5. Existing conditions – surface water

5.1 Catchment description

The 3.95 km^2 Project Area sits within a catchment of approximately 16 km^2. The catchment drains via an unnamed ephemeral waterway which forms the northern boundary of the Project Area. There is a series of three dams on the ephemeral waterway. The catchment is characterised by gentle slopes and plains with a number of basalt outcrops.

Having undergone significant anthropogenic land clearing from the middle of the nineteenth century, cropping and grazing is now the dominant land use in the catchment and certainly the only land use within the Project Area. The unnamed waterway takes the form of an undefined channel in a broad floodplain until downstream of Mount Mary Road, where it passes through culverts (approximately 450 mm diameter) as it flows eastward. Downstream of Mount Mary Road the waterway is incised, dropping from 70 m to 40 m AHD over 1500 m.

The receiving water of the unnamed waterway is the Werribee River. The Werribee River flows for about 110 km, with its headwaters rising in the Wombat State Forest. The confluence of the Werribee and the unnamed waterway occurs approximately 40 km upstream of Port Phillip Bay and 12 km downstream from Melton Reservoir. The Werribee River catchment lies within the Port Phillip and Westernport catchment management region and comes under jurisdiction of Melbourne Water Corporation. The internationally recognised Ramsar Convention listed wetlands and estuaries of the Western Treatment Plant lie at the very downstream end of the Werribee River. The Werribee River is a significant waterway, not only for its environmental values, but also its economic importance in supplying water to the surrounding arable lands and market gardens that supply food to greater Melbourne. Land clearing, agriculture and urbanisation have contributed to widespread erosion, increased nutrient levels and salinity, and loss of habitat for aquatic life in the Lower Werribee River catchment (MWC 2013).

5.2 Climatic conditions

The region experiences a seasonal rainfall pattern with higher rainfall in spring and lower rainfall in late summer and autumn, accompanied by occasional larger flushes in summer and winter. The western volcanic plains lie in the rain shadow of the Otway Ranges and are the driest area south of the Great Dividing Range in Victoria (MWC 2013).

Figure 3, page 12 shows the rainfall pattern at Melton Reservoir, the closest rain gauge to the Project Area (5.6 km north east). The maximum monthly median rainfall of 48.7 mm occurs in October and a minimum monthly median rainfall of 24.4 mm occurs in March. (BOM 2014: Considering average of two closest stations: *Melton Reservoir 87040* and *Balliang East 87008*).

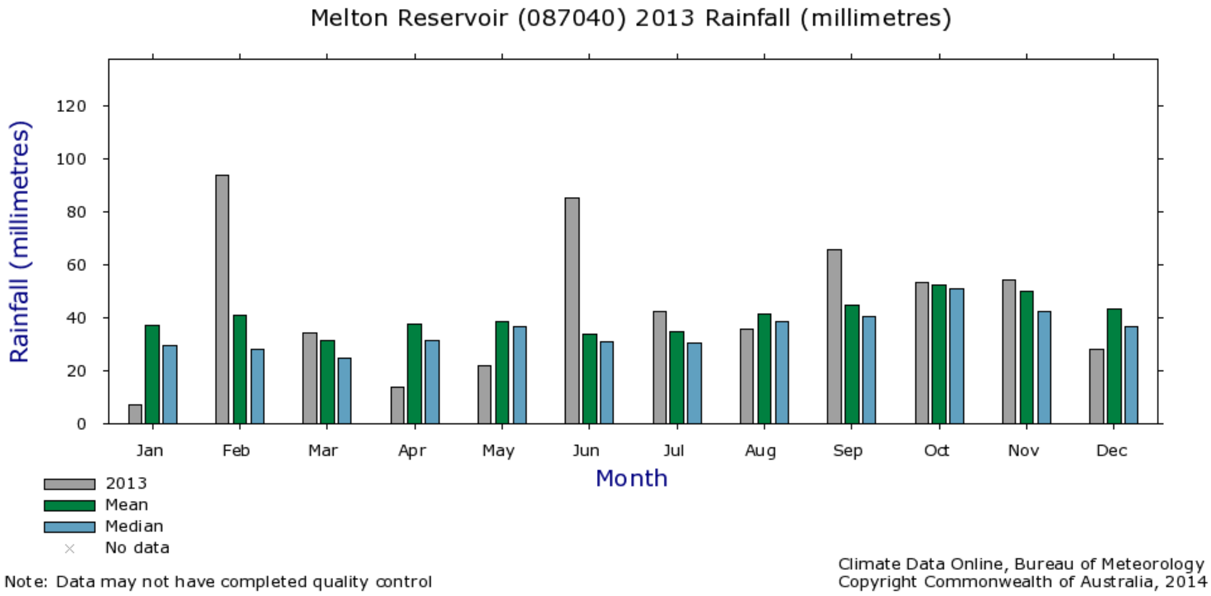


Figure 3 2013 rainfall data for rain gauge at Melton Reservoir

5.3 Waterway health

Water quality

There is no on site water quality or flow monitoring.

The closest recorded water quality data is on the Werribee River at Cobbledick Ford (*site 231208,* DEPI 2014a), approximately 4 km downstream of the Project Area. The crossing is shown in the site inspection photographic record, attached as Photo 13, Appendix B, page B-8. Water quality data at the site consists of 102 in situ samples covering a period of nine years (Figure 4, page 13). This provides an understanding of the expected range of pH, turbidity, dissolved oxygen (DO), temperature and electrical conductivity (EC) and could be used as a control for comparison of any change to water quality as a result of activities (construction, operation) on the Project Area.

Index of Stream Conditions

The unnamed tributary does not come under specific classification of the Victorian Index of Stream Conditions (ISC). However, the receiving waters of Werribee River fall within Basin 31 in the Victorian Rivers State Basin Classification, Reach No. 2, and is classified as Poor in the 2004 and 1999 Index of Stream Condition (DEPI 2014b). Highly regulated flows from Melton Reservoir, changes in natural flow due to private diversions, cleared agricultural areas and increasingly developed land are sited as significant contributors of the poor scoring (DSE 2005). Further, the Lower Werribee exhibited elevated total phosphorus levels and showed summer and winter stresses in its hydrological regime.

