is identified within the *Urban and Fringe Housing Strategy* study as a locality suitable for rezoning to 'R5 – Large Lot Residential' to help meet future land and housing demands. The property falls within the *Brisbane Grove* study precinct which is currently zoned 'RU6 – Transition' and has been identified with an overall potential yield of 132 Lots at a minimum area of 2 hectares. The Brisbane Grove development precinct is located on the southern side of both the Hume Highway traffic corridor and the Mulwaree River which is prone to periodic flooding which according to the study logistically separates this area from the urban areas of Goulburn and would therefore adversely impact any extension of existing utilities and services necessary for continued urban development in this zone - thereby leaving it ideally suited for the development of large-Lot self-sufficient residential blocks.

The proponent is seeking to rezone the land in accordance with Section 4.4.1 of the *Urban and Fringe Housing Strategy* study and in doing so establish the basis upon which to undertake a subdivision of the land that will create a total of sixteen allotments each with a minimum Lot size of 2 hectares, plus a new internal access road. Of the sixteen Lots fifteen will be seeking residential dwelling entitlements whilst the remaining Lot will comprise an existing homestead and curtilage that is listed within the Goulburn Mulwaree LEP as being a *local significant* heritage item.

The development site is bordered by three separate named and formed roads that have a minimum corridor width of 20 metres:
1/. Braidwood Road along the western boundary that is a TfNSW classified road that provides an important transport link between Goulburn and the south coast region of the state. The road is a bitumen sealed formation that also provides access to many rural land holdings between Goulburn and Braidwood, and to several smaller localities that lie in between. The posted speed limit along the section of Braidwood Road that lies parallel to the western boundary of the site is 100kph and therefore access and egress from this aspect is not likely to be granted by TfNSW, and there is also optic fibre communication lines that run parallel to the same boundary.
2/. Brisbane Grove Road along the northern boundary of the site which runs between the Braidwood Road and the Windellama Road transit route to the east. There are several rural holdings accessed via the Brisbane Grove Road traffic corridor and more recently it has been used an alternate route to the city whilst major road and bridge works were being undertaken on a section of road that affected normal traffic movements to and from the southeastern aspect of the city. The posted speed limit along Brisbane Grove Road is 80kph, and it is proposed that a new access road to service the Lots within the northern portion of the development will be formed midway along the length of the northern boundary – approximately 140 metres east from the intersection with Braidwood Road.
3/. Johnsons Lane that borders the southern boundary of the property which junctions off Braidwood Road and terminates approximately 130 metres to the east of the development property. Johnsons Lane that does not have a posted speed limit but is assumed be the same as the Brisbane Grove Road at 80kph is bitumen sealed for the majority of its formation with the exception that the last 230 metres is still gravel. Six of the proposed Lots will be accessed from this roadway.

The development property covers a total area of 34.863 hectares which is comprised of twelve separate registered portions totalling 33.981 hectares plus a separate 8,828m² portion of freehold land still held in the name of a former landowner that was created for possible future road allocation but has never been dedicated as such. The untitled freehold portion of land is located approximately 150 metres north of the homestead and is 20.115 metres wide running in an east → west alignment. The proponent has commenced application for the possessory acquisition of the untitled freehold portion of land through the NSW Land Registry Services under 'possessory title' provisions.

The homestead within the site is currently accessed via a gravel carriageway that enters the property on the northwestern corner of the block, just east of the junction of Braidwood and Brisbane Grove Roads with a second gravel access formed from the Johnsons Lane aspect to the south. The primary carriageway meanders along the western boundary of the block for a short distance and then veers to the southeast and gradually winds up to the curtilage that surrounds the homestead. The site is burdened by a single-phase overhead power transmission line that runs north → south through the site with optic fibre and telecommunications services along the western boundary and across the northwest corner of the block that are identified by posted markers.

The terrain around the subject site is comprised of two small hillocks; one in the southeast corner that continues to rise into the neighbouring property to the east, and the other centrally within the southern half where the existing homestead is located. From these hillocks the terrain falls at relatively minor grades of less than 5°, particularly in the northern, southern and western portions where the slope is less than 2°, however there are a few small areas around the peak of the hill upon which the homestead sits where the slope increases slightly but still less than 10°. The northern portion of the site has a general slope from the southwest toward the north-northeast whilst the southern and western aspects have a general fall in a westerly pattern. The southwestern quarter and northern portion of the site are relatively flat such that they are imperfectly drained and therefore during large rain and storm events can retain shallow pools of surface water for a period of time after the event.

The vegetation formations throughout the property which has historically been used for grazing by cattle are dominated open paddocks of improved pastures and native grasslands, however over the past 5 or so years the property has seen only light grazing and minor silage production. The western boundary that lies parallel to the Braidwood Road traffic corridor, plus the western aspect of the existing homestead and parts of an internal access carriageway are lined with discontinuous single rows of old radiata pine trees – many of which are now displaying signs of necrosis and die-back. The curtilage that surrounds the existing homestead has previously been set to established gardens and lawns, however these have been neglected over time and consequently have lost some of the appeal and character of the historic period in which the homestead was constructed. The owner of the property intends to perform extensive repairs to the homestead and undertake significant ground maintenance to return the site to its former grandeur.

Future Subdivision Proposal.

The conceptual design for the subdivision of the land will include the construction of a new internal access road that will junction off Brisbane Grove Road approximately midway along the northern boundary and terminate in a large radius cul-de-sac formation. The internal road will provide direct access to ten of the proposed Lots whilst the remaining six Lots will be accessed from the Johnsons Lane carriageway to the south. Access from the Braidwood traffic corridor has not been considered as it would require consent from TfNSW which is unlikely to be supported due to the posted speed limit of 100kph, and the need to cross over existing optic fibre and telecommunication services that are installed just inside the western boundary of the site.

The alignment of the new internal access road has largely been designed to follow the path of an existing overhead power transmission line that traverses all the way through the site - entering from the northern aspect and continuing through to the southern aspect where it then exits the property and services adjoining lands on the southern side of the Johnsons Lane traffic corridor. By designing the new access road to follow the alignment of the exiting power lines within the northern portion of the property it means that the proposed new Lots within that area will essentially be free of any easement restrictions that could otherwise impact the location of possible future dwelling sites, and it also negates any reason to relocate the lines. The continuation of the overhead power lines within the southern portion of the property has a minor impact on two of the proposed Lots, however the Lot configuration is such that there is still ample space for the location of suitable dwelling envelopes within the burdened Lots.

All identified dwelling envelopes within the proposed Lots have been placed such that the distance from the front entrance to the site does not exceed 200 metres, and for almost all Lots with the exception of one (proposed Lot 11) it is not possible to construct a dwelling more than 150 metres from the respective front entrances due to the actual depths of the individual blocks whilst also satisfying the Council's Development Control Plan setback provisions.

Section 5.9.1.1 'Buffer Distances' and Table 5.1 'Buffers Between Rural Activities and Rural Dwellings' of the Council's Development Control Plans require prescribed separation distances from various forms of rural land use depending upon which category or categories are most applicable to the neighbouring and/or surrounding properties. The development site is surrounded by 'RU1 – Primary Production' zoned lands on the western aspect of the Braidwood Road traffic corridor, and similarly on the northern aspect of the Brisbane Grove Road traffic corridor which are used for grazing of livestock and seasonal production of fodder crops and silage, whilst the adjoining lands to the immediate east of the site and lands on the southern aspect of the Johnsons Lane road reserve are all zoned 'RU6 – Transition'. Referencing Table 5.1 of the Council's Development Control Plan the minimum setback from 'grazing lands' is 80 metres, or alternatively 60 metres with a 20-metre-wide vegetated buffer zone in the outer 20 metres. The subdivision design has shown an 80 metre separation distance from the boundary fences of the neighbouring western and northern properties, which is essentially an effective internal buffer zone of 60 metres due to the 20-metre width of the road reserves on the respective aspects which has been included in the distance measurements.

For the eastern and southern aspects of the site the subdivision development proposal will be seeking a variation to the provisions of Table 5.1 in accordance with Section 5.9.1.2 'Variations to Buffers' as the adjoining lands are smaller holdings which are not capable of supporting 'rural enterprises' as defined in the DCP, and realistically are essentially hobby farms and/or lifestyle blocks.

The following Table summarises the details of the adjoining land holding to the east and south of the development site, and it can be assumed by the individual land sizes that these blocks are not large enough to support extensive agricultural or rural activities of a type that could cause nuisance or disturbance to any future dwellings within the proposed subdivision:

Address	Lot & DP	Zoning	Land area (ha)
54 Brisbane Grove Road	Lots 58, 58, 65 & 66 DP976708	RU6	9.064
83 Johnsons Lane	Lots 68 – 70 & 78 – 80 DP976708	RU6	16.88
5342 Braidwood Road	Lots 87 & 88 DP976708	RU6	6.77
40 Johnsons Lane	Lot 1 DP834851	RU6	10.46
82 Johnsons Lane	Lot 2 DP834851	RU6	10.79
70 Harringtons Lane	Lots 81, 82 & 96 - 102 DP976708	RU6	37.24

However, as an alternative to the prescriptive separation distances within Table 5.1 of the DCP it is proposed that the new Lots within the subdivision on the eastern and southern aspects would establish minimum building setbacks of at least 50 metres from the boundaries which is designed to achieve several outcomes – in particular general amenity.

The development property is not directly burdened by any mapped drainage depressions as defined in topographical mapping instruments however the lower southern and western portions of the property are subject to periodic inundation during large rain and storm events, particularly the southern aspect where external sources of water enter the site. There are presently two moderate sized dams within the southern third of the site which are proposed to be decommissioned and replaced by a series of smaller and strategically placed farm dams that will be distributed across several of the new Lots. The placement of the dams will be both a feature of the new Lots and also assist with managing the flows of water across the site within a defined corridor that in-turn will allow greater land use within the individual allotments. The new dams and inter-connecting grass-lined drainage swales will be located in the front portion of the new Lots and will be formed with concrete causeways and/or piped culverts to allow all-weather crossing of the systems. The combined surface area and storage capacity of the new dams will be very similar to the configuration of the existing dams.

2/. Stormwater Quality Assessment

The conceptual design for the subdivision of the land will include the construction of a new internal access road that will junction off Brisbane Grove Road approximately midway along the northern boundary and terminate in a large radius cul-de-sac formation. The internal road will provide direct access to ten of the proposed Lots whilst the remaining six Lots will be accessed from the Johnsons Lane carriageway to the south.

The alignment of the new internal access road has largely been designed to follow the path of an existing overhead power transmission line that traverses all the way through the site - entering from the northern aspect and continuing through to the southern aspect where it then exits the property and services adjoining lands on the southern side of the Johnsons Lane traffic corridor. By designing the new access road to follow the alignment of the exiting power lines within the northern portion of the property it means that the proposed new Lots within that area will essentially be free of any easement restrictions that could otherwise impact the location of possible future dwelling sites, and it also negates any reason to relocate the lines.

