# Appendix G Hydrology assessments

FIFTEE50

# Leeson Group

## Hydrologic report for proposed Corop solar farm

19 August 2019

# Technical report for Leeson Group

## Hydrologic report for proposed Corop solar farm

**Prepared by:**
Fifteen50 Consulting PTY LTD
PO Box 155 Moama NSW 2731
T. 0417 788 709
matt.barden@fifteen50.com.au

**Prepared for:**
Leeson Group
11/23 Susan Street
Eltham VIC 3095

**Prepared by:** D Delahunty
**Reviewed:** M Barden
**Approved:** M Barden
**Version:** 5.0
**Date:** 20/07/2022

# TABLE OF CONTENTS



## LIST OF FIGURES

## LIST OF TABLES

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# Development proposal

## Site analysis

# 1. Background

Leeson Group has identified a number of solar farms around Victoria for planning approval and is pursuing a new development located adjacent to the Bendigo to Shepparton High Voltage transmission line. The proposed site has been examined through initial due diligence work and analysis of the hydrologic constraints is sought to define whether these are any fatal flaws to progressing with further development activities.

## 1.1 Scope of work

Fifteen50 was engaged to develop a water assessment to support the development approval application. Due diligence work for the site identified initial constraints with surface water features and a surface water assessment is required for a number of purposes including:

- Confirming the hydrology associated with some mapped wetlands that are to be excised from the database
- Identify parameters for managing water movements associated with stormwater and flooding
- Providing analysis that could be used for the 'prime agricultural land' test as per Victorian Government practice for solar farm approvals (a broader test than just hydrologic).

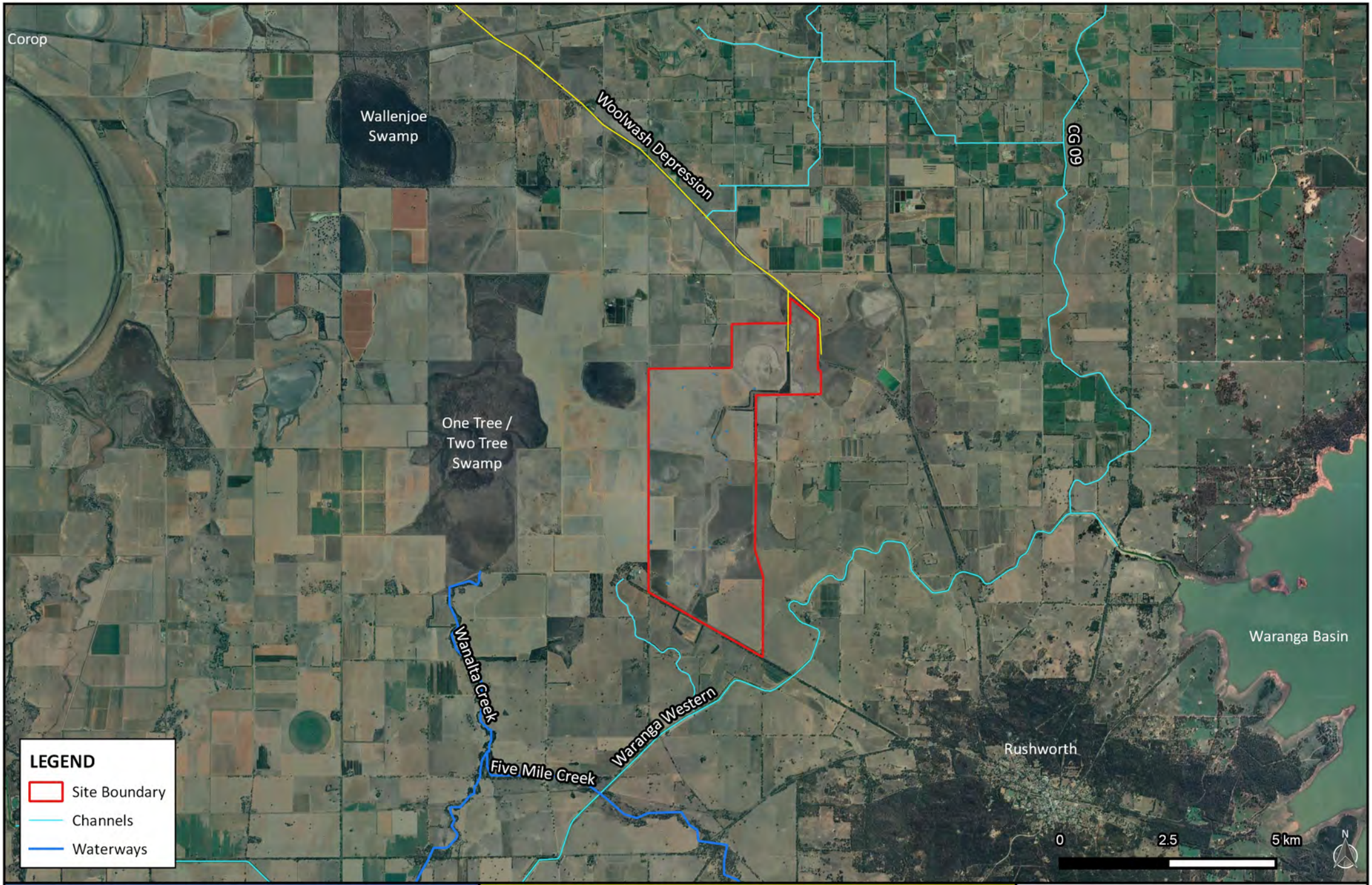
This report responds to the relevant planning issues associated with solar farm development and enables the relevant development approval agency to assess the proposal with full understanding of the potential hydraulic and hydrologic impacts.

## 1.2 Rushworth/Corop area planning

The site (shown in Figure 1) located on Old Corop road within the Campaspe Shire is also located within the Goulburn Murray Irrigation District and Goulburn Broken Catchment Management Authority jurisdiction. The study area falls adjacent to the western boundary of the Deakin Drainage basin which originates above the plains and is defined by the Mt Camel range to the west. The Timmering depression is a natural drainage system (not part of the rated drainage network in the Deakin drainage system) with main tributaries influencing catchment run off within this drainage basin:

- Cornella Creek
- Wanalta Creek
- Five Mile Creek
- Nine Mile Creek
- Short Gully

Immediately to the south of the study area is the Waranga Western Channel (WWC), defining the southern boundary of the Goulburn Murray Irrigation District (GMID), with assets associated with this structure influencing the flow patterns from south to north. Contours in the southern section of the property range from ~109m AHD to ~107m AHD and support the size of flow structures under the WWC and Old Corop Rd. This significant change in gradient adds to the complexity of managing water in the northern section of the property as runoff quickly concentrates and ponds due to the consistently flat gradient from Bedwell road through to Carag Road (~108m AHD).




SITE LOCATION
FIGURE 1
REVISION NO.: B

CLIENT: LEESON GROUP
JOB NO.: 19037
CREATED BY: R CHEOK ON 16/08/2019

LOCATION: COROP, VIC
CRS: GDA94 / MGA ZONE 55
DATA SOURCES: CLIENT, GOOGLE

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PO BOX 155, MOAMA NSW 2731, AUSTRALIA

# 2. Climatic context

A review of climatic influences on hydrology of the proposed site is detailed below.

## 2.1 Rainfall

Rainfall at the site is best represented by data collected at Bureau of Meteorology gauge 81115 Wanalta (see Figure 2). There is a rainfall gauge located at Rushworth, however, there are gaps in the data set and the Wanalta site is preferred as the available data extends to an earlier date (mid-1974). The data set was also infilled in 1974 with data from a nearby Colbinabbin site which has a relatively good correlation with the Wanalta site.