5.4 Annual runoff volumes

The volume of runoff generated from the existing 457 ha Project Area site has been estimated using the equation below. Note this is an approximation only. Rainfall was taken as an average between the two closest rain gauges at Melton Reservoir and Balliang East.

Volume = Rainfall x runoff coefficient x Area

Inputs: * Average annual mean rainfall = 482 mm (BOM 2014)

* Runoff coefficient = 0.1 (estimated based on land use and soil type)

Therefore, annual runoff yield estimate from the Project Area = 220 000 m^3.

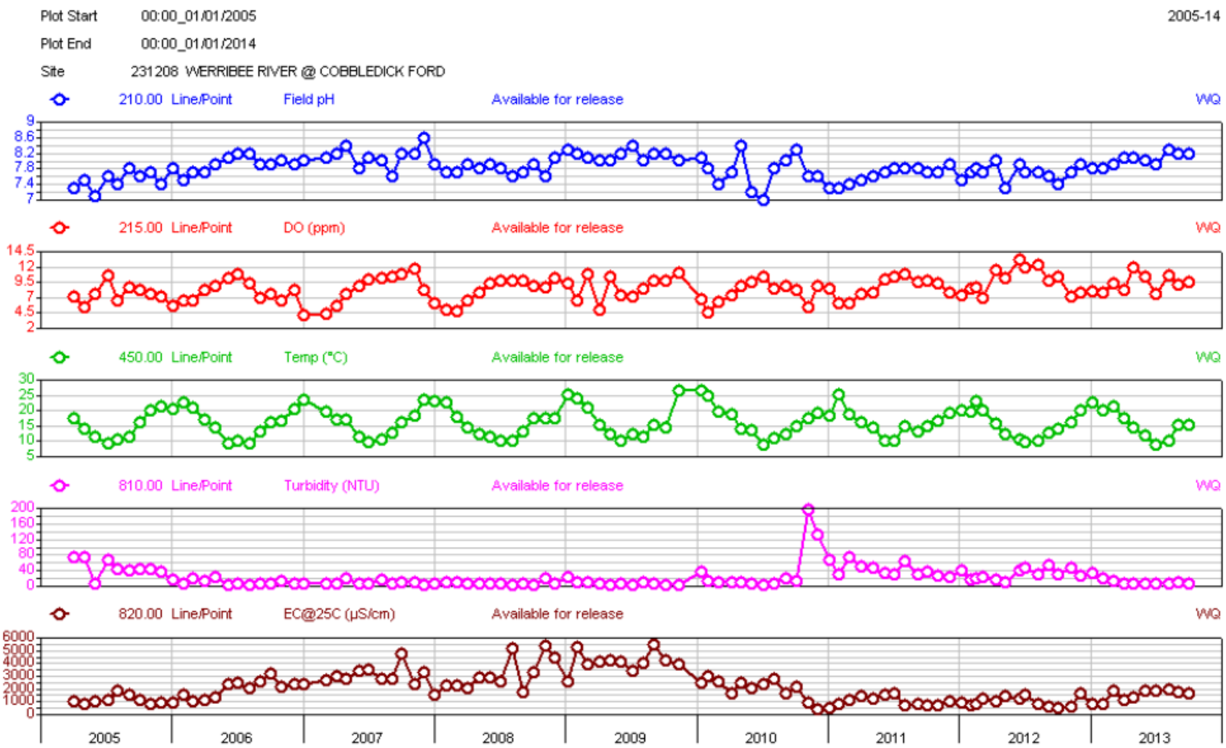


Figure 4 Water Quality of Werribee River at Cobbledick Ford

Source: DEPI 2014a

5.5 Summary of surface water hydrology

Based on a review of available information, and observations made during the site visit, the existing surface water hydrology of the Project Area is understood to be ephemeral in nature and significantly influenced by the three on-line dams (Figure 1, page 2).

Runoff from the catchment is intercepted by the dams hence connectivity of the catchment to its receiving waters is limited by the volume of storage in the dams. As this is a particularly dry catchment, percolation of rainwater into the soil is expected to account for a large portion of runoff generated from the site, again limiting the volume reaching the unnamed waterway.

From historical anecdotal observations it is understood that only in large rainfall events when the dams are at or near to capacity would the unnamed waterway be continually connected from the head to the mouth of the catchment.

There are a number of other waterways in the vicinity of the Project Area. The tributaries of the Werribee River south of Ballan Road will not be affected by the Project. Some runoff from the south east corner of the Project Area may spill over Mount Mary Road and flow into the tributary of the Werribee River south of Cobbledick Ford – see stream in bottom left corner of Figure 1, page 2. The volume of runoff coming from this area that may not make it to the same unnamed waterway as the rest of the Project Area is thought to be negligible.

Water quality of runoff from the Project Area is assumed to be directly correlated to large flow events. Sediment loads are assumed to be in very high concentration when mobilised as there would be large dry periods between flows, however without in situ monitoring equipment it is difficult to estimate nutrient and pollutant loadings. Limited water quality data is available for the Werribee River downstream of the Project Area.

6. Existing conditions - groundwater

6.1 Geology

6.1.1 Geological setting

The property in question is located on the Victorian Geological Survey's Melbourne (1:63,360) geological mapsheet. It lies within the Port Phillip Basin, a structurally controlled depression developed in the late Cretaceous period which has been subsequently infilled with Tertiary and Quaternary age sediments and volcanics. The Port Phillip Basin is considered to be an extension of the Torquay Basin and the two basins are linked offshore from the Nepean Peninsula in Bass Strait.

A summary of the site stratigraphy has been provided in Table 4, page 14.