The formation of the new internal access road will comply with Goulburn Mulwaree Council engineering requirements for rural roads which incorporates a 20-metre-wide road reserve, a 9-metre-wide bitumen sealed formation in the centre of the reserve with 1-metre-wide shoulders on either side of the sealed formation, and grass lined drainage swales and verges for the remainder of the road reserve widths. The cul-de-sac formation at the end of the road which will be aligned directly with the entrance to the existing homestead as a focal point of the development will have a turning radius of 13 metres, and the overall length of the road reserve is 412 metres which creates a total reserve area of 8,560m². It is assumed that the posted speed limit for the new internal access road would be 60kph in accordance with Council's 'Geometric Road Design' Specification – D1.27 – Table D1.8.

The proposed internal access road will remove the need for the existing access track that presently leads from the entrance off Brisbane Grove Road to the homestead within the site, and therefore this equivalent area can be reinstated to non-pervious surfaces and rehabilitated to a grass covering. The new roadway will create a hardstand surface that will invariably have a detrimental effect on water quality and therefore will need to be treated within the scope of the subdivision civil works to achieve a neutral or beneficial effect on water quality in accordance with Water NSW 'NorBE' guidelines. It is proposed that the roadway will be drained in small sections via grass-lined swales and mitre drains to a series of small farm dams to be constructed in the lower corner of the new Lots either side and immediately adjacent to the road reserve.
There will be a total of seven small dams, each with a surface area of approximately 170m² and a permanent pool storage volume of 200m³. Surface water runoff from the edges of the road will pass over a narrow buffer strip treatment device equal in area to 5% of the upstream catchment area before flowing into the roadside drainage swales and then onto the individual dams. Outflows from the dams will be directed back to the roadside swales on the lower side of the dam to effectively cascade down the slope and into the next downstream dam until eventually the last dam in the series will discharge to the existing roadside swales within the Brisbane Grove Road reserve.

It is noted that a secondary access track that provides egress between the homestead and the Johnsons Lane road corridor will also be removed in association with the future subdivision of the land and will therefore be rehabilitated to a grass covering. This has not been picked-up in the preliminary water quality modelling as it assumed that the changes to this carriageway will essentially occur after the subdivision civil works as it will allow continued access to the homestead during construction of the new internal access road to the north.

Stormwater runoff, management, and treatment of hardstand areas within the individual Lots will be a matter for consideration at the time of individual residential development – suffice to mention that the Lots are large enough at a minimum of 2 hectares to manage all stormwater onsite without the need for an inter-allotment stormwater drainage system. It will be a requirement at residential development application stage for the individual Lots to demonstrate how they meet and satisfy the water quality and NorBE criteria.

The site is burdened by an existing overhead power transmission line that traverses through the property from the northern aspect and exits the southern boundary to continue mains electricity supply to the adjoining land holdings on the southern side of Johnsons Lane. A supply line is formed off the overhead power line to service the existing homestead as well as a groundwater bore (GW035726) and surface water pump that are located to the south of the homestead adjacent to an existing dam. Water from the bore which was installed to provide stock drinking water throughout the site is extracted via a deep-well pump system which is currently decommissioned as there are no stock on the property. Similarly, the surface water pump is also decommissioned however when it was operating it is believed to have supplied water for external uses and irrigation around the homestead, and possibly as the primary source of stock drinking water when water is available within the dam. A subdivision of the property would result in the completed separation and removal of the existing infrastructure associated with the groundwater bore and surface water pump that services the homestead however the groundwater bore casing is still integral and could therefore be reinstated if desired by a future owner of the benefited Lot – but only for non-potable purposes.

A stormwater quality assessment associated with the civil works for the subdivision including *MUSIC* model has been undertaken to demonstrate compliance with the NorBE criteria as detailed in the Water NSW publication titled '*Using MUSIC in Sydney's Drinking Water Catchment*' (June 2019). The only works that are required for the subdivision is the creation of the proposed new internal access road as detailed earlier in this section, and in lieu of the new access road the rehabilitation of the existing access carriageway that services the existing homestead. All other land disturbances would be undertaken at the time of individual Lot development whereby it would be a condition of development approval to demonstrate compliance with the NorBE objectives and outcomes.

The following section details the *MUSIC* modelling assumptions, treatment recommendations and outcomes associated with stormwater runoff from the proposed new internal access road.

MUSIC MODELLING			
#	***DESCRIPTION***	***DETAIL***	
2.1	Model Version	6.3.0	
2.2	Rainfall data	Goulburn geographical region – pluviograph data at 6 minute time steps from 1st January 1995 to 31st December 1999	
2.3	Reduction targets	Total Suspended Solids	≥10%
		Total Phosphorus	≥10%
		Total Nitrogen	≥10%
		Cumulative frequency of reductions	≥98%
2.4	Modelling assumptions / settings	The proposed internal access road will be within a 20 metre wide reserve that terminates in a large radius cul-de-sac formation, the total area of the reserve is 8,560m²	
2.5		The pre-development model has an equivalent area for the new road as an 'agricultural' source node with 100% pervious fraction.	
2.6		The road will have a 9-metre-wide bitumen sealed formation in the centre of the reserve with 1-metre-wide shoulders and there will be a 3% crossfall either side of the centre line.	
2.7		The cul-de-sac formation at the end of the road will have a turning radius of 13 metres, and the overall length of the road reserve is 412 metres.	
2.8		The roadway will be formed in a series of small catchment sections and the surface water runoff from each section will pass over a narrow buffer strip treatment device equal in area to 5% of the upstream catchment area before flowing into the roadside drainage swales.	
2.9		The post-development model has the impervious fraction for the 'urban' source node of a 'sealed road' as 45% to cater for the average width of the sealed section including shoulders within the overall width of the road reserve (9 metres within a 20 metre wide reserve = 45%).	
2.10		The verges either side of the sealed formation will be finished as grass lined drainage swales that are constructed at an average grade of 3%, 250mm deep with vegetation height of 200mm, 3.50 metres wide at the top and have a base width of 500mm.	
2.11		The grass swales will be short sections that tail-out via the equivalent of mitre drains to a series of small farm dams to be constructed in the lower corner of the new Lots either side and immediately adjacent to the road reserve.	
2.12		Each swale has been modelled with an effective treatment length of 200 metres which is equal to half the length of the road to allow for potential areas within the swales that may receive less runoff that other sections and therefore be less efficient.	

2.13		There will be a total of seven small dams, each with a surface area of approximately 170m², a permanent pool storage volume of 200m³ and an extended detention depth of 500mm which has been shown within the model as an amalgam of the number of dams on each half of the carriageway formation (4 dams on the western aspect = 680m² surface area and 800m³ permanent pool volume; 3 dams on the eastern aspect = 510m² surface area and 600m³ permanent pool volume) – there has been no reuse of the water in the dams included within the modelling assumptions.
2.14		Outflows from the dams will be directed back to the roadside swales on the lower side of the dam to effectively cascade down the slope and into the next downstream dam until eventually the last dam in the series will discharge to the existing roadside swales within the Brisbane Grove Road reserve.
2.15		The existing gravel carriageway that leads from the front entrance to the homestead covers an area of 1,520m² which will be decommissioned and rehabilitated.
2.16		In the post-development model this equivalent area has been returned to a 'rural residential' land source node with 5% impervious fraction and no further water quality treatment.
2.17		The post-development receiving node is designated as the roadside drainage swale within the Brisbane Grove Road traffic corridor which eventually drains into the catchment of the Mulwaree River system that is located to the north of the site.
2.18		The secondary access track that provides egress between the homestead and the Johnsons Lane road corridor has not been picked-up in the preliminary water quality modelling as it assumed that the changes to this carriageway will essentially occur after the subdivision civil works as it will allow continued access to the homestead during construction of the new internal access road to the north.

Table 2.1. Summary of the different surface types identified in the pre-development and post-development conditions and the associated pollutant parameter within the *MUSIC* model.

	Pre-development	Post development
Agricultural 100% pervious	8,560m²	
Unsealed Road 50% impervious	1,520m²	
Sealed Road 45% impervious		8,560m²
Rural Residential 5% impervious		1,520m²
Total	10,080m²	10,080m²

Table 2.2. Base flow pollutant concentrations used in the pre and post development stormwater model.

Concentration (mg/L-log$_{10}$)						
	Suspended solids		**Phosphorus**		**Nitrogen**	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Agriculture	1.30	0.13	-1.05	0.13	0.04	0.13
Sealed roads	1.20	0.17	-0.85	0.19	0.11	0.12
Unsealed Roads	1.20	0.17	-0.85	0.19	0.11	0.12
Rural Residential	1.15	.017	-1.22	0.19	-0.05	0.12

Table 2.3. Storm flow pollutant concentrations used in the pre and post development stormwater model.

Concentration (mg/L-log$_{10}$)						
	Suspended solids		**Phosphorus**		**Nitrogen**	
Surface type	mean	std. dev	mean	std. dev	mean	std. dev
Agriculture	2.15	0.31	-0.22	0.30	0.48	0.26
Sealed roads	2.43	0.32	-0.30	0.25	0.34	0.19
Unsealed Roads	3.00	0.32	-0.30	0.25	0.34	0.19
Rural Residential	1.95	0.32	-0.66	0.25	0.30	0.19

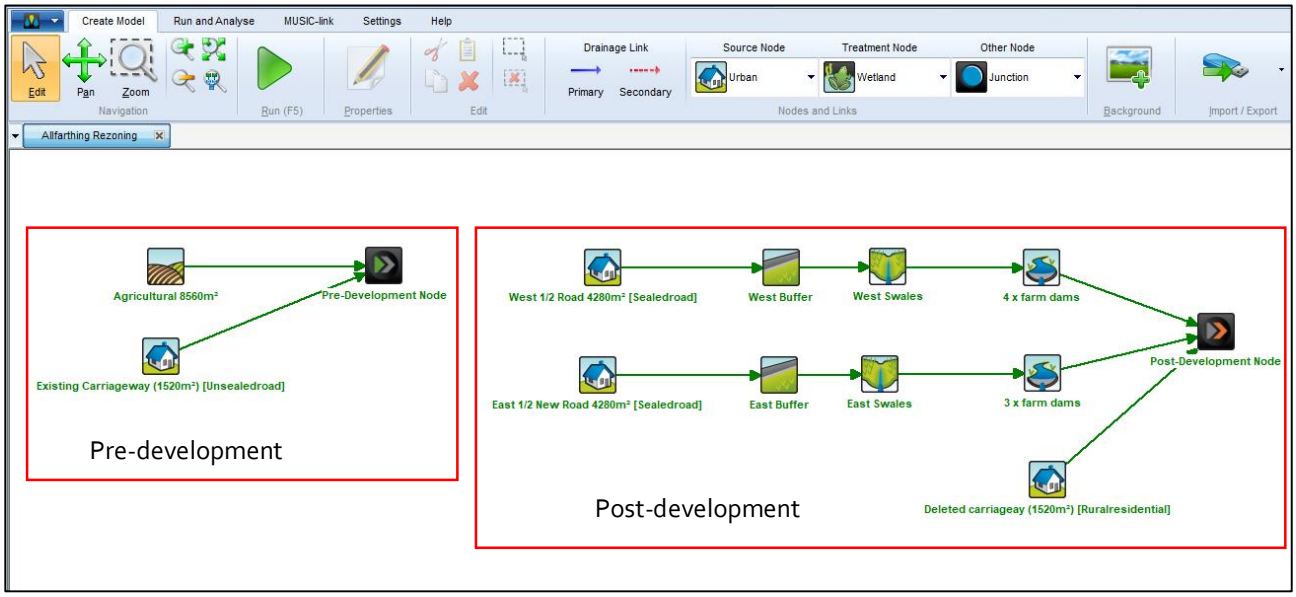

Figure 2.1. Layout of the source, treatment and receiving nodes in the *MUSIC* stormwater model.