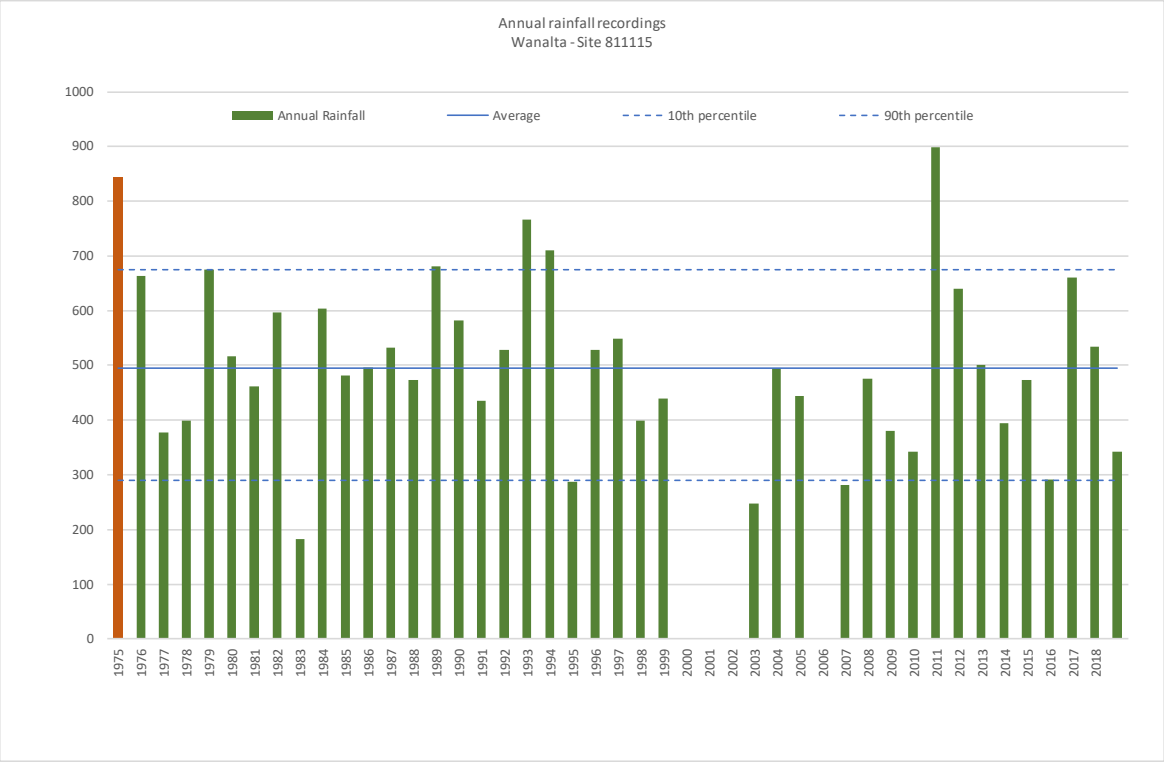



*Figure 2: Annual rainfall statistics*

Average annual rainfall at the site is around 494mm per year (excl. 1974). 10$^{th}$ percentile and 90$^{th}$ percentile statistics show that variability is around +/- 200mm per year from the average.

In general catchment scale flooding is accepted as having occurred in the north of Victoria in 1974/75, 1992/93, 2000 and 2010/11. It is evident in Figure 2 that rainfall in these years was generally at or above the 90$^{th}$ percentile and these events are important to defining the hydrology of the site.

## 2.2 Evaporation

The average annual data indicates that the study area is subject to evaporation between 1,400mm and 1,600mm per year. It is clear from this that there is an annual rainfall deficit for the study site. This means that surface water will not persist for long periods of time if it is accumulated in the landscape as a result of rainfall runoff.

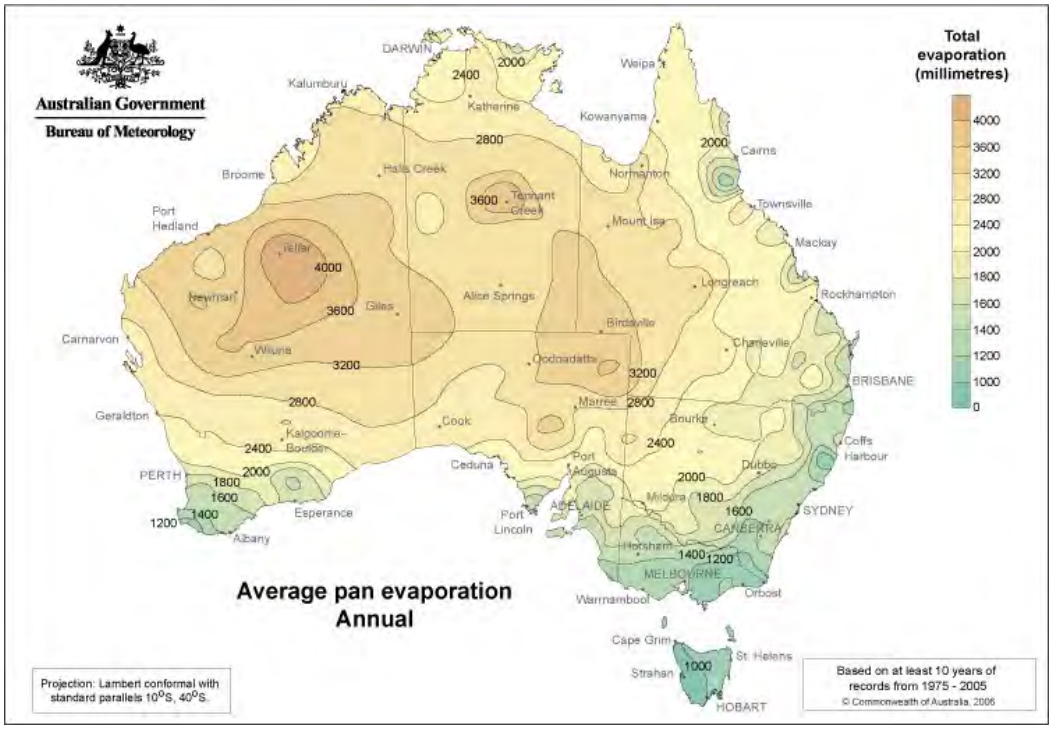



*Figure 3: Evaporation data BoM*

Seasonal average evaporation will be affected by site specific conditions and basic contour data is not precise. However, a high-level benchmark for approximate evaporation rates is included in Table 1 below as context.

*Table 1: Approximate evaporation rates*

| Season | Lower bound (mm/season) | Upper bound (mm/season) | Adopted (mm/mth) |
|---|---|---|---|
| Summer | 600 | 700 | 650 |
| Autumn | 250 | 350 | 300 |
| Winter | 100 | 200 | 150 |
| Spring | 350 | 450 | 400 |
| TOTAL | 1,300 | 1,700 | 1,500 |

A combined view of this data with monthly rainfall suggests that rainfall outside of the autumn / winter period will not persist in the landscape for any significant length of time. This context was used to characterise catchment context.

# 3. Catchment (off site) context

The proposed site is located south west of Rushworth (see Figure 4). The Rushworth area is located along a watershed for the local catchment. Rainfall runoff naturally flows in a north-westerly direction from the watershed towards the Corop Lakes.

A small localised sub-catchment (see red star marked in Figure 4) upstream of the site directs runoff towards the site along the Old Corop road although this sub-catchment does not have a natural outflow to the Corop Lakes. Runoff drains from the area south of the Rushworth Colbinabbin Road and is then routed through the site which is located at the upper end of the Woolwash depression.

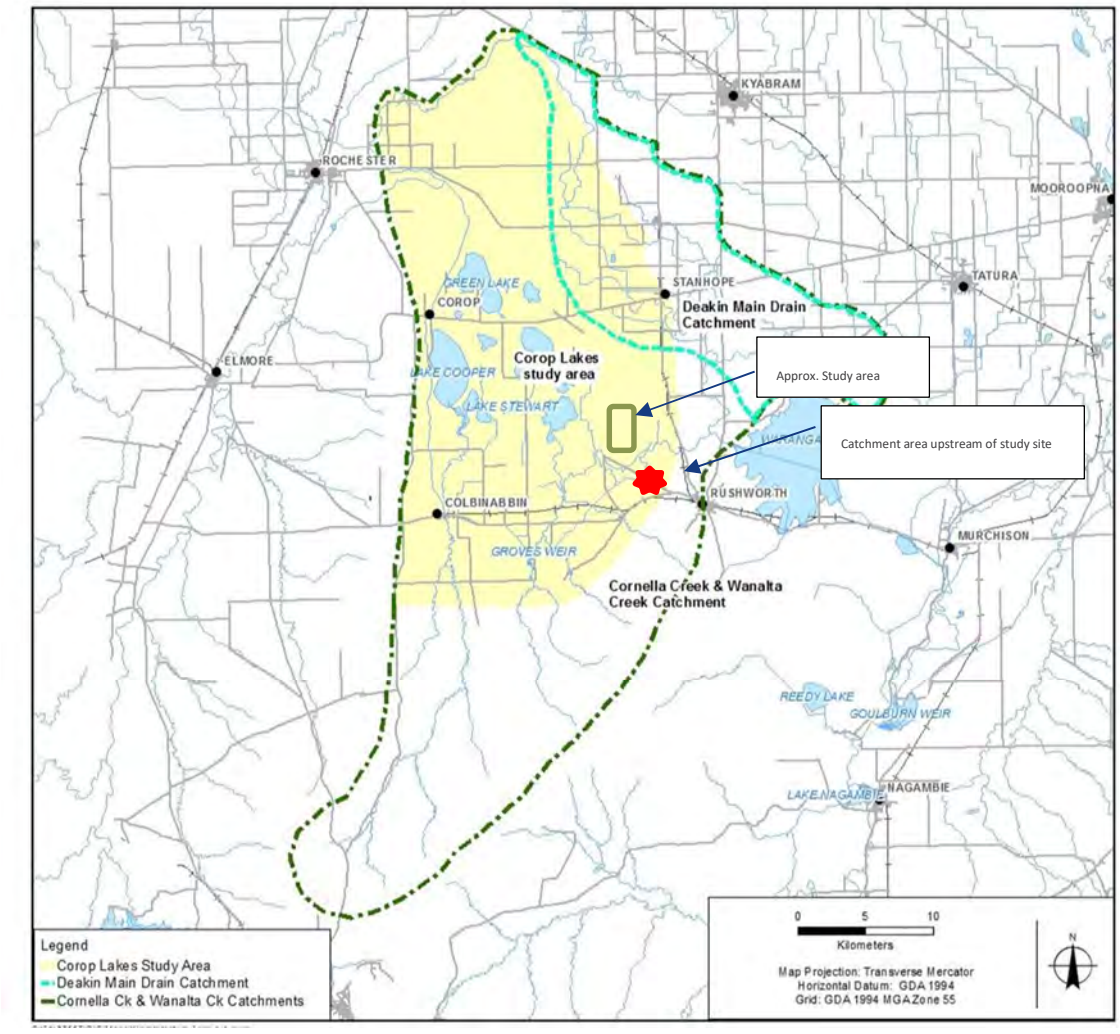



*Figure 4: Extract from Corop flood study (GHD, 2015)*

## 3.1 Characterisation of overland water/flow

The Waranga Western Channel is a contour channel following consistent grade across the catchment. This means that any significant runoff from around Rushworth will either collect on the southern side of the channel or pass through a subway. A number of Goulburn-Murray Water owned and operated subways exists along the channel in the vicinity of the site. GMW provided asset information as shown in Table 2.