Table 4 Summary Stratigraphy

Period	Sub Period	Stratigraphic Unit	Description	Aquifer
Quaternary		Swamp and lagoonal deposits	Sands, clays and silts	Yes – water table aquifer, near present day waterways
		Newer Volcanics	Basalt	Yes – water table aquifer.
Tertiary	Pliocene			
		Brighton Group / Moorabool Viaduct Formation	Commonly comprising mixtures of sands and clays.	Yes
	Miocene	Fyansford (or Newport) Formation	Marine marls, shelly clay stones and siltstones.	No – generally considered confining layer
	Oligocene - Palaeocene	Werribee Formation (and Eastern View Equivalents)	Largely comprises non-marine sands, clays and occasional ligneous materials.	Yes. Interpreted to occur at depth beneath site.
	Eocene	Older Volcanics	Extrusive basalt lavas synchronous with phases of deposition of the Werribee Formation.	Yes. Not identified locally.
Unconformity				
Palaeozoic			Sandstone, slate and chert. Often with Devonian granodiorite intrusives.	

6.1.2 Surface geology

The surface geology of the site predominantly comprises basalts of the Newer Volcanics. Green Hill, a topographical high located to the north of the Project Area, represents a former volcanic eruption point. Green Hill is depicted on the cover of this report and in photos 1 and 3 of Appendix B, page B-2 and page B-3. Based on observations made during the site inspection (refer Section 4) the surface soils comprise dark brown and reddish coloured silty clays and clays, with abundant basalt gravels and cobbles.

A thin veneer of undifferentiated Quaternary age sediments is mapped within topographic lows and the Werribee River floodplain. These sediments tend to be laterally restricted to these lower lying areas. Such material was not identified on the site during the walkover inspection.

The surface geology and an approximation of the Project Area boundary is shown in Figure 5, page 16.

6.2 Identified aquifers

6.2.1 Relevant aquifers

Groundwater occurs throughout the stratigraphic sequence with all formations constituting aquifers to varying degrees. However, the key aquifers of the region are Newer Volcanic basalt, the sub-basaltic sands (Moorabool Viaduct Formation equivalents) and the lower Tertiary age sediments, referred to as the Werribee Formation.

Both the Moorabool Viaduct Formation and the Werribee Formation sediments are considered to be too deep to be impacted by the proposed site operations. The aquifer most relevant to the study area is that within the Newer Volcanic basalts.

The Newer Volcanics represent fractured rock aquifers where groundwater is stored and transmitted via fractures, joints and other discontinuities within the rock mass. The basalts were outpourings from eruption centres such as Green Hill. The lavas comprise of multiple flows superimposed upon each other. Breaks in volcanic activity may have led to the formation of weathered horizons between flows, or the trapping of ash or sediments between eruptions and lava flows.

The remnant valley alluvium (including Werribee Formation and Moorabool Viaduct Formation sediments) and exposed Palaeozoic surfaces were covered by a series of fluid and fast moving lava flows which progressed as a series of overlapping lobes to form irregular units containing massive rock together with granular to blocky porous material and scoria. The basalt lavas filled the topographic low points in the pre-Tertiary surface, eventually filling the valleys and spilling over onto the surrounding surfaces. As the flows filled the palaeovalleys they interrupted and displaced the existing drainage systems.

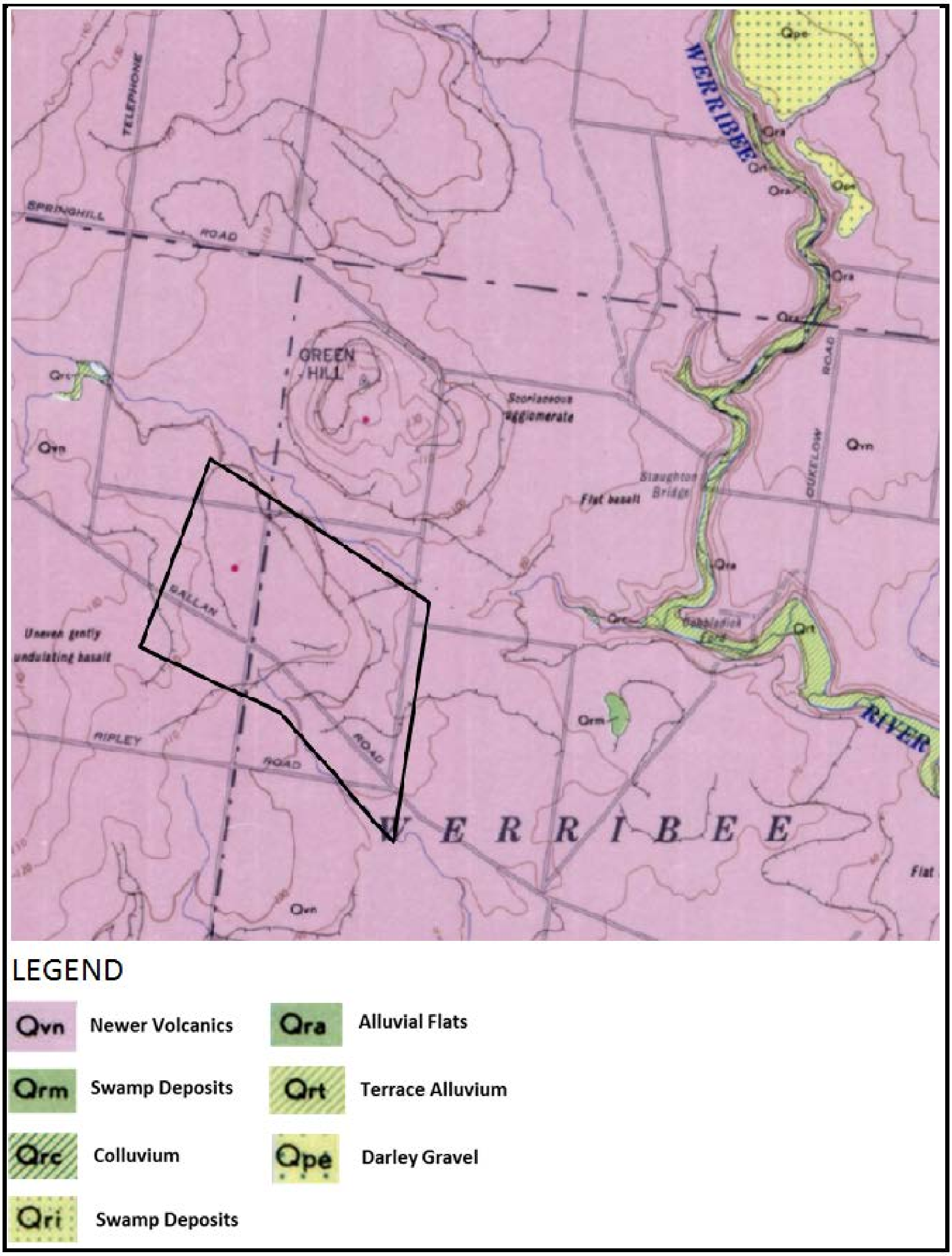


Figure 5 Site Geological Plan

Source: Geological Survey of Victoria (1974)