The Results.

The modelling results are measured on two scales; the reduction of pollutant concentrations between the pre-development and post-development stages by 10% for suspended solids, phosphorus and nitrogen, and the reduction of these pollutants by the design reductions in at least 98% of occurrences. The first of these measures are summarised in Table 4 which demonstrates that the residual pollutant concentrations between the pre-development and post-development stages have achieved the objectives of the NorBE (Neutral or Beneficial Effect) criteria by achieving a minimum of 10% reduction for all three pollutants types.

Table 2.4. Comparison of the residual pre and post development pollutant concentrations for the development model

	Annual pollutant loading (kg/year)		
	TSS	TP	TN
Pre development loading	674.0	0.564	2.57
Post development loading	23.50	0.115	1.25
Reduction %	96.51	79.61	51.36

The second of these measures is the frequency at which these pollutant reductions achieve the objectives, with a neutral or beneficial effect (NorBE) being satisfied if the pollutant reductions are attained in 98% of occurrences. The following images (Figures 3 to 5) of the pre and post development cumulative frequency charts for the flow weighted daily mean values for suspended solids, phosphorus and nitrogen demonstrate that pollutant reductions proposed by the respective treatment measures are achieve for the required frequency of occurrences. In the respective images the pre-development outcomes are represented by the red lines whilst the post-development outcomes are in blue.

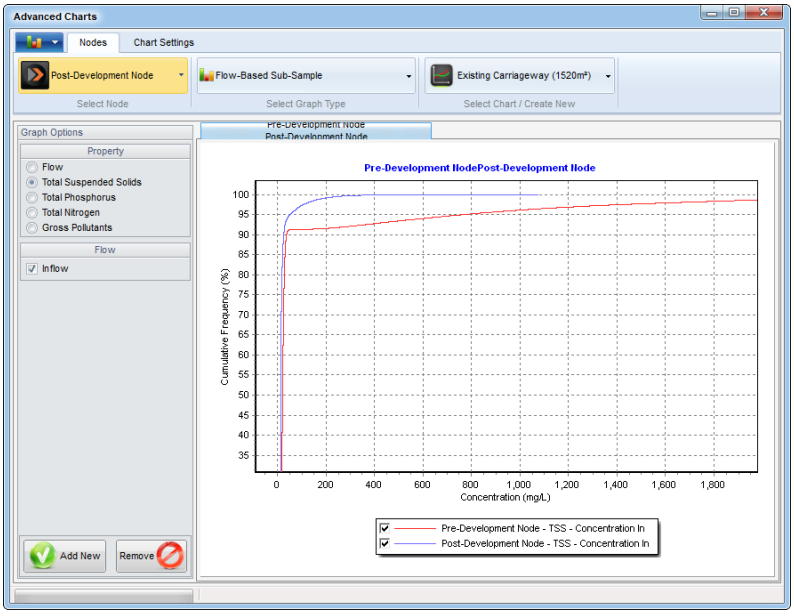

Figure 2.2. Comparison of the pre-development and post-development outcomes for Total Suspended Solids (TSS).

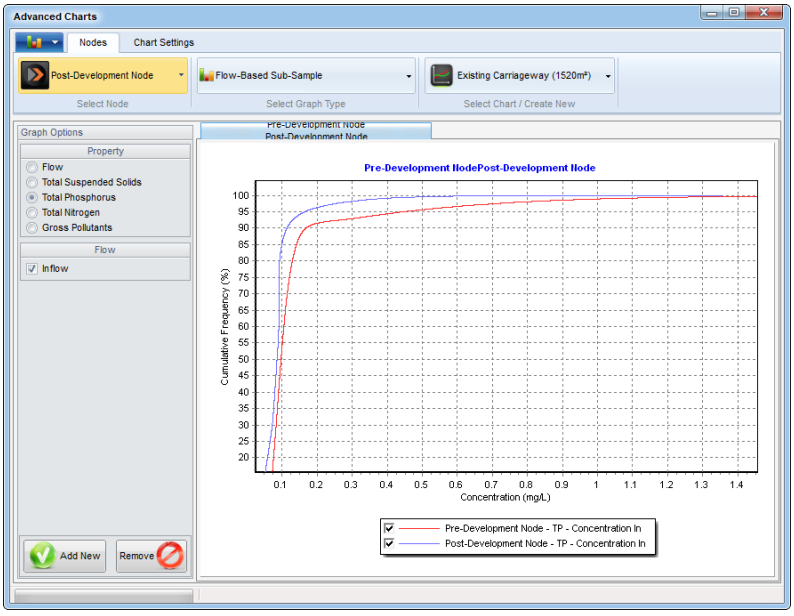

Figure 2.3. Comparison of the pre-development and post-development outcomes for Total Phosphorus (TP).

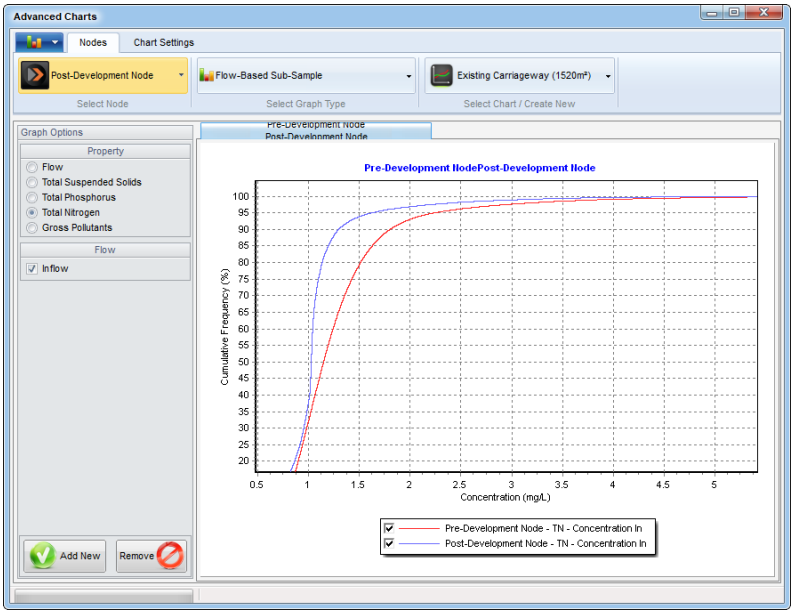

Figure 2.4. Comparison of the pre-development and post-development outcomes for Total Nitrogen (TN).

The proposed stormwater conveyance and treatment measures as detailed above demonstrate that the passive undertakings will satisfy the objectives of the NorBE guidelines. It is noted that at the time of lodging a formal application to Goulburn Mulwaree Council for the subdivision of the land an appropriate *Soil and Water Management Plan* and an *Erosion and Sediment Control Plan* will need to be submitted as part of the stormwater quality undertakings for consideration and approval by Council and Water NSW.

3/. Stormwater drainage and flood impacts.

The development property is not directly burdened by any mapped drainage depressions as defined in topographical mapping instruments however the lower southern and western portions of the property are subject to periodic inundation during large rain and storm events, particularly the southern aspect where external sources of water enter the site. There are presently two moderate sized dams within the southern third of the site which are proposed to be decommissioned and replaced by a series of smaller and strategically placed farm dams that will be distributed across several of the new Lots. The placement of the dams will be both a feature of the new Lots and also assist with managing the flows of water across the site within a defined corridor that in-turn will allow greater land use within the individual allotments. The new dams and connecting grass-lined drainage swales will be located in the front portion of the new Lots and will have concrete causeways and/or piped culverts to allow all-weather crossing of the systems. The combined surface area and storage capacity of the new dams will be very similar to the configuration of the existing dams.

Whilst the site is not directly burdened by any defined drainage depressions it is located approximately 400 metres south of the banks of the Mulwaree River which is subject to frequent flooding of varying magnitudes. The Goulburn Mulwaree Council commissioned a study of flooding associated with both the Mulwaree and Wollondilly Rivers which was completed by WMA Water in 2016, and whilst the site was not identified as being affected by the flooding of the Mulwaree River it is acknowledged that surface water runoff from the site and surrounding area forms part of the drainage and overland flow network that contributes to the flooding of the river system during these events.

To ascertain the impacts if any of overland flows and surface water drainage on the proposed rezoning and future subdivision a preliminary (pre-development) stormwater drainage and flood impact model was undertaken of the site and adjoining Braidwood Road traffic corridor using available Lidar mapping for the road reserve and development property. To create a terrain profile for the stormwater drainage and flood impact assessment LiDAR information was obtained for the development area from the Geoscience Australia '*Elevation and Depth Foundation Spatial Data'* website (ELVIS). The defined catchment area and development property is captured within a single dataset which has a grid area of 2km x 2km (Goulburn201107-LID1-AHD_7486146_55_0002_0002) which was downloaded as 2 metre grid Digital Elevation Model metadata item.

The primary objective of the modelling is to determine the existing overland flow patterns and stormwater depths within the development property and to conservatively estimate for the 1% AEP rain event where residential dwellings, access and egress provisions, and effluent management systems should not be located level for each of the proposed new Lots which will have residential dwelling permissibility.

It was initially proposed that a combination of programs such as RAFTS, DRAINS and HEC-RAS would be employed to undertake the assessment modelling however as of November 2020 the agents responsible for distributing licenses and support for the RAFTS model ceased to issue new licences and instead have replaced the older software with a new product. The new software is distributed by Innovyze Pty Ltd and is named *'ICMOne SC'* which is a stormwater and flood modelling program incorporating 1D network and 2D scaled mesh operations to perform both above and below ground hydrology and hydraulic simulations.