*Table 2: Subway details on Waranga Western Channel*

| Fifteen50 Plan No. | GMW structure | Approx. diameter (mm) | Approx. capacity (ML/d) |
|---|---|---|---|
| A | ST037789 | 1,050 | 43 |
| B | ST037791 | 1,050 | 43 |
| C | ST037794 | 1,400 | 72 |
| D | ST037796 | 1,250 | 57 |
| E | ST037797 | 1,220 | 60 |
| F | ST037799 | 910 | 33 |
| G | ST037800 | 1,050 | 43 |

Note: Sites C, D and E are located along the main flow path adjacent to Old Corop Road (see Figure 5).

The primary rainfall runoff path towards the site is along the southern side of Old Corop Road. North of the Waranga Western Channel the runoff is confined to the property between Corop Road and the GMW No 11 channel (Figure 5). Water then spills into the property of interest at the floodway opposite a recycle dam on located on the southern side of Old Corop Road (Figure 6 for photos of water entry points). This location is nominally the origin of the Woolwash depression. This general water flow arrangement is confirmed through the planning overlays which show an LSIO overlay along the Old Corop road extending into the property.


*Figure 5: Current overland flow into/from water control structures*

*Figure 6: Water entry points to property from Old Corop Road*

A site inspection was also completed on 13th May 2019 and it is evident from visible features throughout the property that it has a number of characteristics that are specifically configured for managing drainage and flooding. These are described further in following sections. Whilst general connectivity of waterways is maintained through the property, there are some clearly defined earthen embankments that enable runoff to be directed to manage on-farm production. These and other features form part of the description of how the land is currently used and could be adapted to an alternate land use for both normal climatic regimes and flood regimes.

## 3.2 Irrigation and drainage

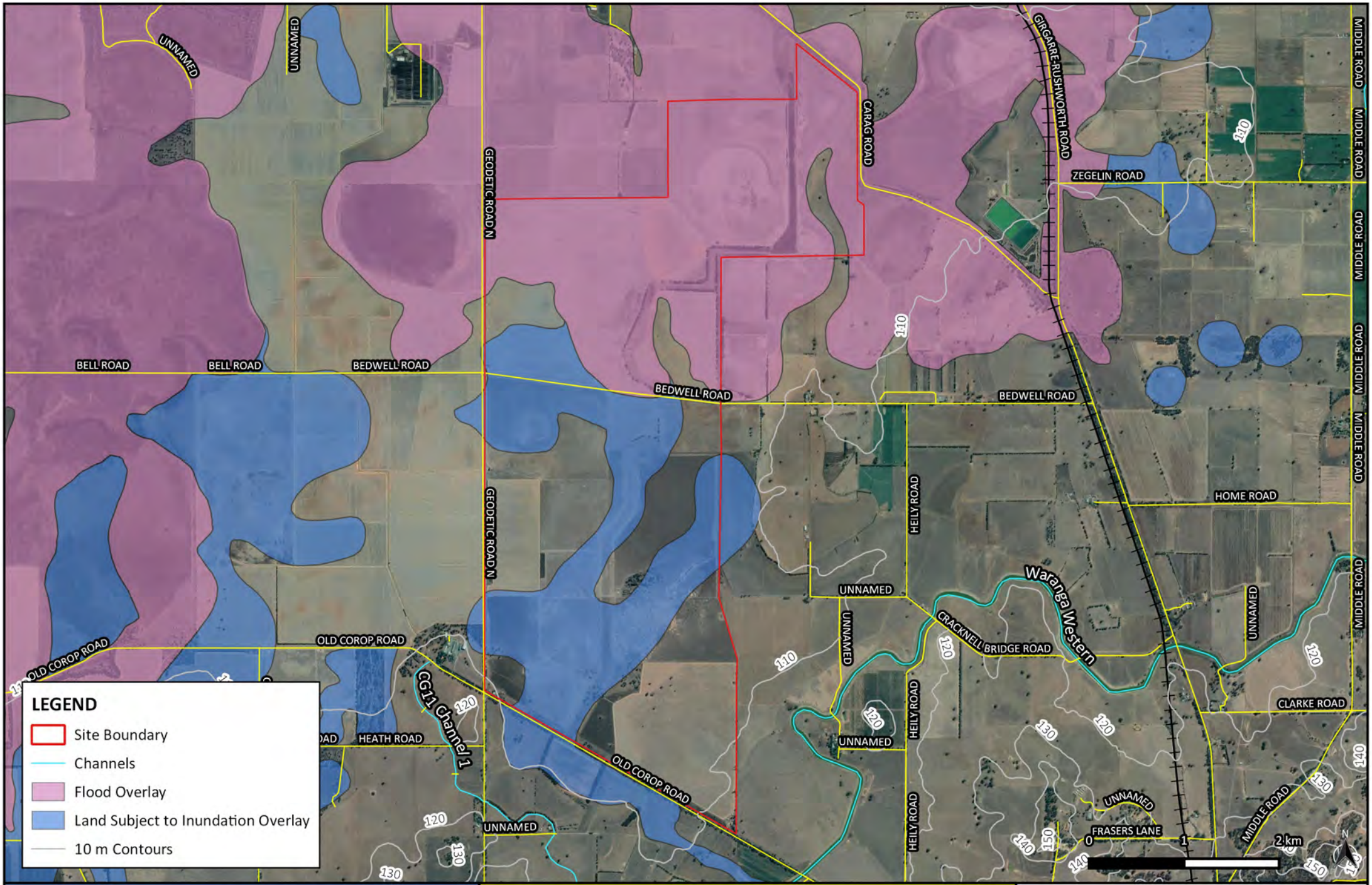
The site is within the GMID but is not currently irrigated. It is adjacent to a number of irrigation channels and historically would have been watered. An old 'Trust' channel which sourced water from the No. 10 channel crosses the south-east corner of the property. The property does not currently have an irrigation outlet or a formal Water Use License (WUL).

The Shepparton Irrigation District is overlaid with a drainage strategy to manage impacts of waterlogging and salinity. A review of the drainage strategy shows that there are no formal drainage assets servicing the property. The nearest formal service is the Deakin drainage system which extends to the properties north of Two tree road (which is immediately north of site). Other controls that could be activated (have not yet been) under the drainage strategy include:

- Drainage course declaration – allows for waterway to be cleared of flow obstructions
- Water management scheme – allows a suite of works to be implemented to manage water movements.

These options were flagged in the Shepparton Irrigation Region Drainage Strategy for the Woolwash Depression but there is no formal declaration in place. The local planning scheme overlay relating to water movements (Figure 7) shows that there are two key issues and these are about managing water in the landscape more generally than managing on-property runoff.

Drainage lines are well established on the southern property as shown in Figure 7 and Figure 8. Work was completed in around 2002 on developing a whole farm plan but it does not appear to have been fully implemented. The schematic shows that the southern property is essentially laid out to allow water to be transmitted from the southern end to the northern end and this should be allowed to be the case with new infrastructure proposed.