6.2.2 SAFE aquifer layers

To gain an appreciation of the thickness of each major aquifer and aquitard underlying the Project Area the Secure Allocation Future Entitlement (SAFE) framework mapping program was interrogated with the results presented in Table 5, page 17.

The SAFE mapping suggests that the basalts are approximately 100 m thickness on the site. This search has also confirmed that the Werribee Formation should be encountered below depths of 280 m from surface at the property separated by almost 100 m of aquitard from the shallow aquifer system.

It should be noted that the SAFE mapping is based on regional datasets. There is no deep onsite drilling information to confirm the stratigraphy, however a search of neighbouring bore information (refer Section 6.3) identified some deep exploration bores (most likely for coal resources) located on the southern side of the Ballan Road. Lithological information regarding these sites could not be obtained.

Table 5 SAFE Aquifer Report

Aquifer / Aquitard	Description	Depth (m)	
		From	To
UTB Upper Tertiary / Quaternary Basalt	Basalt	0	94
UTAF Upper Tertiary (Fluvial) Aquifer	Sands, gravels and clays	94	107
UMTD Upper Mid-Tertiary Aquifer	clay, silt, marl (fractured rock) and minor sand	107	183
LTA Lower Tertiary Aquifer	sand, gravel, clay and silt, minor coal	183	283
BSE Mesozoic and Palaeozoic Bedrock (basement)	sedimentary (fractured rock): Sandstone, siltstone, mudstone, shale. Igneous (fractured rock): includes volcanics, granites, granodiorites	>283	

Source: DEPI 2014c

6.2.3 Nature of confinement

Without localised information on groundwater potentiometry, it is difficult to confirm the nature of confinement in the aquifers within the area; however inferences can be made based on the geological setting.

The Newer Volcanic basalt forms an unconfined or water table aquifer where it is mapped in outcrop. The aquifer system may become semi confined to confined where locally, deeper fracture sets and flows are developed that are hydraulically disconnected (or have restricted connection) with shallow fracturing.

Interaction between the Moorabool Viaduct Formation and the overlying Newer Volcanics can be variable. Interaction between the two aquifers onsite is not known, however elsewhere within the Port Phillip Basin, the two aquifers are commonly linked. This potential thickness of the Newer Volcanics (refer Table 5, page 17) may result in some confinement should massive (low fracture density) flows occur within the Newer Volcanics.

The Werribee Formation is expected to be confined by the overlying marls.

6.3 Groundwater bore information

6.3.1 Data limitations

A search of the State Groundwater Management System (GMS) was undertaken to identify and characterise groundwater use in the region. A filter was applied to identify all bores within a 3 km radius of the site. The following comments are made regarding the GMS data:

- Bores installed prior to the proclamation of the original *Water Act* (1969) may not be registered as there was no mandatory requirement to licence bores prior to this date.
- The GMS does not provide information regarding the operational status of groundwater bores.
- The GMS does not provide information regarding the casing condition status of groundwater bores.
- Bores installed without a bore construction licence, are unlikely to be registered on the GMS (unless detected by later audits by drilling inspectors/diversions officers).
- Many bores have not been surveyed for location. Bore locations as registered were often those initially proposed on the bore construction licence application. In many instances drilling contractors could not gain access to these sites and final locations often have a positional accuracy greater than ± 250 m.
- The information registered on the GMS is subject to the accuracy of bore completion reports submitted by drilling contractors.
- Information registered on the GMS is subject to change since the completion of the bore e.g. water level information, pump setting depth, groundwater quality.
- Some information is not available on the GMS, e.g. pump setting depth, bore ownership.

The GMS does not provide information regarding the currency of bores with licensable extractive use i.e. a bore indicated as being an irrigation bore may not have any allocation attached to it. That is, the intended use may have altered due to low yield potential recorded or poor quality groundwater intercepted. These use changes are not reflected in the GMS.

6.3.2 Groundwater use

Based on the bore search, a total of 30 bores were found within a few kilometres radius of the study area. Most of the bores were installed for stock and domestic purposes, however a few investigation bores were identified. These investigation bores may have been installed as part of coal investigations, as seams have been mapped within the Werribee Formation.

A summary of the neighbouring bore information is shown in Table 6, page 19 and shown in Figure 6, page 20. Most of the stock bores were drilled to depths between 20 m and 80 m, and likely develop the Newer Volcanic basalt, although specific lithological information regarding each bore is limited.