The digital elevation model was imported into the software to create a terrain profile which was paired with a georeferenced aerial image of the catchment area for ease of identification, correlation, and result assessment purposes. As no previous flood modelling is available for use or comparison the current recommended guidelines for rainfall information, urban hydrology, and flood modelling as prescribed by Engineers Australia and Australian Rainfall and Runoff (2019) was adopted. Design parameterisation and rainfall data for the site was obtained directly through the Australian Rainfall & Runoff Data Hub and the Bureau of Meteorology portal.

A range of IFD (intensity, frequency and duration) information and Annual Exceedance Probability options were gathered to enable comparison modelling to be performed however most of the data was focused on the 1% AEP durations as this is the critical storm of interest for the development. As the upstream catchment area is reasonably uniform and comprised of similar land use and surface types a single model has been prepared that has adopted a uniform roughness coefficient (Manning's 'n') of 0.020 that addresses both open spaces with grass and crop groundcover vegetation and road pavements and driveways in accordance with Table 6.2.2 of the AR&R2019 guidelines, and an initial loss of 16mm and a continuing loss of 2.7mm per hour has been modelled in accordance with the storm loss figures from the Australian Rainfall & Runoff Data Hub for the geographical area.

The total area within the catchment model is approximately 80 hectares which covers all of the upstream catchment areas including the adjoining properties to the south of the Johnsons Lane road corridor as previously defined as well as downstream outflows to assess any significant impacts. The large model area also validates the effective upstream catchment that enters the development property by identifying other drainage regimes that occur outside, around and beyond the property. The 80 hectares of catchment area is broken down into approximately 49,000 meshing triangles that have an average area of 16.24m², and each 'working' face allows normal flow conditions from one mesh triangle to the next.

Within the 1-hour storm ensemble of 10 different temporal patterns the maximum water level and hydraulic hazard was essentially the same across each of the patterns with just the timing of peak water level varying. For analysis purposes the 1-hour storm with temporal pattern #1 run for a 90-minute duration was adopted as this tended to have an earlier peak in the rainfall intensity with a constant rainfall pattern continuing until the end of the run, and it was possible to observe how long the depths of water remained after the peak rain event.

The modelling results for the 1% AEP storm event indicates that the northern half and the western boundary of the property are somewhat affected by stormwater runoff that is generated from the Braidwood Road corridor. The depth of stormwater within these areas is variable, however there is clear migration of external stormwater from the road corridor into the property, particularly in the northwestern corner. The same modelling clearly maps the flow of internal and external sources of stormwater that burden the southern portion of the site from the Johnsons Lane aspect with the outflow from these sources eventually merging with the Braidwood Road sources approximately 220 metres north of the southwest corner of the property – within the northern portion of the proposed Lot 10. Refer to Figure 3.1 for 1% AEP maxima stormwater depth and extent details of the pre-development model.

Recent road works were undertaken within the Braidwood Road traffic corridor along the western boundary of the property which included resurfacing of the bitumen seal and also raised the finished level of the road slightly to reduce the occurrence of stormwater laying across the road surface. In undertaking the works additional stormwater drainage infrastructure was installed adjacent to the property boundary which included the construction of several new junction pits, entrance and outfall headwalls, concrete pipes, and realignment and deepening of roadside drainage swales. The extent of the new road works was captured by a recent detailed survey of the road corridor for incorporation into a 'post-development' stormwater drainage and flood impact assessment of the proposed subdivision.

To assess the potential for stormwater drainage impacts created on or by the proposed subdivision development a 'post-development' model of the same area was undertaken which included the survey details for the modified road works and drainage upgrades within the Braidwood Road traffic corridor, regarding within the southern portion of the development site to remove the existing dams and include the construction of the new dams and inter-connecting swales, and, the alignment and construction details for the new internal access road in the northern part of the site was merged with the a detailed contour survey of the property. The resulting stormwater assessment model which has water depths of less than 50mm excluded showed moderate drainage improvements within the southern portion of the site that would benefit future residential dwelling development within the proposed Lots that front Johnsons Lane, and whilst the comparison of pre-development and post-development improvements along the western boundary and northwest corner of the site do not look significant, the post-development model clearly identifies areas within these zones where development and access provisions should not be undertaken or created. The results of the post-development stormwater drainage and flood impact assessment have been used in the preparation of the conceptual subdivision design and for the placement of potential dwelling envelopes and effluent management areas. Refer to Figure 3.2 for 1% AEP maxima stormwater depth and extent details of the post-development model.

It is noted that there are quite apparent variations between the images of the pre-development and post-development models with regard to the extent of water depths and coverage which apart from the physical changes to the landscape that have occurred across the catchment area in real time is largely explained by the quality of the background data that is used to create them.

The Lidar data is a close representation of the site contour levels based on 2011 resources and can in some areas particularly around trees and structures experience variations of up to 400mm to 500mm. The detailed site contour survey data is a more accurate and reliable source of site information and in the post-development model the two sources are merged together with the detailed survey data imposed over the top of the Lidar data and preferentially referenced such that Lidar data only fills the information voids around the outer margins of the catchment area where the detailed survey has not been undertaken due to access and resource constraints.

The post-development modelling results have also been converted into a second level of risk assessment – a hydraulic hazard (flood depth and velocity) assessment based on the guidelines within Chapter 7 of Book 6 within AR&R2019 – Section 7.2. The model has categorised the hydraulic hazard into six separate risk profiles in accordance with the hazard curves and properties tables based on work undertaken by Smith et al. (2014).

The hydraulic hazard is a measure of the risk to human life and evacuation opportunities as a consequence of water depths and flows velocities with a scaling chart system used to identify suitable thresholds for different population demographic groups, structures, and vehicular transport options for evacuation situations. The hydraulic hazard is comprised of six critical levels, with levels 1 to 3 being acceptable for a range of human occupancy and transport options, whilst levels 4 to 6 are essentially unsuitable for people and vehicles but may be suitable for different types of building structures – although Level 6 is essentially not suitable for any form of land use.

The modelling results for the post-development conditions indicate that all hydraulic hazards across the site where created are within the lower end of the risk scale ranging from Level 1 to level 2 which is generally suitable for all demographic groups, buildings and most transport options, with the exception of water storage bodies such as dams as they are by default deeper than 1 metre and therefore in the higher end of the scale. Refer to Figure 3.3 for the 1% AEP maxima hydraulic hazard details of the post-development model and to Figure 3.4 for the Hazard risk curves and classification tables from Chapter 7, Book 6 of AR&R2019.

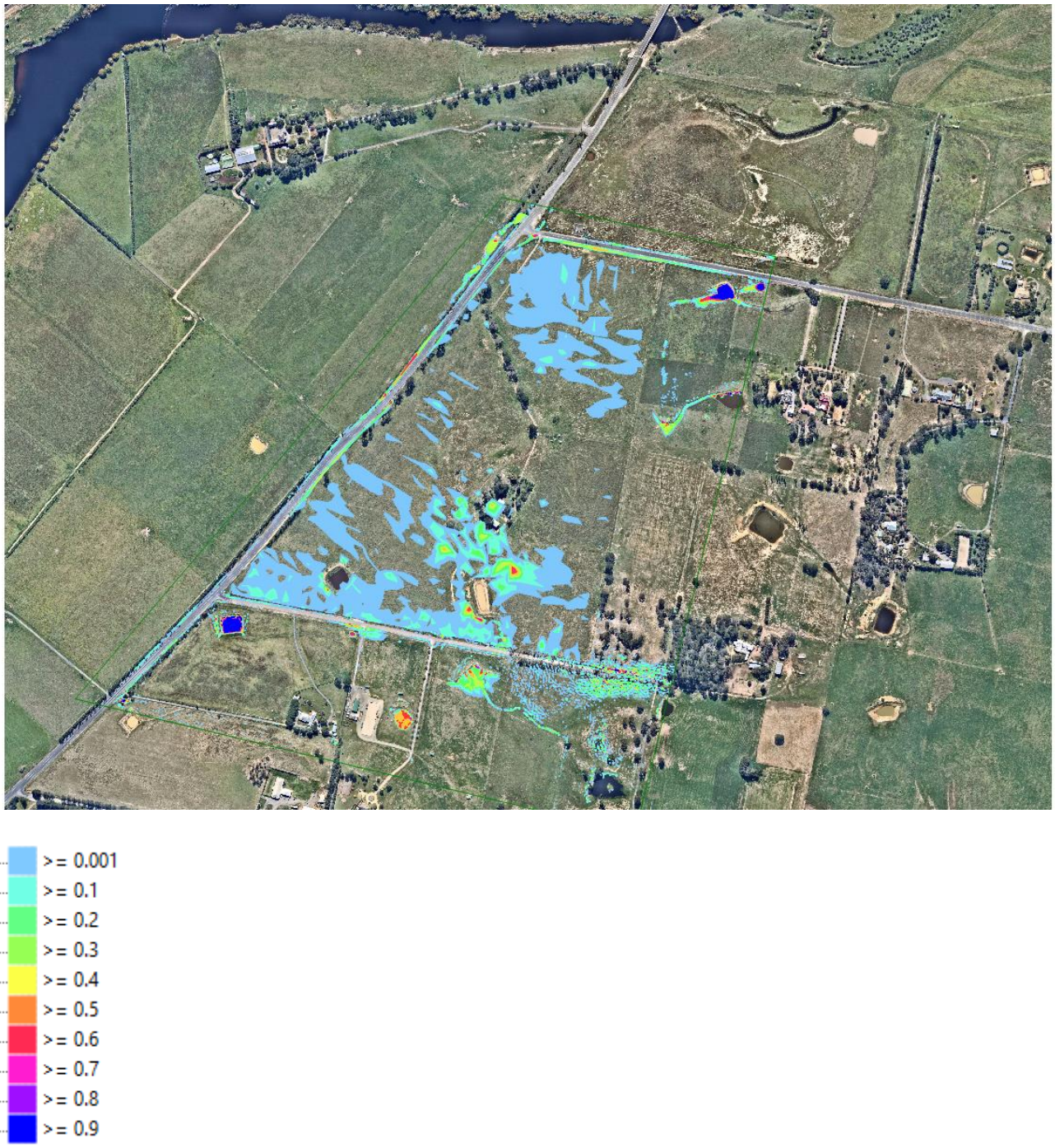

Figure 3.1. 1% AEP maxima stormwater depth and extent details of the pre-development model.