# LAND SUBJECT TO INUNDATION AND FLOOD OVERLAY

FIGURE 7
REVISION NO.: B

CLIENT: LEESON GROUP
JOB NO.: 19037
CREATED BY: R CHEOK ON 16/08/2019

LOCATION: COROP, VIC
CRS: GDA94 / MGA ZONE 55
DATA SOURCES: VICMAPS, GOOGLE

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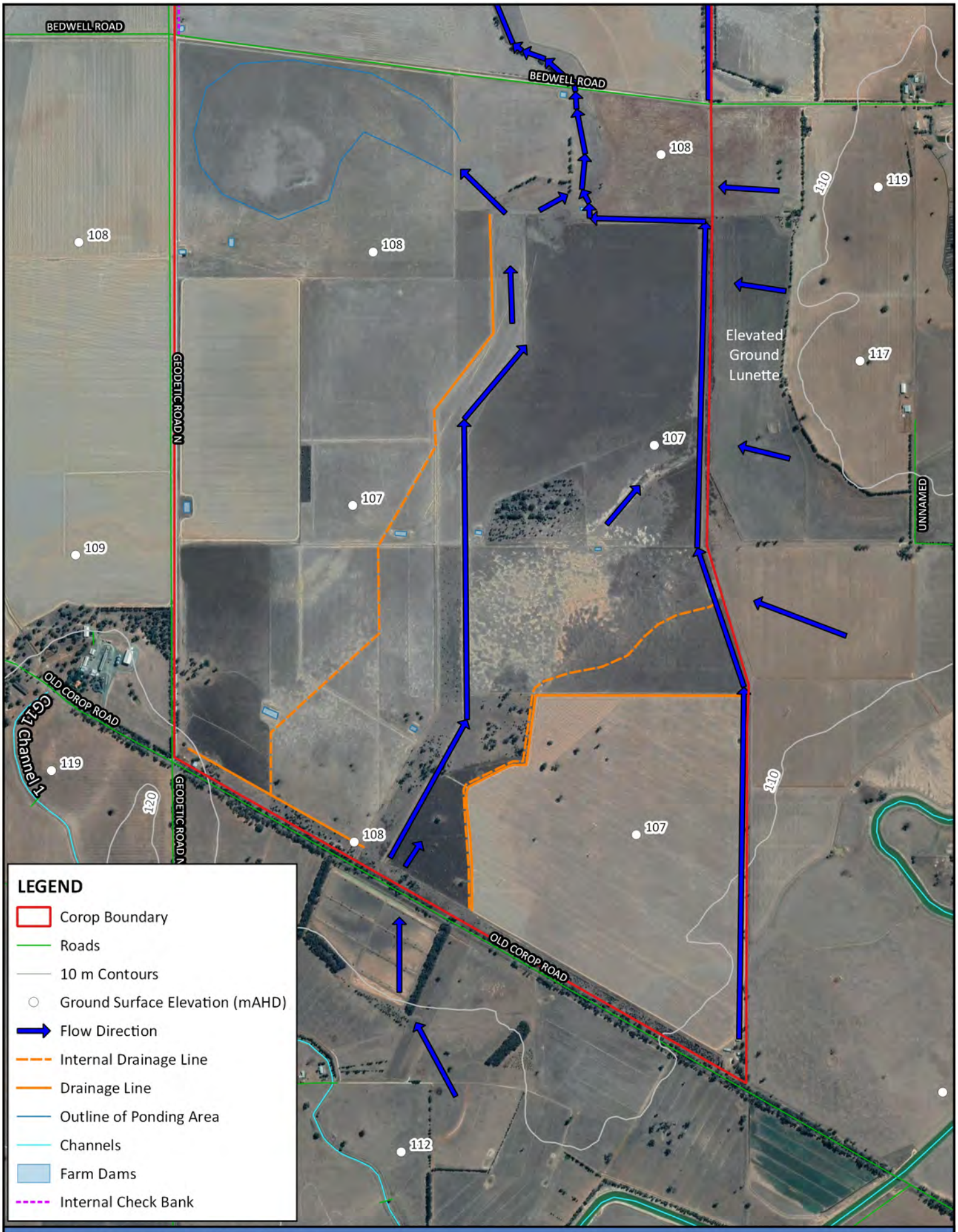
PO BOX 155, MOAMA NSW 2731, AUSTRALIA




# SOUTHERN BLOCK - FLOW OF WATER

FIGURE 8
REVISION NO.: D

0 250 500 m N

CLIENT: LEESON GROUP
JOB NO.: 19037
CREATED BY: R CHEOK ON 16/08/2019

LOCATION: COROP, VIC
CRS: GDA94 / MGA ZONE 55
DATA SOURCES: FIFTEEN50, VICMAPS, GOOGLE

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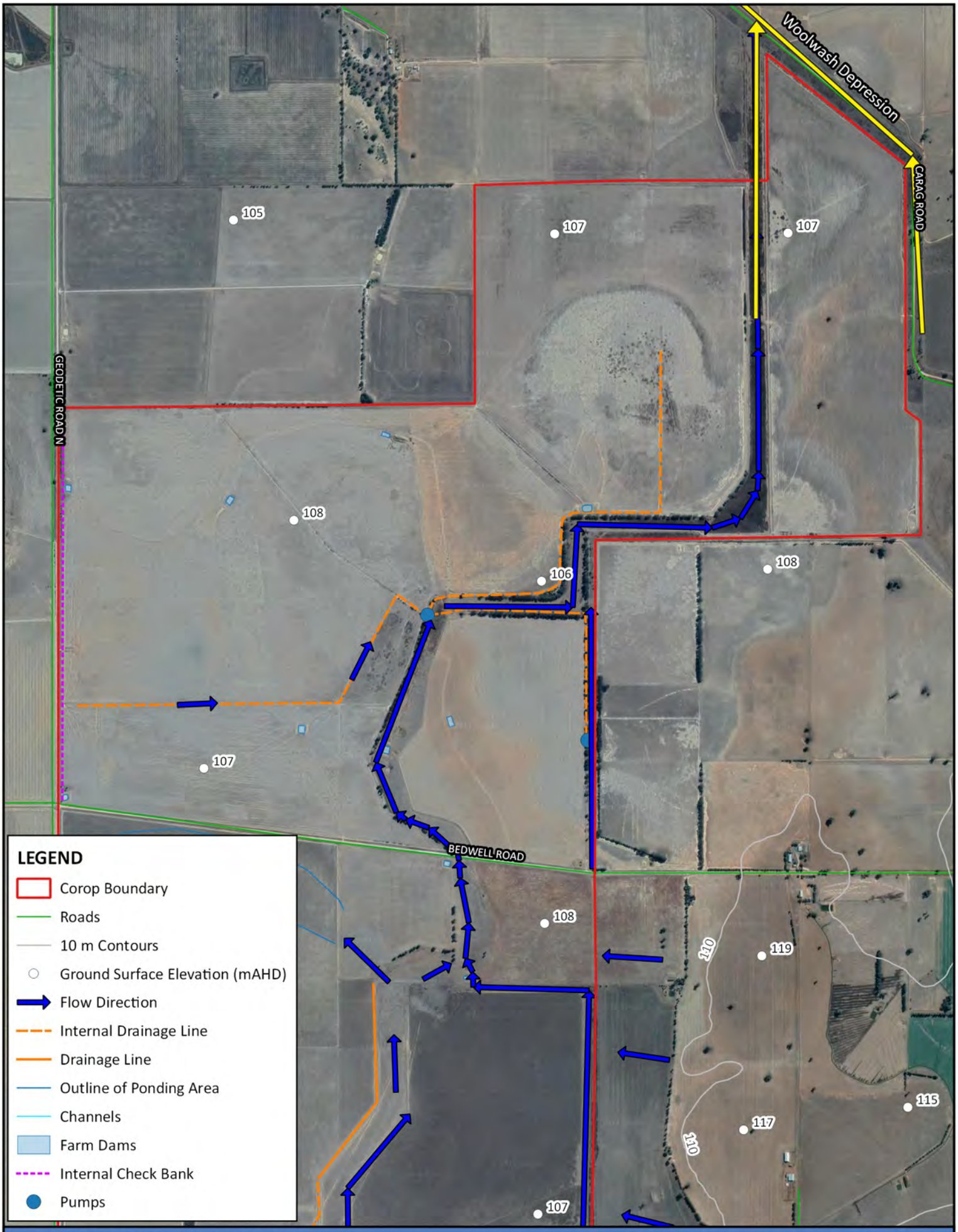


# NORTHERN BLOCK - FLOW OF WATER

FIGURE 9
REVISION NO.: D

CLIENT: LEESON GROUP
JOB NO.: 19037
CREATED BY: R CHEOK ON 16/08/2019

LOCATION: COROP, VIC
CRS: GDA94 / MGA ZONE 55
DATA SOURCES: FIFTEEN50, VICMAPS, GOOGLE

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The flow of water on the northern property, shown in Figure 9, incorporates an elevated floodway through the centre (south to north). On-farm pumps discharge from lower lying areas back to the floodway. The overall hydrology is more complex due to the flat topography and is better described in terms of flood behaviour rather than in terms of runoff processes.

## 3.3 Flooding behaviour

Flooding is formally documented in the planning scheme as affecting the northern portion of the study area (between Bedwell road and Carag Road). The area to the north-west of the site is in broad terms the Timmering depression, a natural catchment area that has not been developed for irrigation due to lack of drainage. Sub-catchments within this include the Woolwash depression, Wanalta/Cornella Creek and Nanneella Depression. The site is located at the upper end of the Woolwash depression.

Goulburn Murray Water and the Goulburn Broken Catchment Management Authority have undertaken a number of studies on the Cornella Creek/ Wanalta Creek to manage flooding issues associated with the asset life and suitability of the Waranga Western Channel crossing. There is limited analysis available on the flood behaviour within the Woolwash Depression. The existing flood overlay zone covers the northern part of the property of interest. This overlay is based on a 100 year ARI flood extent delineation within the Corop Lakes study area which is based partly on the 1974 flood aerial photography.

Analysis of natural surface levels along the Carag Road (and along the Woolwash depression) show that there is little to no relief once water passes downstream of Bedwell Road. Downstream of the northern property boundary there is a double box culvert under Carag Road and a defined, albeit shallow and flat, floodway (Figure 10). Other sub-catchments also discharge water to the area upstream of the Carag Road culvert. The size of this culvert indicates that substantial water movement occurs along Carag Road.