6.3.3 Bore yields

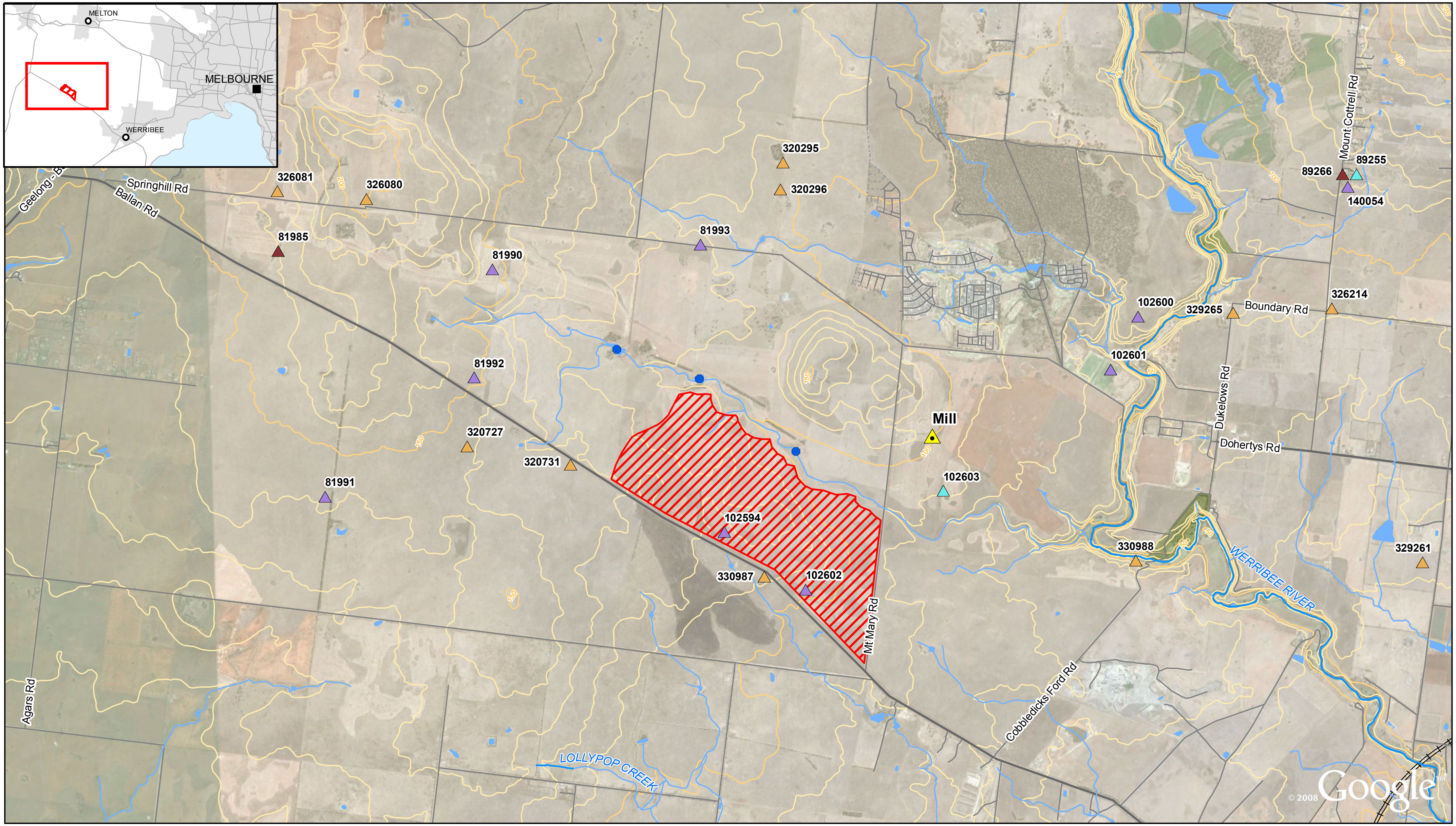
Aquifer yield can be used as a guide to the hydraulic character of aquifers. It should be noted that aquifer yield is dependent upon bore construction and aquifer penetration / intersection, and that many stock and domestic bores may not necessarily have been constructed as high yielding bores.

Limited bore yield information was available for some of the neighbouring bore, which suggested the basalts yield was generally less than 1 L/s (refer Table 6, page 19).

Table 6 Summary of Neighbouring Bore Information

Bore ID	Easting (MGA)	Northing (MGA)	Constructed date	Constructed depth (m)	Bore Use	Yield (L/s)	Aquifer			Salinity
							From	To	Lithology	
102594	282063.1	5811684	16/06/1984	30.48	Stock	0.5	3.05	30.48	Not Known	-
102600	286894.1	5814208	1/01/1988	51.2	Stock	-	-	-	-	-
102601	286576.1	5813586	1/01/1988	45.7	Stock	-	-	-	-	-
102602	283010.1	5811010	1/01/1988	82.2	Stock	-	-	-	-	-
102603	284622.1	5812167	1/01/1988	45.7		-	-	-	-	-
140054	289348.1	5815724	17/09/1999	75	Stock	0.2	55.5	60	0	
320295	282745.1	5816011	6/10/1981	67	Non Groundwater					
320296	282718.1	5815695	9/10/1981	165	Non Groundwater					
320727	279053.1	5812686	30/08/1981	102	Non Groundwater					
320731	280265.1	5812471	27/02/1984	204	Non Groundwater					
326080	277876.1	5815581	16/02/1984	21	Non Groundwater					
326081	276834.1	5815671	26/02/1984	178.93	Non Groundwater					
326214	289160.1	5814303	30/11/1982	202.5	Non Groundwater					
329261	290223.1	5811333	31/12/1967	4.87	Non Groundwater					
329265	288009.1	5814250	17/09/1975	84	Non Groundwater					
330987	282527.1	5811162	27/09/1981	148	Non Groundwater					
330988	286870.1	5811351	19/12/1982	209	Non Groundwater					
81985	276843.1	5814975	20/01/1983	103	Domestic & Stock	0.25	96	103	BASALT	
81990	279347.1	5814760	1/01/1988	92.3	Stock					
81991	277395.1	5812097	1/01/1988	66.4	Stock					
81992	279136.1	5813492	1/01/1988	88.6	Stock					
81993	281779.1	5815048	1/01/1988	71.6	Stock					
89255	289449.1	5815873	31/12/1970	0						
89266	289287.1	5815872	18/09/1976	88	Domestic & Stock	0.5	75	81	NOT	EC: 25,400.TDS: 15,909

Source: DEPI 2014d



1:60,000 Paper Size A4

0 0.5 1 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Bore Use

- Domestic & Stock
- Stock
- Non Groundwater
- Not Known
- Mill (identified during site inspection)