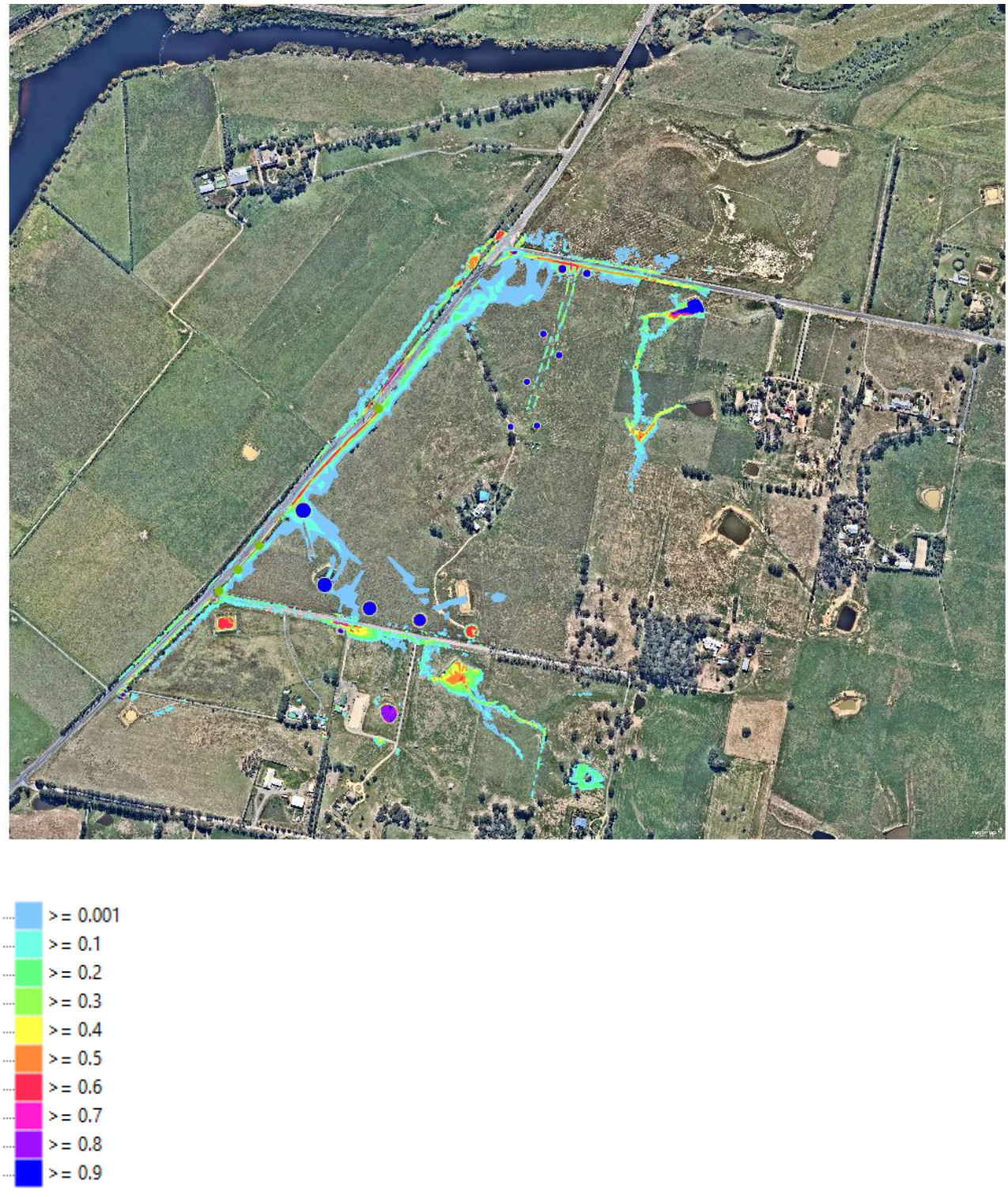

Figure 3.2. 1% AEP maxima stormwater depth and extent details of the post-development model.

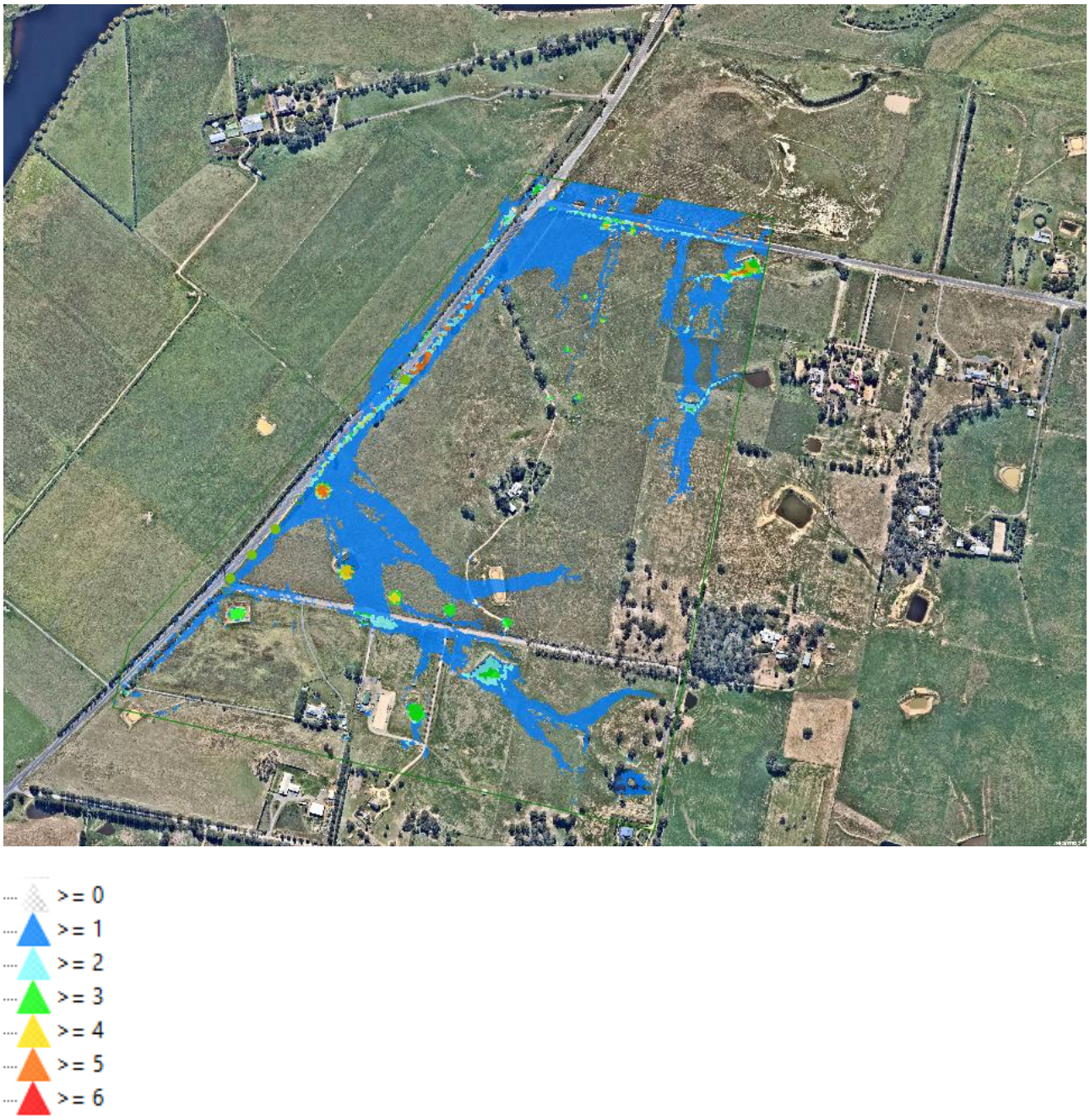

Figure 3.3. 1% AEP maxima hydraulic hazard details of the pre-development model.

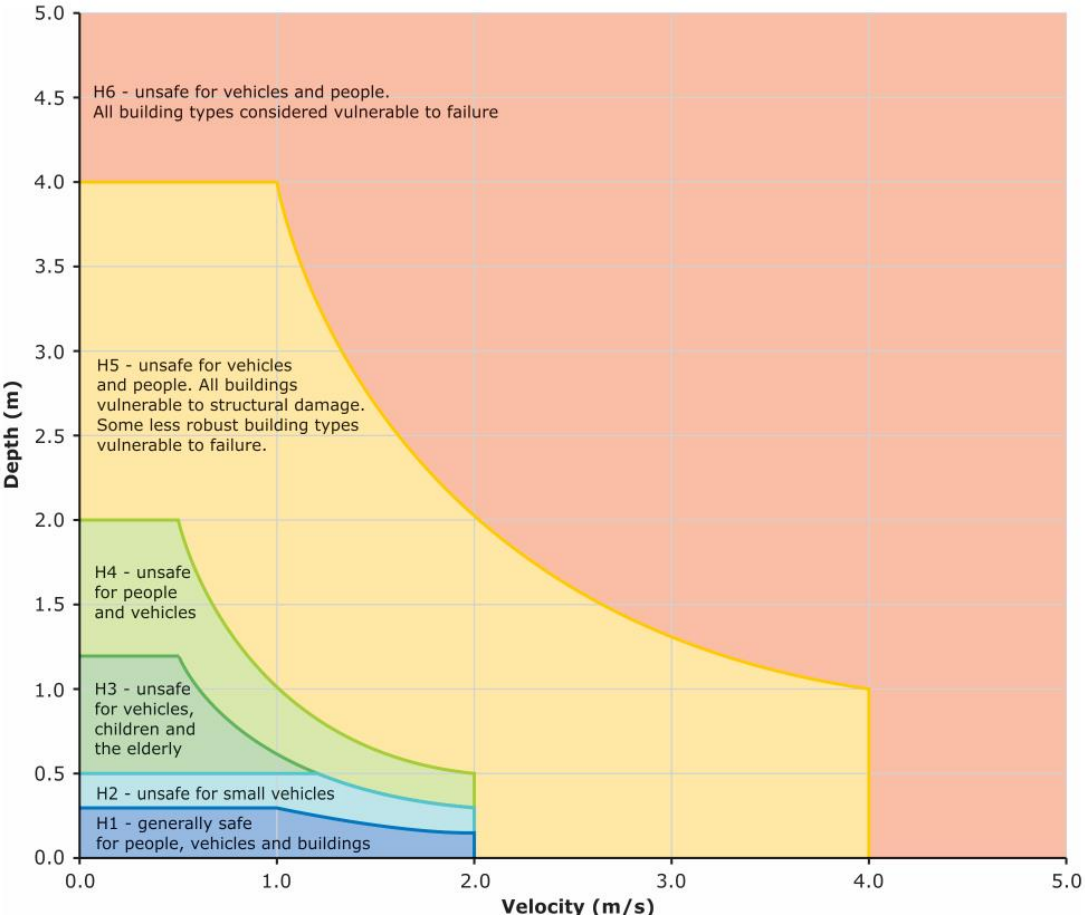

Table 6.7.3. Combined Hazard Curves - Vulnerability Thresholds (Smith et al., 2014)

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.