*Figure 10: Downstream flood infrastructure [box culvert (left) and downstream of culvert looking north west (right)]*

Based on the above information the driver of flooding in the study area appears to be mostly as a result of the area being landlocked with little to no natural relief. In particular, the northern block between Bedwell Road and Carag Road is located in a natural low-lying area within the landscape and it accumulates water after larger rainfall events. The flooded area can spill downstream through the Woolwash depression to beyond the Midland Highway when volumes and levels of water exceed storage capacity within the local landscape. On-farm pumps can also discharge water from low lying areas back to the depression after flooding has occurred.

The existing property layout is a good indication of how the drainage and flooding issues have been managed historically. It is clear from the farm layout shown in Figure 9 that the Woolwash depression is well formed (with constructed banks) within the property and that there are several adjacent low-lying area that are drained to the depression via lift pumps. It is not immediately obvious as to what magnitude of rainfall event would see this feature spill into the property and subsequently cause extensive flooding. Further analysis of some general hydrologic parameters to define north of Bedwell road would improve the definition of how the hydrology behaves.

Analysis of state flood database information indicates that water levels in a 100 year ARI could be between 1 to 2m deep in the parts of the northern property. However, the flood level information is considered to be low reliability. Discussions with the landowners confirmed that in the 2010/11 flood event water levels were in the order of 1m deep in places and so this confirms that the 100 year ARI could have been 1-2 m deep in the lower parts. This is an issue for asset protection rather than flow intervention as there would be minimal water velocity within the property area given there is minimal downstream relief.

Eastern arm Woolwash depression – looking north Bedwell Road

Western arm Woolwash depression – looking south towards Bedwell Road

*Figure 11: Woolwash depression photos*

An analysis of the typical runoff volumes that might be influencing the hydrology at the site was undertaken by analysing the cumulative rainfall deviation. For the purposes of developing a high level estimate of the quantity, a consistent rate of 25% runoff was adopted for purposes of calculating the order of magnitude of flow arriving at the property from the south. This rate is similar to the runoff known to be generated from for irrigation drains in the area. Figure 12 shows that the events that generate significant runoff are the larger rainfall events with extended duration for around two to three months at above average rainfall. According to GHD 2012 “there is no new aerial flood photography available for the Corop Lakes study area coinciding with any of the flood events during the period 2010 till now”.

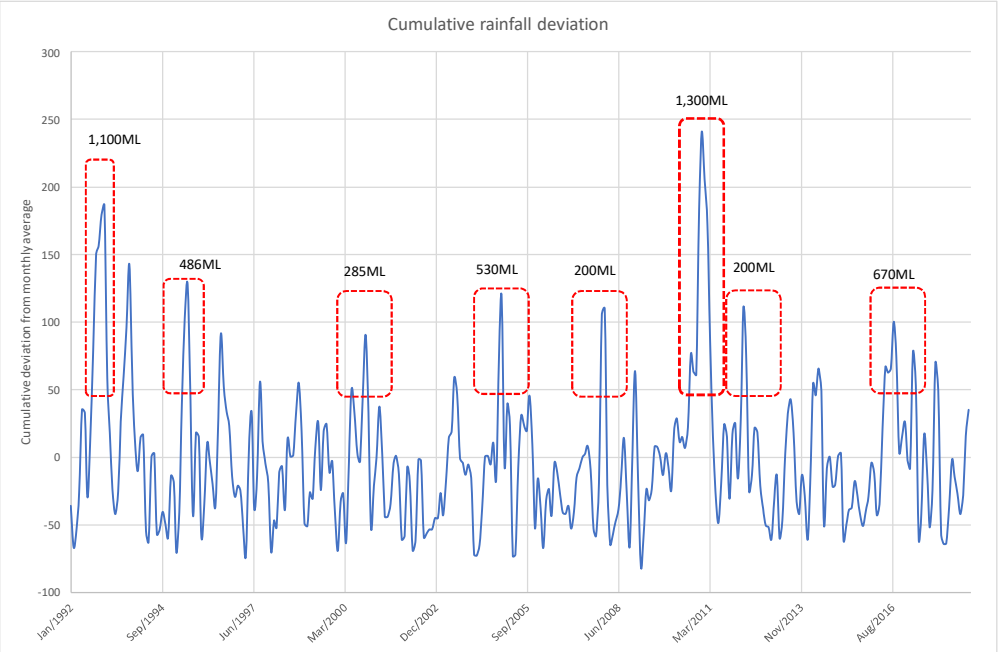


*Figure 12: Cumulative rainfall deviation*

The 1974 flood is the benchmark for flood extent associated with a 100 year ARI. There are no similar events in the period up until 1992/93 and so the analysis has focussed on the post 1992 period. The two larger events (1993 and 2011) are similar in magnitude to the runoff estimated for the 1974 year (1,341ML) and are known anecdotally to have caused flooding in the area. Groundwater responses to these events which are document in the following section back up this position. However, it is the behaviour that occurs for smaller rainfall runoff events that is of most interest for assessing risk to new built assets (solar pedestals).

Without local records, an analysis of the enduring effects of rainfall events was undertaken by comparing bulk runoff with natural evaporation rates. The analysis assumed that 25% of rain in each month is converted to runoff which is in turn stored as floodwater on the northern property. On the basis that the storage is a nominal 150ha, the timeframe to return the area to dry was calculated. In each event analysed in

Table 3 below the property returned to a dry state by around Nov / Dec each time.  While this does not necessarily provide a definitive assessment of the frequency or impact of flooding it demonstrates that the site characteristics do not support any enduring water body or wetland.

*Table 3: Analysis of surface water persistence*

| Period | Runoff to storage (ML) | Evaporation mm | Return to dry |
|---|---|---|---|
| Jan 1974 – Oct 1974 | 1,306 | 1,110 | Dec |
| Aug 1992 – Jan 1993 | 1,104 | 955 | Dec/Jan |
| July 1993 – Oct 1993 | 605 | 295 | Nov/Dec |
| Oct 2000 – Nov 2000 | 285 | 325 | Dry each month |
| Nov 2004 – Feb 2005 | 530 | 900 | Dry each month |
| Aug 2010 – Feb 2011 | 1,344 | 1,155 | Feb |
| May 2016 – Sept 2016 | 670 | 260 | Dec |

## 3.4 Groundwater

Exist groundwater [observation] bores in the vicinity of the site are shown in Figure 13.

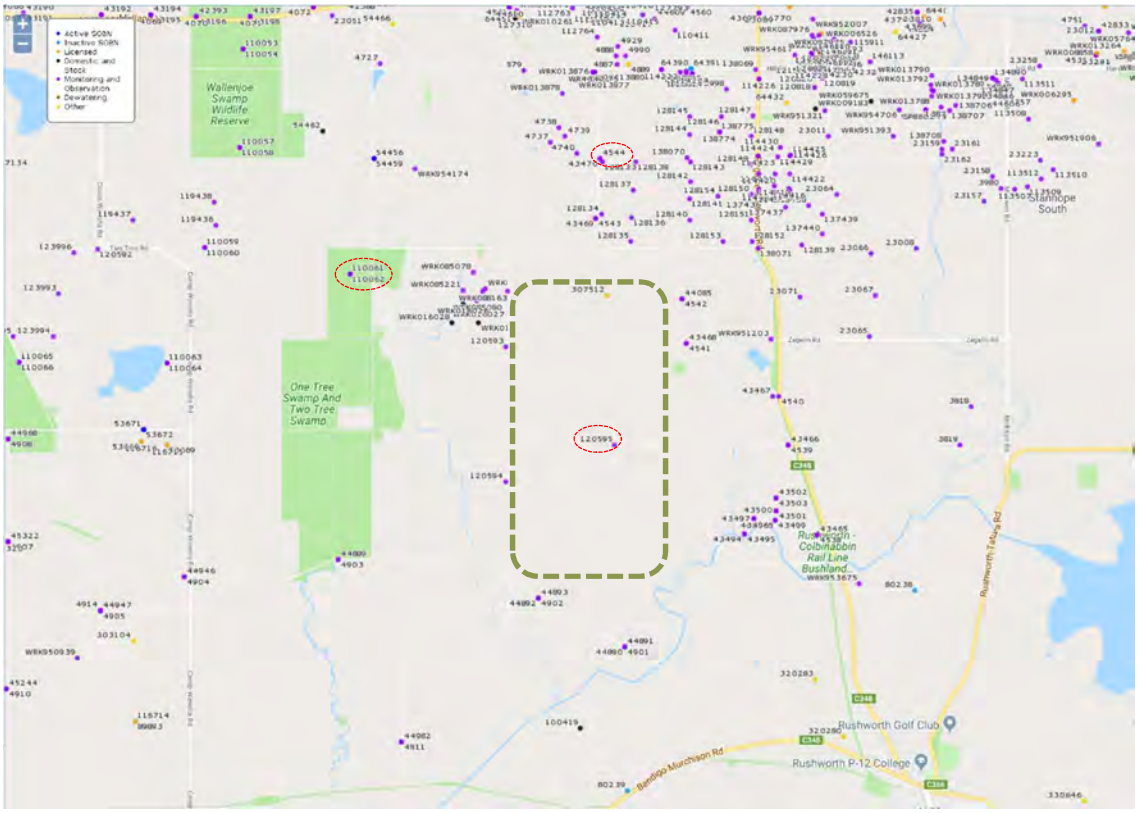


*Figure 13: Victorian water measurement information system [extract of sites]*

Data relating to a selection of three bores in Figure 14 to Figure 16 indicate that depth to groundwater in the study area and surrounds is typically less than 2m below natural surface.