- Project Area
- Other Parks
- Water Area
- River
- Stream
- Drain/Channel/Other

- Arterial
- Collector
- Proposed
- Railway
- Minor Contours (10m AHD)
- Major Contours (50m AHD)
- Dam Locations

Woodhouse Pastoral Company
Eynesbury Precinct Hydrology Assessment

Job Number	31-31238
Revision	0
Date	19 Mar 2014

Groundwater Bore Location Plan

Figure 6

G:\31\31238\GIS\Maps\Working\31_31238_004_Bores_A4L.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: DSE Vicmap (Jan 2014), Google Eath Pro (Image captured 13/02/2013) GHD (Feb 2014) Mill location, Project Area boundary. Created by:jlloyd

6.4 Groundwater management

The Victorian Department of Environment and Primary Industries (DEPI) have recognised areas of intensive groundwater use throughout Victoria. The principle management unit for groundwater resources in Victoria is the Groundwater Management Unit or GMU. A GMU may be a Groundwater Management Area (GMA), a Water Supply Protection Area (WSPA) or an Unincorporated Area. These are declared under the *Water Act* (1989) to ultimately provide sustained management of the groundwater resources.

Under the *Water Act* (1989), the Minister may declare the total volume of groundwater (and/or surface water) which may be taken in an area. This is termed the Permissible Consumptive Volume (PCV).

A WSPA is essentially a GMA with a management plan. Within WSPAs, caps or moratoriums on the issue of additional extraction licenses are often present. An unincorporated area is a region falling outside of a GMA or WSPA. The total volume of water allocated under the PCV is a trigger for declaration of a GMA.

Based on a review of the SAFE mapping layers, the site is not located within a designated GMA, and is thus classified as being 'unincorporated'.

6.5 Groundwater quality

6.5.1 Site groundwater monitoring

There is no on-site groundwater monitoring information.

6.5.2 Neighbouring bore information

There is limited information regarding the groundwater quality based on neighbouring bore information. Bore 89266, drilled to 88 m has a salinity of 15,900 mg/L. The salinity is too high for stock watering purposes (refer Table 7, page 22).

6.5.3 Other sources

Based on regional scale mapping (SAFE Mapping) the salinity in the Newer Volcanic basalt is estimated to be between 3,500 mg/L and 13,000 mg/L.

The DNCR (1995) mapping also indicates a groundwater salinity of 3,500 mg/L to 13,000 mg/L.

6.5.4 Interpreted segments

For the purposes of this discussion it is assumed that the groundwater quality falls within Segment C (3,500 mg/L to 13,000 mg/L TDS), based on regional data (Table 2, page 6). Groundwater quality must be protected to maintain beneficial uses such as the protection of aquatic ecosystems, and abstractive uses including stock watering, primary contact recreation (e.g. swimming pool topping) and industrial use, and the protection of buildings and structures.

The protection of aquatic ecosystems applies to the point of groundwater discharge in the environment. Although groundwater potentiometry is not known (refer Section 6.6), it is suspected that there would a component of groundwater discharge towards the Werribee River floodplain. Use of groundwater for recreational purposes is unlikely given the existing landuse, and proposed development of the site. Based on the site topography and lack of evidence of shallow groundwater levels it is assumed that buildings and structures are likely to have shallow foundations and are unlikely to interact with the groundwater environment.

Stock water is the only beneficial uses that is locally realised, however it is suspected that the use of groundwater for such purposes would be limited with increasing salinity. The tolerance of livestock to salinity has been summarised in Table 7, page 22.

Table 7 Livestock Salinity Tolerances

Type	Salinity (mg/L)		
	No adverse effects on animals expected	Animals may have initial reluctance to drink or there may be some scouring, but stock should adapt without loss of production.	Loss of production and a decline in animal condition and health would be expected. Stock may tolerate these levels for short periods if introduced gradually.
Beef cattle	0 – 4,000	4,000 – 5,000	5,000 – 10,000
Dairy cattle	0 – 2,500	2,500 – 4,000	4,000 – 7,000
Sheep	0 -5,000	5,000 – 10,000	10,000 – 13,000
Horses	0 – 4,000	4,000 – 6,000	6,000 – 7,000
Pigs	0 – 4,000	4,000 – 6,000	6,000 – 8,000
Poultry	0 – 2,000	2,000 – 3,000	3,000 – 4,000

Source: Berkman 2001

Note: Sheep on lush green feed may tolerate up to 13,000 mg/L TDS without any loss of condition or production.

6.5.5 Potentially contaminating land uses

Land use activities within and surrounding the study area include:

- Broad acre cropping, and livestock grazing
- Township/urbanisation e.g. Eynesbury
- State Forest/Park

Farming landuses have the potential to adversely impact groundwater quality in terms of:

- Storage, spills of hazardous materials (e.g. petroleum)
- Septic systems
- Application of pasture improvement chemicals, fertilisers, herbicides, pesticides

These landuses are typical in the rural parts of Victoria. It is noted that often the basalt may have a well developed clayey soil horizon which may retard the migration of contaminating substances to the groundwater system.

6.5.6 Salinity mapping

The Port Phillip and Westernport Catchment Management Authority (PPWCMA) undertake assessment of salinity within their jurisdictional area. The PPWCMA (2010) indicates that the site falls within Salinity Management Zone 11 – Wyndham – Melton Growth Area. Mapping completed by the PPWCMA (2010) does not identify salinity discharge sites near the study area.

6.6 Groundwater potentiometry

6.6.1 Site groundwater monitoring

There is no on-site groundwater monitoring information.

6.6.2 State groundwater observation bores

A search of the GMS was undertaken to identify the presence of any active State Observation Network (SON) bore. The SON bores can provide valuable information for a region as they provide a water level monitoring record, and at some sites, water quality monitoring data. Most SON bores are monitored at a quarterly frequency, however monthly monitoring frequencies are adopted in some WSPAs.

No SON bores were identified within a 5 km radius of the study area.

6.6.3 Neighbouring bores

No groundwater level information was available from the neighbouring bores.