Table 6.7.4. Combined Hazard Curves - Vulnerability Thresholds Classification Limits (Smith et al., 2014)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

Figure 3.4. Hazard risk curves and classification tables from Chapter 7, Book 6 of AR&R2019.

4/. Wastewater Management Assessment.

The purpose of the wastewater management assessment at the proposed land rezoning stage is to determine the suitability of proposed new Lots seeking residential building entitlements to support a residential development incorporating an on-site wastewater management facility and reviewing the available treatment and disposal options. Site investigations were conducted over two days in April 2021 and included:

- Identification and/or confirmation of any constraints shown within the Water NSW "Site Design Analysis Tool" mapping instruments included within Appendix B
- Detailed description of site characteristics.

A total of 14 soil samples were undertaken across the site to determine the existing conditions and look for any significant variations, and each was analysed for the basic chemical and physical characteristics which are summarised in the accompanying soil logs. It is noted that at the time of the site inspections the southern third of the property was quite wet and the likelihood of vehicles getting bogged in the conditions prohibited access for soil sampling purposes, although it is anticipated based on the number of samples taken across the site that the conditions would not vary considerably – if at all from the average observations of the other samples. Refer to Figure 4.1 for an aerial image of the property and the locations of the soil samples.

As a general description based on the average conditions encountered across the site the soil profile is comprised of a shallow loam topsoil to 200mm with a rather abrupt transition into a sandy clay loam to clay loam at the termination depths, and some samples did display light clay properties in the lower extractions. The soil columns were moist due to recent and frequent rain events, and the fact the grasses throughout the site are quite long due to the lack of grazing pressure thereby not stimulating vigorous plant growth. Several of the sample sites encountered layers of weathered gravels and weakly structured quartz fragments at varying depths below the surface level, however all coarse material was easily penetrated by the sampling device such that all samples were able to achieve a depth of at least 1000mm without significant resistance.

The terrain around the subject site is comprised of two small hillocks; one in the southeast corner that continues to rise into the neighbouring property to the east, and the other centrally within the southern half where the existing homestead is located. From these hillocks the terrain falls at relatively minor grades of less than 5°, particularly in the northern, southern and western portions where the slope is generally less than 2°, however there are a few small areas around the peak of the hill upon which the homestead sits where the slope increases slightly but still less than 10°. The northern portion of the site has a general slope from the southwest toward the north-northeast whilst the southern and western aspects have a general fall in a westerly pattern. The southwestern quarter and northern portion of the site are relatively flat such that they are imperfectly drained and therefore during large rain and storm events can retain shallow pools of surface water for a period of time after the event.

The significant factors of the development area:

1. The development property will not be serviced by a Council maintained reticulated water supply or a gravity sewer system thereby requiring all Lots to be self-sufficient in the provisions of these facilities.
2. In the WaterNSW NorBE tool, the un-sewered sixteen Lot subdivision is a 'Module 4' class of development - "*moderately complex developments that are a high risk to water quality*".
3. The assessment has addressed the potential water quality impacts as defined within the Current Recommended Practice guidelines titled *Water Sensitive Design for Rural Residential Subdivision* (Water NSW - 2021) and any potential concerns that have been identified in that process. The subdivision assessment has used the Sydney Catchment Authority *Site Design Analysis Tool* information as a basis for design considerations (copies of which are attached in Appendix B), however where appropriate, revised information based on the findings of the actual site inspections have been used.
4. Of the sixteen new allotments, all Lots except for Lot 12 will be seeking new residential dwelling entitlements, whilst the proposed Lot 12 will comprise an existing *locally significant* heritage listed homestead. The homestead is serviced by a passive wastewater management system comprised of a septic tank and absorption disposal system. The septic tank is an old rectangular cast-in-situ structure that is located on the southwestern aspect of the dwelling within a defined house paddock. The absorption disposal trench is located downslope and further to the southwest of the septic tank outside the defined house paddock boundary. The absorption disposal trench is showing signs of failure with effluent breaching the surface and migrating done the slope into the surrounding grasslands. It is proposed in association with planned renovations to the homestead that the existing septic tank and absorption disposal system will be decommissioned in accordance with NSW Health Department guidelines and that a new wastewater management system will be installed further to the west of the current location. Specific details of the new wastewater management system for the homestead will be provided with the submission of a formal subdivision application for assessment and approval.
5. Within each of the proposed new Lots seeking residential dwelling entitlements a 'potential building envelope' having a nominal area of 600m² has been identified. The location of the 'potential building envelopes' within each of the Lots is based on a combination of considerations and not simply limited to wastewater management objectives hence these locations are not intended to be fixed or tied to title.
6. An 'indicative effluent management area' has been positioned within each Lot adjacent to the nominated dwelling envelopes to meet the required setbacks from buildings, Lot boundaries, easements, and areas identified within previous sections of this Water Cycle Management Study that are prone to stormwater inundation during large rain events. The nominated effluent management areas are highlighted by a magenta-coloured rectangle with solid colouring within the accompanying site plan, Ref: 0030321-01F.
7. Whilst the individual Lots are relatively large in area (minimum of 2 hectares) and not necessarily constrained by site characteristics such as soil texture, depth, slope, or climate, the combination of Lot configurations, vegetation retention, existing easements for utilities and services, and the identified areas of poor stormwater drainage suggest that some of the Lots along the southern, western, and northwestern portions of the property

may be 'slightly constrained' in relation to effluent management opportunities and therefore will require a detailed site analysis and design at the time of future residential land development.

8. The wastewater management assessment and subsequent recommendations have been undertaken with reference to the relevant standards; ("AS/NZS 1547:2012 On-site Domestic Waste Management"), the guidelines; "On-site Sewage Management for Single Households" (1998), "Design and Installation of On-site Wastewater Systems" (Water NSW 2019), and the regulations; the Goulburn Mulwaree Council Development Control Plan.

Figure 4.1. Aerial image of the property showing the location of the soil samples undertaken as part of the wastewater management site analysis

Constraints

1/. For developments that occur within the boundaries of the Sydney drinking water catchment a site analysis tool that identifies potential geophysical constraints for the proposed site in relation to natural features such as soil, drainage, slope, vegetation, permeability, phosphorus sorption capacity, precipitation, and certain other parameters has been made available for reference by wastewater management consultants and other land planners

In relation to this development the site analysis tool indicates that the parameters of drainage, and soil depth in particular may be a potential constraint throughout the property, whilst the parameters of permeability and phosphorus sorption capacity were also identified in the southern portion of the site but the size and location of these features which mirror each other is relatively small and located away from any of the nominated effluent disposal systems and therefore has not been assessed within the scope of the report.

Using these potential constraint maps as a guide for siting the development and the effluent disposal system, some if not all the potential constraints can in the first instance be confirmed, and thereafter as necessary be avoided or addressed by appropriate design and siting measures.

The development property is not specifically burdened by any mapped drainage depression however the site is burdened by overland flows as detailed in the previous sections of this Water Cycle Management Study that warrant consideration in the design of the subdivision and the location of the future dwelling envelopes. The other factor to consider in the design of the subdivision and future wastewater management systems is the location of the proposed new dams within the subject site and the location of existing roadside drainage swales along the perimeter roads and new drainage swales for the proposed internal access road.

It is noted that the stormwater drainage and flood impact modelling undertaken and discussed in Section 3 of this Water Cycle Management Study identified areas within the northwest corner of the property that are subject to periodic inundation that could burden the location of a wastewater management system, however the modelling was for the 1% AEP rain event and the depth and time of retained water in these events normally subsided after approximately 2 hours within the time-lapse projections of the model.
The location of the nominated effluent management areas within the accompanying plan of subdivision has been specifically undertaken to ensure that each system is at least 40 metres from any open channel, farm dam, drainage or conveyance pathway and therefore 'drainage' as a potential constraint can be overcome.

A total of fourteen soil samples undertaken across the development property consistently achieved depths of at least 1 metre with relative ease, and the majority of soil profiles comprised a silty loam to sandy loam topsoil of 200mm to 300mm, with a sandy clay loam to clay loam below to the termination depths (further details of the individual samples are contained in the following sections of this report).

It is anticipated that the samples undertaken across the site are a fair indication of the anticipated soil depths and conditions to be encountered across the entire site within the areas suitable for effluent management and it is therefore considered that soil depth or condition will not be a constraint for the development.

Notwithstanding the possible limitations imposed by various geophysical constraints, an examination and assessment of the existing site and soil characteristics within each of the nominated effluent disposal areas has determined that the natural conditions are conducive for effluent disposal purposes. Refer to the attached 'Water Sensitive Design Mapping Constraints' overlay images in Appendix B of this report for graphic representation and details of the site characteristics discussed in this section.

2/. In addition to the site analysis tools referenced above, an online modelling tool is used to check that the effluent plume associated with a proposed wastewater treatment system does not migrate outside the property boundary or to environmentally sensitive receiving points.

The modelling outcomes identified as the *WEM Summary* (Wastewater Effluent Model Summary) from the Water NSW NorBE Assessment portal produces a predictive plume representing the anticipated migration of effluent, nitrogen, phosphorus and faecal coliforms based on the combined measures of effluent treatment, disposal method and disposal area location.
The resulting plume is a prediction based on a combination of factors including the site's soil characteristics, the topography, daily loading and treatment methodologies.

By achieving a plume for all four constituent parameters that remain inside the property boundary whilst also not effecting sensitive environmental receptors then the design is deemed to satisfy the Neutral or Beneficial Effect (NorBE) criteria for wastewater management assessment purposes.

A model for each of the proposed effluent management systems predicting the respective effluent plumes has been prepared with the summary results presented at the end of the detailed soil summary sheets that follow this section.

3/. The development property is located within the 'Sydney Basin – Goulburn Fractured Rock Groundwater Source' as defined in the W*ater Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* administered under 'Section 50 of the Water Management Act (2000)', which sets out prescribed activities and conditions for water supply works associated with a groundwater source – including bores.

Part 9 > Clause 40 > Subclause (1) states that a water supply work approval must not be granted or amended to authorise the construction of a water supply work which, in the Minister's opinion, is or is proposed to be located:

a/. within 250 metres of the plume associated with a contamination source listed in **Schedule 3,** or
b/. between 250 metres and 500 metres of the plume associated with a contamination source listed in **Schedule 3,** unless the Minister is satisfied that no drawdown of water will occur within 250 metres of the plume associated with the contamination source, or
c/. at a distance specified by the Minister that is more than 500 metres from the plume associated with a contamination source listed in **Schedule 3,** if a greater distance is determined by the Minister to be necessary to protect a water source, the environment or public health or safety

Schedule 3 of the W*ater Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* specifically defines an onsite sewage disposal system or septic tank as a contamination source, irrespective of the use of water from the bore. Whilst the development proposal is not for a 'water supply approval' as defined under the Water Management Act, the installation of a wastewater management system must still consider the effect of such an installation on existing and possible future water supply works.