Data for bore 110061 would be affected by the characteristic so the Two Tree Swamp and so this figure provides a different result. It is clear that the water levels declined throughout the millennium drought and returned to between 2m and 3m below natural surface after the 2010/11 floods.

Groundwater peaks correlate well with higher rainfall seasons which provides a proxy indicator of flooding in the area. At site 120595 the following peaks correlate with wet years:

- July 1995
- November 2000
- August 2003
- February 2005
- 2010/11 Season

The key outcome from a groundwater perspective is that any development will need to be in consideration of a limit on excavation depths and persistence of saturation post rainfall runoff [flood] events.

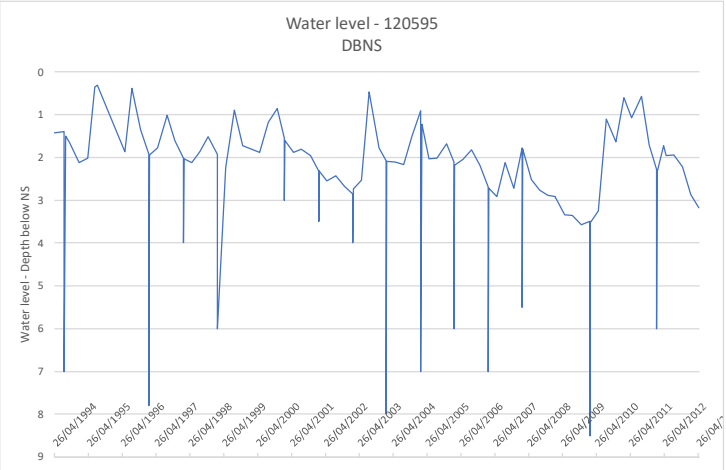


*Figure 14: Groundwater bore 120595 historic levels*

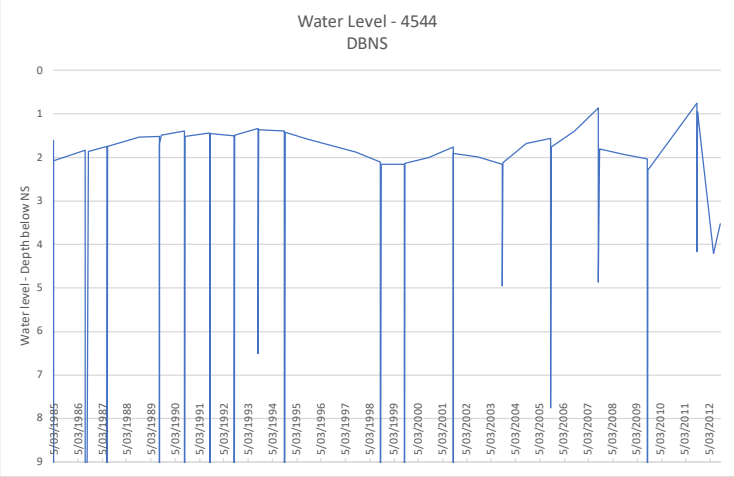


*Figure 15: Groundwater bore 4544 historic levels*

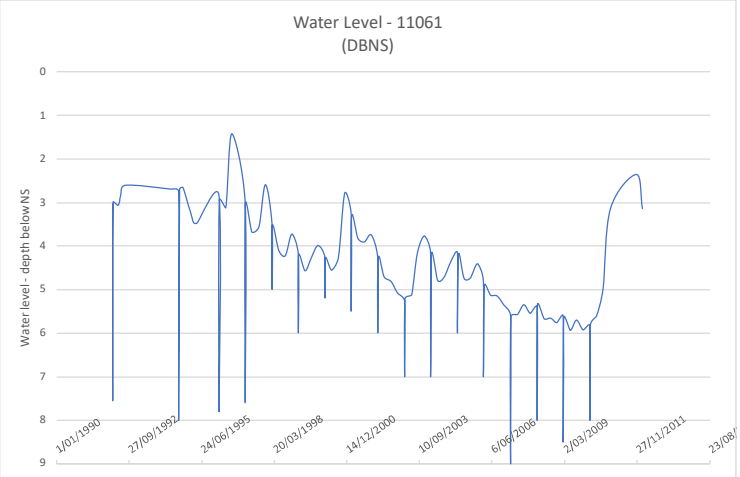


*Figure 16: Groundwater bore 110061 historic levels*

[Peaks: 1996, 2000, 2003, 2010/11]

# 4. On-site constraints

The site for the proposed development has a number of constraints that will need to be incorporated into the design/layout of new infrastructure.

## 4.1 Flow / displacement of water

### 4.1.1 Southern block

The existing farm layout on the southern portion of the property is configured with a number of features to manage excess water across the property. Drainage lines along the centre and eastern flank (Figure 17) of the property are clearly designed to convey water on natural grade to a discharge point at Bedwell road (Figure 18) where the Woolwash depression commences. An analysis of daily rainfall data for the 2010 / 11 event indicates that the peak daily rainfall was around 90mm. Based on the catchment area this could result in runoff in the order of 150ML/d.

This existing infrastructure combined with natural gradient, provides confidence that any short-term (peak) flow rainfall events will not create permanent water features on the property. Rather, excess water will naturally drain off after the peak has passed.

Internal drainage commencement– eastern boundary – southern block

Internal drainage mid -section, southern block – note scouring

*Figure 17: Examples of the form of existing drainage lines on property*

It is recommended that the work to install pedestals and inverters avoid new earthworks. Given that the Woolwash depression zone through the centre of the land is around 90m wide there is no material constraint to siting pedestals within the zone. The greater issue for locating pedestals in this zone is around operational access and integrity of the footings for asset longevity.

| | |
|---|---|
|  |  |
| Existing drain leading up to Bedwell Road (photo looking south from Bedwell Road) | Internal drainage mid -section, southern block – note scouring |

*Figure 18: Engineering works at Bedwell Road*

### 4.1.2 Northern block

The water management characteristics of the northern block are well defined and generally more restrictive for development. There are two distinct points of water entry onto the property; one from the southern block via the Bedwell road culvert (the western arm of the Woolwash depression) and a second which conveys runoff from the lunette to the east of the site which creates the eastern arm of the depression.

The critical impact of the depression on water management within the property is the presence of confining (check) banks which contain water within the depression. Effectively this watershed splits the property into multiple parcels where internal drainage is managed separately. The confluence of these watersheds occurs in the middle of the northern block before heading north to Carrag Road. Within each parcel on the property are multiple natural low points and these are the areas that are encapsulated by the 100 year ARI flood overlay. This internal drainage network that has been implemented on the property creates protection for the land until larger floods inundate the entire depression area and spill.

Currently there are two internal pump locations on the northern block discharging into the Woolwash depression; one on the eastern and one on the western flow path. These discharge points remove water via an internal drainage network implemented to protect agricultural assets from water logging (namely broadacre crops, sheep, cattle). The property is also protected by a small earthen embankment on the western side running parallel with Geodetic road. This embankment protects the property from south western flows

The capacity of the Woolwash depression is not known, however, a high level calculation of the indicative range was undertaken based on:

- Bedwell Road to Carag Road ~4km
- Width waterway 70m to 90m
- Check banks – say 300mm high

It is estimated that the capacity of the depression could be between 150ML/d to 250ML/d depending on water levels downstream and actual cross-sectional form. As discussed in the previous section the peak flow through the southern property could be in the order of 150ML/d. It is noted again that this water will spill to the low-lying areas on the property if the depression is flooded downstream.

*Figure 19: Geodetic Road works (internal embankment on western boundary)*

Eastern embankment and access track mid-section of northern block (looking north, depression on left, farm layout on right)

Discharge point into Woolwash depression eastern boundary

*Figure 20: Engineering works at Bedwell Road*

Internal drainage leading to pump on Western arm of depression

Discharge point into Woolwash depression eastern arm (located on western boundary)

*Figure 21: Discharge point to Woolwash depression*

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# Development assessment
## Recommended approach

# 5. Key development risks

The key site risks relate to third party impacts of developing the land:

### 5.1.1 *Water Act 1989* provisions relating to drainage and flooding impacts

The *Water Act 1989* provides for declaration as land liable to flooding as follows:

> A person other than a public statutory body must not, without the Authority's consent (being an Authority to which this Division applies and that has the function referred to in section 202(1)(d) or (e) or referred to in section 202(2)(d) or (e))— cause or permit the undertaking or erection, within an area of land declared to be liable to flooding or declared to be a floodway area, of works or structures that may have the effect of—
>
> (i) controlling or mitigating floodwaters; or
>
> (ii) discharging stormwater; or
>
> (iii) excluding tidal water; or
>
> (iv) concentrating or diverting floodwater or stormwater; or

In practice this means that any impacts of development works will need to be shown to not materially change the movement or extent of floodwater across the property as highlighted in red text above.