6.6.4 Groundwater recharge and flow systems

Owing to a lack of onsite groundwater monitoring, inferences regarding the groundwater flow directions have been made based on the site topography. In general, the direction of the regional groundwater flow is expected to be a subtle reflection of topography, from the higher topographies to the low lying areas. Groundwater flow in the water table aquifer is expected to be influenced by:

- Localised groundwater flow systems
- Connected waterways
- Groundwater extraction

Based on the inferred salinity of the groundwater, and the low bore densities, groundwater extraction is expected to be negligible. Therefore it is considered to have a limited effect on local groundwater levels. It is noted that there is a quarry to the southeast of the site, however the water regime in the quarry is not known.

The topography of the site suggests that groundwater would radiate from the elevated areas such as Green Hill. The unnamed drainage line suggests an eastwards component of groundwater flow towards the Werribee River.

Further information is required (i.e. standpipes installed), to characterise the exact depth to water and thus the groundwater flow directions within the study area.

As part of salinity investigations in the region, groundwater flow system mapping was undertaken by the Port Phillip and Westernport Catchment Management Authority (Dahlhaus *et al*, 2004). The flow systems relevant to the site are GFS18 (using Dahlhaus *et al*, 2004 nomenclature), which has been summarised in Table 8, page 24.

Table 8 Groundwater Flow System (GFS18)

Parameter	Description
Name	Regional and intermediate flow systems in the Volcanic Plains.
Geology	Newer Volcanics basalt and scoria
Topography	Undulating plains and low rises, volcanic cones
Regolith	Duplex soils and heavy clay soil developmed on weathered basalt of variable thickness, occasional scoria and pyroclastic deposit.
Aquifer Type	Fractured rock
Aquifer Conditions	Unconfined to semi-confined
Hydraulic Conductivity	Extremely variable. 10^{-3} m/day (tight fractures) to 10^{2} m/day (Open fractures)
Aquifer Transmissivity	High variable. Estimated to be generally less than 200 m2/day
Hydraulic Gradient	Estimated to be very low (0.0001) in regional systems and low (0.001) in intermediate systems. Locally steep around volcanic cones.
Flow length	<50 km for regional systems and <10 km for intermediate systems.
Groundwater Salinity	Generally in the range of 2,000 mg/L to 10,000 mg/L.

6.7 Groundwater dependent ecosystems

6.7.1 Definition

A groundwater dependent ecosystem (GDE) is an ecosystem which has its species composition and natural ecological processes determined by groundwater. That is, they are natural ecosystems that require access to groundwater to meet all, or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. If the availability of groundwater to GDEs is reduced, or if the quality is allowed to deteriorate, these ecosystems will be impacted.

It is widely acknowledged that a poor understanding exists in recognising GDEs, or understanding the hydrogeological processes affecting GDEs, or their environmental water requirements. GDEs can be broadly grouped into three categories:

- Ecosystems that depend on the surface expression of groundwater:
  - Swamps and wetlands can be sites of groundwater discharge and may represent GDEs. The sites may be permanent or ephemeral systems that receive seasonal or continuous groundwater contribution to water ponding or shallow water tables. Tidal flats and inshore waters may also be sites of groundwater discharge. Wetlands can include ecosystems on potential acid sulphate soils and in these cases maintenance of high water levels may be required to prevent waters from becoming acidic.
  - Permanent or ephemeral stream systems may receive seasonal or continuous groundwater contribution to flow as baseflow. Interaction would depend upon the nature of stream bed and underlying aquifer material and the relative water level heads in the aquifer and the stream.

- Ecosystems that depend on the subsurface presence of groundwater. Terrestrial vegetation such as trees and woodlands may be supported either seasonally or permanently by groundwater. These may comprise shallow or deep rooted communities that use groundwater to meet some or all of their water requirements. Animals may depend upon such vegetation and therefore indirectly depend upon groundwater. Groundwater quality generally needs to be high to sustain the vegetation growth.
- Ecosystems that reside within a groundwater resource. These are referred to as hypogean ecosystems. Micro-organisms in groundwater systems can exert a direct influence on water quality, for example, stygofauna typically found in karstic, fractured rock or alluvial aquifers.

6.7.2 GDEs in the study area

The National Groundwater Dependent Ecosystem Atlas (BOM, 2012) was interrogated to identify potential GDEs within the study area. No potential GDEs were identified on the site; however the Werribee River has been identified as a system that relies upon the surface expression of groundwater.

6.8 Acid sulphate soils

6.8.1 Definition

The occurrence of ASS can be present in the form of:

- PASS – Soil that contains unoxidised iron sulfides. When exposed to oxygen through drainage or disturbance, these soils produce sulfuric acid.
- Actual Acid Sulfate Soil – Potential ASS that has been exposed to oxygen and water, and has generated acidity.

These soils are rich in organics and were formed in low oxygen or anaerobic depositional environments. They are rich in sulphides and when oxygen is introduced, the sulphides oxidise to sulphate, with resultant soils having low pH and potentially high concentrations of the heavy metals. When water levels rise, pH and heavy metals are subsequently mobilised into the environment and can potentially impact deep-rooted vegetation, aquatic flora and fauna, and can be aggressive to reactive materials (e.g. concrete, steel) of foundations, underground structures (e.g. piles, pipes, basements) or buried services in contact with groundwater.

6.8.2 Acid in the study area

In Victoria, ASS materials are commonly associated with Holocene age geology (i.e. recent Quaternary) or lithified sedimentary rock that may contain disseminated pyrite (when unweathered). It is noted that the volcanic geology of the site is not conducive to the formation of acid sulphate soils.

A review of published mapping was undertaken which included the CSIRO Australian Soil Resource Information System (CSIRO 2014). Whilst it is noted that the mapping is regionally based, the study area was considered to have a low probability of the presence of ASS material.