Where the proposed location of an effluent disposal area may be less than 100 metres of an identified groundwater bore then a 'draw down analysis' similar to that prescribed by Cromer, Gardner and Beavers '*An Improved Viral Die-off Method to Estimate Setback Distances'* (2001) may be undertaken to demonstrate that the proposed lesser separation distance will be suitable.

In relation to this assessment a search of the Water NSW 'Groundwater Data Base' for any registered bores within 500 metres of the centroid of the development property has been undertaken which has resulted in several findings which is not an uncommon occurrence within a rural residential area that are not serviced by a Council maintained reticulated water supply.

The nearest of the identified groundwater bores (GW035726) is actually located within the development property - approximately 150 metres south of the existing homestead adjacent to one of the existing dams and within the proposed Lot 7. Water from the bore which was installed to provide stock drinking water throughout the site is extracted via a deep-well pump system which is currently decommissioned and has not operated for several years as there are no stock on the property. A subdivision of the property would result in the completed separation and removal of all existing infrastructure associated with the groundwater bore however the groundwater bore casing is still integral and could therefore be reinstated if desired by a future owner of the benefited Lot 7 – but only for non-potable purposes.

All remaining groundwater bores identified within the search are located greater than 100 metres from the nearest identified effluent management system and therefore a draw-down analysis is not deemed necessary at this time, however individual Lots should undertake their own assessment of any potential development impacts at the time of lodging a formal application to Council for residential dwelling development.

It is considered that the separation distance between the existing bores and the nearest of the proposed new effluent management areas will be at least 100 metres, and therefore 'groundwater sources' will not be a constraint for the proposed development.

Figure 4.2. Image from the Water NSW Groundwater Data Base showing the location of the registered groundwater bore within the property (yellow circle) and the proximity of other bores in the surrounding land holdings.

Conclusion

The conceptual subdivision as proposed in the accompanying plans meets the Neutral or Beneficial Effect (NorBE) criteria, and each of the new Lots seeking new residential building entitlements are deemed suitable to support a residential development incorporating an on-site wastewater management facility. Future dwellings within the proposed subdivision will be required to submit individual development applications to Council which will include a detailed assessment of the proposed onsite wastewater management system relative to the size of the daily effluent loading being generated by the proposed dwelling.

Based on the site and soil conditions observed dutring the site inspection process that each of the proposed Lots could as a minimum impact support a passive energy wastewater management system comprised of a septic tank and absorption disposal system. The size of the wastewater management system and effluent disposal area is based on the equivalent of a five bedroom dwelling that is reliant upon rainwater harvesting as the primary source of all potable and non-potable water uses. It is recognised that other wastewater management options are available and viable, however the use of a passive wastewater management system for the proposed number of Lots is less likley to have a significant and/or cumulative affect on groundwater quality.

At the time of future subdivision works the existing wastewater management system servicing the homestead will need to be decommissioned in accordance with the NSW Health Department Advisory Notes 3 Guidelines (2017) – Clause 1.1 – a copy of which is included as 'Appendix C' of this assessment for reference.

The following sections provide a summary of the individual soil samples, and separate *WEM Plume Maps* for each of the proposed Lots based on a septic tank with absorption disposal system. The WEM modelling has assumed each Lot has a five-bedroom equivalent dwelling with non-reticulated water supply. The general information sheet for each of the WEM models are essentially the same so avoid unnecessary duplication only the details of Lot 1 have been included as an example for all.

The wastewater management assessment is supported by the accompanying Wastewater Management Site Plan – Ref: 0030321-01F which also has a visual representation of the results from the stormwater drainage and flood impact assessment to highlight the 'non-development' areas of the site. Additional information is provided in the following appendices which are at the conclusion of this section:

- Appendix A - Recommended Buffer Distance for On-site Wastewater Management Systems in the Sydney Drinking Water Catchment
- Appendix B - Water Sensitive Design Constraints Maps
- Appendix C - NSW Health Advisory Note 3 (2017) – Section 1.1

Soil Sample 1

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Crest to simple slope	**Topography:** Slopes east to west-southwest		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.79178 **Longitude:** 149.70537
Elevation: 652m	**Aspect:** Westerly	**Slope:** 5°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.3		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.3		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.04 / 5.0			
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				

Soil Sample 2

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** South to north		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.79059 **Longitude:** 149.70555
Elevation: 647m	**Aspect:** Northerly	**Slope:** <5°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.2		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.2		gradual	B2
	600-700	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm			abrupt	B2A
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm	0.02 / 5.0			
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	dry, firm				

Soil Sample 3

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** South to North		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78978 **Longitude:** 149.70575
Elevation: 643m	**Aspect:** Northerly	**Slope:** <5°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.3		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.01 / 5.2		gradual	B2
	600-700	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<10mm		polyhedral moderate	rough ped	dry, firm			gradual	B2A
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	dry, firm	0.02 / 4.9			
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	dry, firm				

Soil Sample 4

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** South to North		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78748 **Longitude:** 149.70630
Elevation: 639m	**Aspect:** Arc north, east & west	**Slope:** <3°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.2		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.0			
	600-700	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.0		gradual	B2A
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 5

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** South to North		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78591 **Longitude:** 149.70659
Elevation: 635m	**Aspect:** Arc north, east & west	**Slope:** <3°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, imperfectly drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.4		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.3		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.9			
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 6

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** South to North		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78565 **Longitude:** 149.461
Elevation: 635m	**Aspect:** Northerly	**Slope:** <3°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, imperfectly drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<30mm		polyhedral weak	earthy	moist, weak	0.01 / 5.6			
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.00 / 5.4			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.00 / 5.2			
	900-1000	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 7

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** South to North		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78625 **Longitude:** 14970411
Elevation: 637m	**Aspect:** Northerly	**Slope:** <3°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, imperfectly drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.9		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.2			
	600-700	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.01 / 5.3		gradual	B2A
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 8

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** South to North		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78698 **Longitude:** 149.70367
Elevation: 638m	**Aspect:** North-northeasterly	**Slope:** <3°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<30mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<30mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.9		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.0		gradual	B2
	600-700	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.02 / 4.9		gradual	B2A
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 9

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 21st April 2021
Landform: Simple slope to open depression	**Topography:** Southeast to northwest		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78774 **Longitude:** 149.274
Elevation: 640m	**Aspect:** Arc north, east & west	**Slope:** <5°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.3		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.01 / 5.0			
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 10

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 29th April 2021
Landform: Simple slope to open depression	**Topography:** East to west		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78777 **Longitude:** 149.70245
Elevation: 640m	**Aspect:** West-northwesterly	**Slope:** <5°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, imperfectly drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	silty loam	<20mm		polyhedral weak	earthy	moist, weak	0.04 / 5.3			
	300-400	sandy loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	B1
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.3			
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 5.2			
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 11

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 29th April 2021
Landform: Simple slope to open depression	**Topography:** East to west		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78873 **Longitude:** 149.70152
Elevation: 641m	**Aspect:** West-northwesterly	**Slope:** <5°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<10mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<10mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.2		gradual	B1
	300-400	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.01 / 5.0		gradual	B2
	600-700	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.01 / 5.2			
	900-1000	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 12

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 29th April 2021
Landform: Simple slope	**Topography:** East to west-northwest		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.79048 **Longitude:** 149.69978
Elevation: 643m	**Aspect:** Arc north, east & west	**Slope:** <3°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<10mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<10mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.2			
	300-400	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm			gradual	B1
	400-500	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.00 / 5.1		gradual	B2
	600-700	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	700-800	sandy clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.8		gradual	B2A
	900-1000	clay loam	<10mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 13

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 29th April 2021
Landform: Simple slope to open depression	**Topography:** East to west		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.79009 **Longitude:** 149.70186
Elevation: 649m	**Aspect:** West-southwesterly	**Slope:** 5°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	gradual	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 5.0		gradual	B1
	300-400	gradual	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	gradual	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.02 / 4.9		gradual	B2
	600-700	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm			gradual	B2A
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.03 / 4.8			
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Soil Sample 14

Site Details: Lots 61 to 64 & 71 to 77 DP976708 and Lot 60 DP1090981 2 Brisbane Grove Road, Brisbane Grove. NSW. 2580			**Date of Inspection:** 29th April 2021
Landform: Crest to simple slope & open depression	**Topography:** East to west-northwest		Sample 1
Vegetation: Grasslands	**Land Use:** Rural Residential		**GPS Coordinates** **Latitude:** -34.78848 **Longitude:** 149.70341
Elevation: 638m	**Aspect:** Northerly	**Slope:** <3°	**Microrelief:** Elongated depression

The soil is assessed to have a design loading rate (DLR) for absorption purposes of 10mm per day, set at a conservative rate for primary treated effluent discharging within a moderately structured clay loam soil environment (Table A1 from the publication titled "Neutral or Beneficial Effect on Water Quality Assessment Tool, Consultants and Consultant Administrators User Guide" - WaterNSW – Feb. 2015, page 51)

	Depth mm	Texture	Coarse Fraction	Condition of Surface Soil	Pedality / Structure	Fabric	Consistence	EC / pH	Water Regime	Boundaries	Horizons
	0-100	silty loam	<20mm	soft	polyhedral weak	earthy	moist, weak		moderately permeable, moderately well drained		A1
	100-200	silty loam	<20mm		polyhedral weak	earthy	moist, weak			gradual	A2
	200-300	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.05 / 5.2		gradual	B1
	300-400	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	400-500	sandy clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	500-600	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm	0.03 / 5.0			
	600-700	sandy clay loam	<30mm		polyhedral moderate	rough ped	moist, firm			gradual	B2
	700-800	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				
	800-900	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm	0.04 / 4.9		gradual	B2A
	900-1000	clay loam	<20mm		polyhedral moderate	rough ped	moist, firm				

Standard WEM Model General Information Summary – Typical for All Lots

NorBE Assessment

WEM Summary

version 3

General Information

WEM model ID	2364623	Associated DA number	
Model description	Septic tank to absorption bed		
Consultancy	SOWDES	Consultant	sowdes@sowdes.com
Consultant reference number	0030321		
Council	Goulburn Mulwaree	Assessing officer	
Nominated lot	60//1090981	Associated lots	
Development class	Subdivision unsewered >=4 lots		

Lot	Section	Plan
60		1090981
61		976708
62		976708
63		976708
71		976708
72		976708
73		976708
74		976708
75		976708
76		976708
77		976708
64		976708

Date of model run 9/5/2021 12:39:58 PM

WEM Model Run Summary

Model run outcome **Satisfied**

Any of the sub-surface plumes reaches:

Lot boundary	No
Drainage depression	No
Top bank of watercourse	No
Another disposal field or onsite stormwater management system	No
Within 50m, and up gradient of,a licensed drinking water bore	No

Proposed Front End Design

Length (across slope)(m)	20.0	Width (up slope)(m)	5.0
Proposed area(m2)	100.0	Minimum Required area (m2)	90.0
Number of trenches	0		
Effluent volume proposed (l/day)	90		

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NorBE Assessment

WEM Summary

version 3

Effluent volume calculated (l/day)	900

WEM Model Inputs

Location

Easting	9547566.029656	Northing	4326590.852719
Slope (m/m)	0.00405	Slope is suitable based on site inspection (Applicable to some disposal systems on steep slopes)	N/A

Development

Development type	Dwellings	Development detail	5 bedrooms
Water supply type	Rainwater	Spa Bath	No
Continuous system use	Yes		
Treatment system	Septic tank	Disposal system	Absorption Bed – primary effluent

Site

Lot size(m2)	22083		
Subject to severe frost	No	Bulk density(g/cm3)	1.50
Vegetation for nutrient uptake	Lawn - fully managed (clippings removed)	Phosphorus sorption (mg/kg)	400
Soil depth (to impermeable layer) (m)	1.00	Soil structure	High/moderate
Saturated hydraulic conductivity (Ksat)(m/day)	0.75		
Soil texture	Clay loams		

Effluent disposal risk factors

Depth to water table	0.4 - 1.0
Flood potential of disposal system	Above 1 in 50 year ARI
Landform score	Hill crests, convex side slopes and plains
Run-on and upslope seepage	None-low, diversion possible
Rock outcrops, scarp and bedrock	< 5%
Distance to drainage dpression	> 50
Distance to watercourses and water supply reservoirs	> 120
Distance to licenced drinking water bores	> 150

WaterNSW

Individual Lot WEM Plume Map Summaries


NorBE Assessment
WEM Summary
WEM Plume Map
LOT 2
version 3
NorBE Assessment
WEM Summary
Legend:
Selected lots
Effluent management area
Phosphorus
Nitrogen
Faecal colifroms
WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 3

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 4

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 5

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 6

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 7

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 8

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 9

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 10

version 3

WaterNSW


NorBE Assessment
WEM Summary
WEM Plume Map
LOT 11
version 3
NorBE Assessment
WEM Summary
Legend:
Selected lots
Effluent management area
Phosphorus
Nitrogen
Faecal colifroms
WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 12

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 13

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 14

version 3

WaterNSW

NorBE Assessment

WEM Summary

WEM Plume Map

LOT 15

version 3

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NorBE Assessment

WEM Summary

WEM Plume Map

LOT 16

version 3

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Appendix A

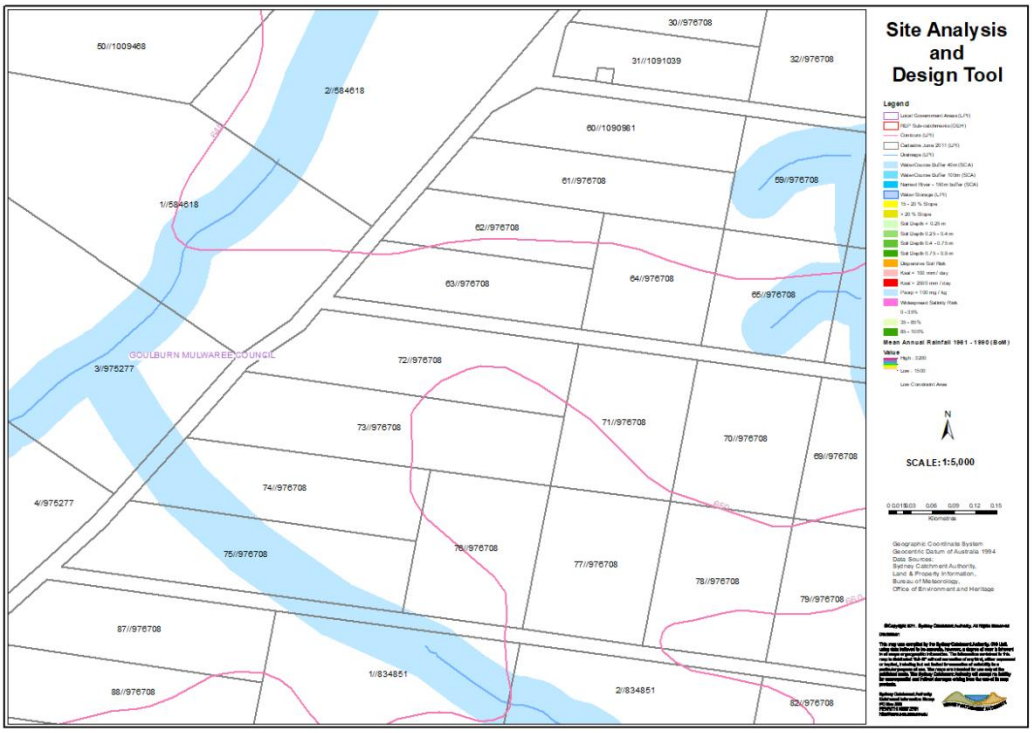
Recommended Buffer Distance for On-site Wastewater Management Systems in the Sydney Drinking Water Catchment

Feature	Level of effluent treatment	Application method	Buffer distance	
			Upslope	Downslope/Flat
Buildings, boundaries, paths and walkways, retaining walls	Primary	Subsoil	4.0m	2.0m
	Secondary (disinfected)	Subsurface and surface irrigation (including drip and trickle)	6.0m	6.0m
Premises boundaries, paths and walkways, recreation areas, in-ground swimming pools	Primary	Subsoil	6.0m	3.0m
	Secondary (disinfected)	Subsurface irrigation	4.0m	2.0m
		Surface irrigation	6.0m	6.0m
In-ground potable water tanks	Primary	Subsoil	15.0m	15.0m
	Secondary (disinfected)	Subsurface and surface irrigation	Not applicable	15.0m
Permanent and intermittent watercourses	Primary	Subsoil	100m from high water level 100m from an SCA named river	
	Secondary (disinfected)	Subsurface and surface irrigation	100m from high water level 100m from an SCA named river	
Bore or well used for domestic consumption	Primary	Subsoil	100m from high water level	
	Secondary (disinfected)	Subsurface and surface irrigation	100m from high water level	
Dam and drainage depression	Primary	Subsoil	40m from high water level	
	Secondary (disinfected)	Subsurface and surface irrigation	40m from high water level	

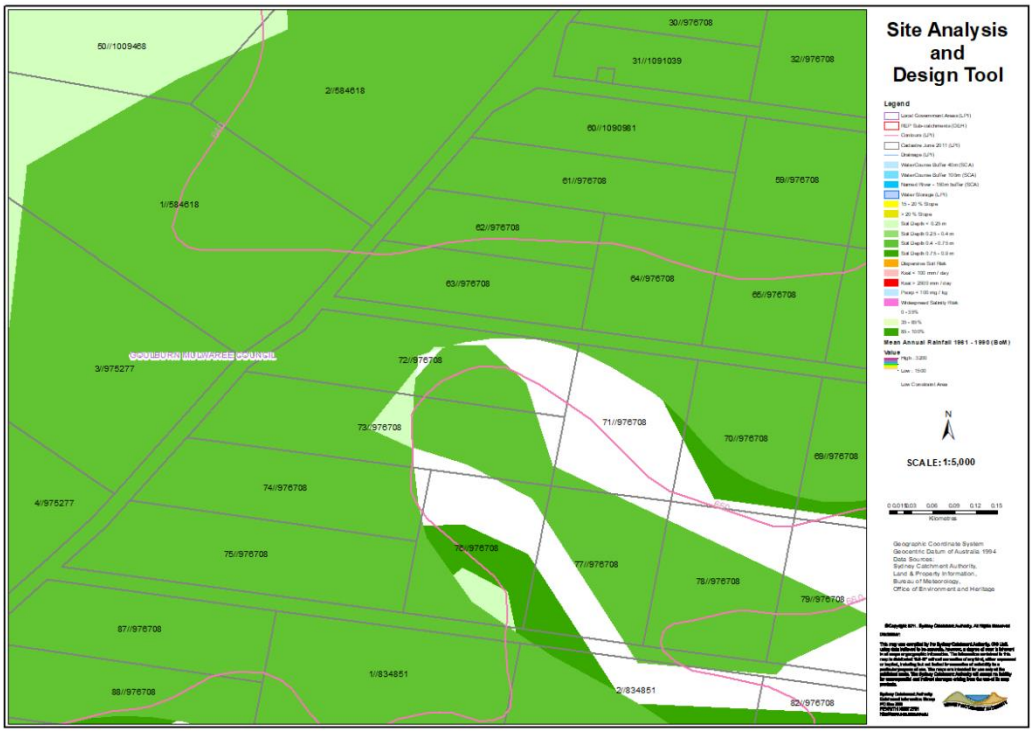
Adopted from 'Designing and Installing On-site Wastewater Systems – A Water NSW Current Recommended Practice (November 2019), Table 2.6 (pages 23 & 24)

Appendix B

Water Sensitive Design – Drainage and Soil Depth Constraints



Drainage constraints overlay with 40 metres buffer zones.



Soil depth constraints overlay

Appendix B

Water Sensitive Design – Permeability & Phosphorus Sorption Constraints

Permeability constraints overlay

Phosphorus sorption constraints overlay

Appendix C – NSW Health Advisory Note 3

NSW GOVERNMENT Health

Advisory Note 3 — Revised January 2017

Destruction, Removal or Reuse of Septic Tanks, Collection Wells, Aerated Wastewater Treatment Systems (AWTS) and other Sewage Management Facilities (SMF)

1. Septic Tank / Collection Well:

1.1 Demolition On-Site

1.1.1 The contents of the septic tank / collection well are to be removed by a method acceptable to the local council, either by tanker removal to an appropriate authorised site or pumped into the existing disposal trench if of sufficient capacity and which then should be sealed. The contents of a septic tank or collection well must not be broadcast or discharged above ground.

1.1.2 The sides, lid, baffle or partition (if fitted) and square junctions of the tank should be hosed down as the waste is being removed.

1.1.3 The tank is to be treated by liberally broadcasting "Builders' (hydrated) Lime" over the exposed surfaces. It is advisable to wear personal protective equipment.

1.1.4 Several holes should be punched or drilled into the base of the tank. The lid and those parts of the walls baffle and square junctions above the ground should be demolished and collapsed into the tank and the tank filled with clean soil or rubble and topped with clean soil. This should be performed to ensure that voids cannot develop which would allow collapse and injury in the future.