Our assessment based on information included in the previous section of this report is that:

- the southern property (Lot 35) can be configured to maintain water flow paths without materially impacting the movement of flood water.
- new solar farm infrastructure on the northern property will not displace floodwater due to the following
  - The area that is assigned to the major flow path of floodwater (Woolwash depression) will not be developed
  - The areas currently utilised for farming (existing land use) have drainage via pumps – therefore flood water will accumulate at these low points but the area under flood water will not flow at any substantial velocity.
  - The area of new solar panel posts will not materially change the total storage volume of floodwater.
  - A number of (container sized) inverters have a minor footprint. It is estimated that these would cover <1 % of the entire land parcel and a majority would be outside of any flood zones.

The risk is therefore on the developer to accept that infrastructure may be surrounded by floodwater and will be difficult to access during flooding events. This should be an input into the design process.

### 5.1.2 Planning scheme development allowed in flood overlay (Campaspe)

The Campaspe planning scheme seeks to obtain a risk assessment of the following:

#### 5.1.2.1 Flood risk report

If a local floodplain development plan for the area has not been incorporated into this scheme, an application must be accompanied by a flood risk report to the satisfaction of the responsible authority, which must consider the following, where applicable:

- The Municipal Planning Strategy and the Planning Policy Framework.
- The existing use and development of the land.
- Whether the proposed use or development could be located on flood-free land or land with a lesser flood hazard outside this overlay.
- The susceptibility of the development to flooding and flood damage. The potential flood risk to life, health and safety associated with the development.

- Flood risk factors to consider include:
  - The frequency, duration, extent, depth and velocity of flooding of the site and accessway.
  - The flood warning time available.
  - The danger to the occupants of the development, other floodplain residents and emergency personnel if the site or accessway is flooded.
- The effect of the development on redirecting or obstructing floodwater, stormwater or drainage water and the effect of the development on reducing flood storage and increasing flood levels and flow velocities.
- The effects of the development on river health values including wetlands, natural habitat, stream stability, erosion, environmental flows, water quality and sites of scientific significance.
- An application must be accompanied by any information specified in a schedule to this overlay.

In this instance the "Campaspe local floodplain development plan precinct of Corop Lakes, October 2010" has been applied. Figure 7 shows that the site is partially affected by this overlay.

#### 5.1.2.2 Floodplain development plan conditions

The conditions specified are as follows:

> *In order to minimise flood impacts on adjacent properties, buildings and works need to be located away from drainage lines and flow paths. The depth of flooding along drainage lines and flood storage areas will be substantial. An application to construct a building, construct or carry out works or subdivide land, must be accompanied by four sets of plans and supporting documents that demonstrate the following relevant development requirements have been met. Where relevant, the supporting documents and plans (drawn to scale) must show the following:*
>
> - *The boundaries and dimensions of the property.*
> - *A regional locality plan showing the property whereabouts within the region, including roads, streams and other prominent land-marks.*
> - *The layout plan of the existing and proposed building, works or subdivision boundaries.*
> - *Floor level of any existing and proposed buildings to Australian Height Datum.*
> - *Natural ground levels of the proposed dwelling site to Australian Height Datum, taken by a licensed surveyor.*
> - *Natural ground levels along access routes to flood free land (as indicated by the planning scheme flood overlays and zone) to Australian Height Datum, taken by a licensed surveyor. The access route includes access along any relevant government road to the property and then to the proposed dwelling location*.
>
> *In relation to rural areas, works [not buildings] are to be assessed as follows:*
>
> - *any earthworks do not obstruct natural flow paths or drainage lines on land located within the overlay.*
> - *any earthen land fill at the site of a new building or a building extension should be no more than 2 metres from the building footprint.*
> - *any works that are designed to protect the immediate surrounds of existing habitable dwellings, where the floor level is below the 100-year ARI flood level, and do not enclose an area of more than 1,000 m2 including the footprint area of works.*

Our interpretation of the above is that pedestals could be installed without impact in areas outside of the flood zone. The hydrologic analysis also supports pedestals being installed without having a material impact on flows within the flood overlay area (which is on the northern property).

Earthworks should be avoided within the Woolwash depression (as well as associated banks) within both the southern and northern properties and where there are access roads/tracks these should incorporate culverts to maintain water flows.

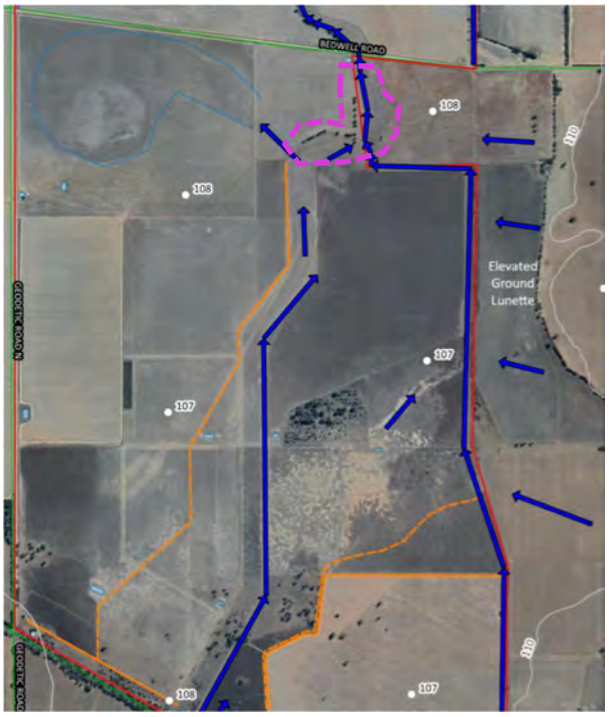
All buildings proposed should be located on higher ground on the southern property.

### 5.1.3 Mapped wetland management

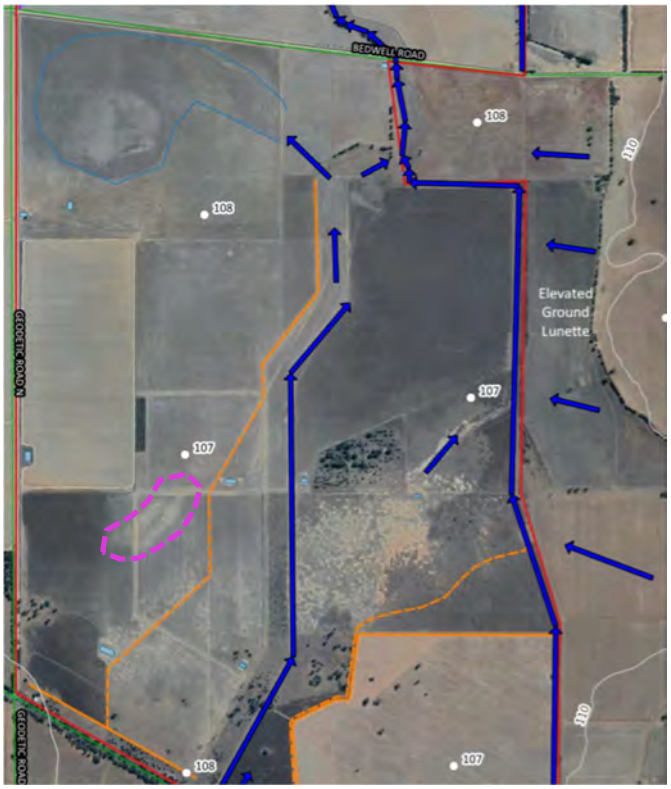
Three mapped wetlands exist on the two properties:

- 60109 – Part of the Woolwash depression immediately upstream of Carag Road (pink dashed outline)

- 60108 – Located immediately upstream of Bedwell road on the drainage depression (pink dashed outline)




- 60106 – Located on southern property west of the central depression (pink dashed outline)



The rainfall deficit for the region indicates that it would be difficult to maintain vegetation that is characteristic of wetlands. The existing land use is primarily dryland cropping and sheep enterprises with little to no irrigation run off available on site. This, combined with the relatively stable and saline groundwater level at or below 2m below surface, supports a position that areas flagged as wetlands lack the vegetation and ecosystem function that would be expected of wetlands.

The hydrologic analysis demonstrates that surface water runoff is only as a result of more significant rainfall events and that this travels through the property via a floodway. The larger rainfall events are driven by Winter and Spring rainfall and excess water in the environment after these events will not persist beyond late Spring (November / December) in most years.

The areas where runoff water is currently contained is surrounded by check banks that are part of the Woolwash depression. It is recommended that these areas be retained and not developed with any new earthworks as part of the proposal. This will ensure that the proposed works are not likely to impact on the current flow regimes within this depression.

# 6. Management measures

A number of management measures are recommended to be incorporated into further designs:

- Design site layout to maintain existing flow path of the main Woolwash depression. Site investigations indicate that this floodway is well delineated for normal runoff [non-flood] conditions. The floodway is also around 90m wide and so the siting of any pedestals within this zone will not create a material change to flow.
- Maintain water storage areas clear of assets – There are a number of low-lying areas within the property boundary (outside of the main depression) that should be protected as drainage sumps. These are primarily on the northern property adjacent to the floodway, with the ability to pond water to depths of one metre or more, once inundated in flood conditions.
- Site access roads are to incorporate culverts / structures to allow lateral movement of water. The main site access issues will be on the northern property which is divided into a number of parcels when flooding occurs
- Buildings / facilities to be located on the southern portion of the development property.

The locations where the above items are applicable can be identified on the Solar Farm Layout Drawing (CFS-001-004).

It should be noted that the area on the northern property could be inundated by more than 1m of water in a 100 year flood and so this is to be considered for engineering integrity and extended access constraints rather than as a statutory planning constraint.

# 7. Regulatory approach to development

The following is proposed:

- Planning meeting with Campaspe Shire
- Consult with local landowners to confirm flood years and water inundation characteristics assumed in this report
- Develop and submit planning application.

Shop 5, 210 Pakenham Street
Echuca Vic 3564
PO Box 155 Moama NSW 2731
www.fifteen50.com.au

5 August 2020

Peter Leeson
Leeson Projects
Eltham

Dear Peter,

Please find attached a short summary of what we see to be the key technical issues associated with the objections to the Corop Solar Project's site hydrology assessment.

Note that the intent of this is to assist in interpretation of the key issues by those reviewing the permit application. In providing this response we have not sought to provide the level of detailed analysis that we might otherwise provide if the issues were being tested as an expert witness for legal proceedings. We could provide a formal scope of work for this if the need eventuates and is requested.

Yours Sincerely,

Dean Delahunty
DIRCETOR

0407 520 758
Dean.Delahunty@fifteen50.com.au

The following is a response based on whether any approval conditions should be imposed to manage potential changes (as a result of the proposed development):

**1. Catchment size and flow**

The upstream catchment characteristics (size, shape, response to rainfall and discharge location) are not being changed by the proposal and are not relevant to assessing the impact of the proposal.

The descriptions provided for the upstream catchment in the report is to demonstrate context; that the primary source of water (the potential volumetric quantity) arriving at the property is via a narrow entry point or frontage along Old Corop Road. The volumes and flow rates arriving at the property are incidental to any impact assessment. Whether they are treated as estimates or not does not materially change the assessment of potential impacts of the development.

**2. Surface water behaviour**

The objection raises the issue of rainfall direct to the property which is best addressed in two parts below:

**Part 1 - Movement of water through Site 1**

Property 1 has a whole farm plan and is configured to naturally move water towards a single road culvert on Bedwell Road. Due to the low relief on the property specific flow paths may vary from event to event depending upon the volume of runoff. Whether the source of any surface water moving through the property is from the entry from Old Corop Road or from internal rainfall runoff, the site is graded such that most water will drain to this point.

The potential barriers to allowing the movement of water through property 1 under the current land configuration, and the drivers for recommended development conditions, are:

- Posts for solar arrays – The primary drainage path is approximately 90m wide so the capacity for solar array posts to impact the velocity of flow are not material to water movement. We do not envisage that there is a physical change that needs to be managed by development conditions about these posts.
- Inverters – The development is avoiding placing these within main drainage pathways and the development conditions should be structured to ensure this is the case on any detailed design documents.
- Access tracks / roads – Report recommends that these are configured so that water flow / velocity is maintained appropriately. This should still apply and is appropriate to check during detailed design to demonstrate compliance with approval conditions.

**Movement of water through Site 2**

Water movements on Property 2 could behave according to a number of different modes depending on whether two conditions arise:

- rainfall runoff from upstream of Bedwell road creates volumes of water that exceed the capacity of the existing Woolwash Depression throughflow system (i.e. this type of event is not within property owner's control); or
- high water levels or obstructions within the drainage path along Carag Road, adjacent to the northern boundary of the site, prevent water from flowing away from the site.

In either of these situations water levels that build up and can spill from the defined drainage system into low lying areas on the property and surrounds. The potential for the proposed works to displace water under these two situations, and the drivers for recommending development conditions, are:

- Posts for solar arrays – The primary drainage path is approximately 90m wide so the capacity for solar array posts to impact the velocity of flow are not material. When the area is flooded then it is expected water velocity would be close to zero and so the presence of posts is not material for changing the velocity. There is no material physical change that needs to be managed by development conditions about these posts.
- Inverters – The development is avoiding placing these within main drainage pathways as well as low lying areas adjacent the main drainage path. Development conditions should be structured to ensure this is the case on any detailed design documents.
- Access tracks / roads – Report recommends that these are configured so that water flow / velocity is maintained appropriately. This should still apply and is appropriate to check during detailed design to demonstrate compliance with approval conditions.

**3. Groundwater impacts**

The potential for land to be affected by waterlogging and salinisation is acknowledged as a legitimate concern particularly if significant land use changes are proposed. Historically the broadscale development of irrigated agriculture across much of northern Victoria is known to have caused widespread waterlogging and salinization and the property is adjacent to the irrigation district where these effects have been known to occur. It should be noted that the property being examined no longer has access to formal irrigation delivery infrastructure.

The objection is focussed on a concept that the proposed development will change land use through converting the vegetation type from cropping to grazing (perennial). The suggestion is that alternate vegetation types may change (increase) the infiltration rate of water from the surface through the soil profile to the watertable.

The key consideration in assessing potential impact is whether there is evidence of historic changes to groundwater behaviour under existing land use practices. This can be viewed at varying scales:

- Regionally: A review of available (shallow) groundwater monitoring bores adjacent to Two Tree Swamp (where it might be expected water levels would be high) has been declining (>3m DBNS) since the early 1990's. A review of levels at bore 4544, which is within the irrigation district immediately north of the site, has been consistently within 2m of the surface since the mid-1990's. These outcomes suggest that groundwater in the region of the proposed development has been, and will continue to be, fluctuating in a range where capillary rise could be an issue. Regardless of whether the development proceeds, salinisation could occur at low points in the landscape where watertable is within 1.5m to 2.0m of the surface.
- On property: There are three bores located on or close to the property boundary (120593/120594/120595) that provide more than 30years of behavioural data. There is a clear groundwater response to the climatic events examined in Section 3.3 of the report (high residual rainfall) but the spikes in groundwater level are temporary and typically can be seen to decline when the effects of this surface water loading have passed. The volume and timing of water application to the land parcel is not controlled under current operations and will remain uncontrolled with the proposed development.

Rainfall events represent the most significant driver causing spikes in groundwater levels at the development site. In considering changes to evapotranspiration, associated with converting from one vegetation type to another, the

magnitude of change in water use is likely to be many orders of magnitude less in volumetric terms than from surface water flows entering the property. The potential for incremental effects on land salinization will be difficult to separate.

While further analysis may be able to quantify the volumes, it is unlikely to show that the developed will increase further salinization risks to the land than exist now.

We also note that crop water use is likely to be higher on an annual basis with perennial (grazing) vegetation relative than it is with cropping.

**Wetlands**

It is acknowledged that wetlands exist in the general area and that these are capable of supporting a range of flora and fauna species. It is likely that the wetland sites that exist outside of the property on which the development is proposed do so because they have better characteristics to support wetland values. The potential wetland sites identified on the property, from a hydrologic perspective, do not.

Shop 5, 210 Pakenham Street
Echuca Vic 3564
PO Box 155 Moama NSW 2731
www.fifteen50.com.au

30 September 2020

Peter Leeson
Leeson Projects
Eltham

Dear Peter,

Please find attached a short summary of technical issues associated with the objections by DELWP to the Corop Solar Project's assessment. We understand that this will be a supporting input to a broader response to an RFI to DELWP on these issues.

Yours Sincerely,

Dean Delahunty
DIRCETOR

0407 520 758
Dean.Delahunty@fifteen50.com.au

The following is a response to questions about 'mapped wetlands' identified by DELWP objection letter REFSP469487 (200191106CN):

1. **Shading**
   Refer response from others.

2. **Hydrology**
   It was established in Fifteen50, August 2019 that the dominant hydrologic process for the site is flood routing through the Woolwash Depression and that the hydrology of two of the listed wetlands located within the path of this will not materially change as a result of the proposed development. We further outlined in supplementary letter dated 5 August 2020 that the three activities with potential to change hydrology are installation of pedestals, inverters and access tracks. None of these actions will change the volumes of water passing into, through and out of the Woolwash Depression and neither will alter the seasonality of this water presenting at the wetland sites.

   The local watershed for the third listed wetland site is so small that water is highly unlikely to persist for long enough to support wetland vegetation in that location. The proposal is also not altering the natural flow path into or out of the location.

3. **Effluent**
   Location and source of potential effluent will be associated with the site office facility to be located on the southern property. This is located on higher ground and outside of the main flow path of the Woolwash Depression. The site is also likely to be greater than 100m from the waterway and is more than two to three kilometres upstream of the first of the two wetlands on the flow path.

   Providing that the proponent makes the appropriate application for installation of a suitably designed septic system then the potential for effluent to impact vegetation health will be negligible. Appropriate approval mechanisms are available to ensure septic system is approved prior to proceeding.

4. **Stormwater**
   Potential for additional runoff generated from proposed buildings is assessed as negligible relative to the runoff potential of the whole site. The location of potential runoff from the building/s is > 2km from the wetlands located on the Woolwash Depression and will more than likely be attenuated in soil profile in small to medium sized rainfall runoff events (i.e. little or no runoff reaching wetlands). Larger rainfall events are likely to generate flood flows into the property from outside areas and these will be much greater flows than the runoff generated inside the property boundary.

   Storage of runoff from building/s in tanks for purpose of fire-fighting reserves will mitigate any impacts of changes to runoff by creating impervious areas associated with the buildings.

5. **Compaction**
   Refer response of others.

6. **Excavation**
   Refer response of others.