7. Discussion of potential impacts

7.1 Proposed site developments

Limited information is available regarding the proposed infrastructure to be constructed on the site and the construction method and schedule; however the following summary is provided with the existing Referral Application Form (additional sources: GSC 2014a & 2014b):

- The total project area is 457 ha.
- A series of 14 greenhouses, flanking Ballan Road or western side of the Project Area, and the Mount Mary Road or eastern side of the Project Area (refer to Appendix A, page A-1), totalling 240 ha.
- Offices and associated staff facilities.
- Technical services areas (packing/grading operations, boiler room, heat buffer tank, irrigation/fertigation/sterilisation technology).
- Access road improvements, both internally and externally from the Project Area boundary.
- Provision of utilities, connected from Eynesbury and from the south-east (Ballan Road), including possible open trenching.
- Rainwater storage dam(s).
- Sediment ponds.
- Vegetated swales.
- Production and storage of wastewater which may be used for pasture irrigation or discharged to the sediment ponds and swales.

7.2 Assessment of impacts – surface water

To help comprehend the possible impacts to hydrology of both construction and operation of the proposed hydroponics precinct works, the impact has been assessed on two scales: the immediate Project Area and the greater watershed of the Werribee River. Where necessary the assessment considers construction and operational aspects separately.

Discussion of recommendations following the identification of possible impacts is provided in Section 9.

7.2.1 Impact to unnamed waterway

Peak Runoff Characteristics

Increased responsiveness of runoff from the roofs and additional impermeable surfaces (internal roadways, car parks, footpaths) will alter the time to peak in the local catchment of the unnamed waterway. This will result in shorter response times for runoff to discharge into the waterway as well as an increase in the peak flow volumes. This may impact the stability of the receiving waterway.

During the operational phase there will likely be some change to natural overland flows. Stormwater discharge not captured on roofs will be concentrated on hard surfaces and in local drainage systems and will need to be appropriately managed before entering the waterway. The conveyance of the stormwater runoff to the main drainage line will need to be provided without causing erosion within the floodplain.

Runoff from the site to the waterway is likely to be disturbed during construction of the hydroponics precinct. Provision for capture and storage of runoff during construction should also be considered for managing water quality impacts. Appropriate site environmental management controls to prevent erosion, and temporary measures to contain sediment-laden water and treat before discharging from site, will need to be implemented during construction.

Annual Runoff Volumes

A major component of the master plan is the capture of rainwater which would otherwise make its way to the unnamed waterway. This captured rainwater will be stored in lined basin(s) with a raised bund perimeter. The likely location of these basins is at the end of each greenhouse (GSC 2014b p3).

Existing annual runoff from the Project Area is estimated to be 220 000 m^3. The water needs of the crops is estimated to surpass the potential volume of captured rainwater from the site (GSC 2014a). The masterplan shows a total of 240 ha of greenhouse complexes that would otherwise generate runoff that would enter the unnamed waterway (Appendix A, page A-1). This accounts for approximately 61% of the Project Area that would otherwise generate runoff.

Whilst the greenhouse roofing, sealed roads and hardstand areas of the Project will result in additional yield in runoff, the Project intent is to capture the majority of this additional runoff volume through the rainwater harvesting initiatives. However, in an optimised rainwater harvesting scheme it can be expected that harvested rainfall will bypass detention when the storage systems are full. This scenario will result in a net increase in volume received by the unnamed waterway. The rainwater harvesting scheme will help maintain a hydrologic regime that mimics existing conditions (i.e. by reducing the number of runoff days and net runoff volumes as occurs naturally through percolation into the soil) compared to the change due to the increase in roof area.

Consider further that the western volcanic plains are the driest area south of the Great Dividing Range in Victoria, it is not expected that the unnamed waterway will be greatly impacted upon from the proposed harvesting of rainfall.

This change in annual runoff volume is not expected to significantly impact the hydrologic regime of the unnamed waterway as the existing condition streamflows are already limited to large events and existing capture and storage by the three dams located on the unnamed waterway.

Water quality

The following issues have been identified as possible negative impacts to the water quality of the unnamed waterway:

Construction

- Dewatering of trenches, sediment ponds, building foundation.
- General runoff from site with increased turbidity from the site runoff.
- Sedimentation of the main drainage line ("unnamed waterway").

Trenching and dewatering during the laying of utilities such as gas, telecommunications, sewer etc. could impact the natural waterway by draining surface water and groundwater reserves. A preferential flow path could develop along the trench, draining the immediate surrounding area. The discharge of turbid bypass water from dewatering during the construction phase could impact the surface water hydrology by degrading the stream quality and by increasing sedimentation through the floodplain, especially through flat areas as identified in Figure 2, page 9. This is also a consideration under the SEPP (*WoV*) legislation.

Spoil piles and access tracks, as well as the actual sites of construction present as possible point sources for mobilisation of sediment and pollutants during construction. Appropriate measures must be imposed to allow for conveyance of runoff to the unnamed waterway in a manner which does not adversely impact the water quality.

It is understood that sediment ponds are proposed as part of the works of the Project (refer to Appendix A, page A-1). These should be constructed as part of the site management controls during the construction phase and cleaned out prior to commissioning of the site. Sediment ponds should be combined with other appropriate site environmental management controls to prevent site erosion, for containment of sediment laden water and treatment of runoff before discharging from site. Sediment ponds will need to be implemented during construction.

Operation

- Accidental leaching, or overwater, of organic matter/fertilisers from greenhouses.
- Runoff from hard stand areas (turbidity, sediment, petrochemicals from vehicles and machinery).
- Thermal pollution from overflows from Heat Buffer Tank or shandying process.
- Excess runoff from basin overflow (collected roof water runoff).
- Disposal of effluent by-product of sterilisation process/nutrient recycling.

Though the proposed hydroponics nutrient system is fully closed, there may be a “minimal amount of waste water at the end of each 12 month crop whereby nutrient recycling tanks may be emptied” (GSC 2014b p6). If this effluent were to be used for pasture improvement the seasonal timing, volume and quality of water applied to the catchment would have to be assessed against the SEPP (*WoV*) to ensure the receiving waterways- both the unnamed tributary and the Werribee River- are not detrimentally effected.

The approach to stormwater management for minimising impacts to the environment will be expected to include a combination of the following:

- Preventative measures - Separation of process activities from stormwater runoff to prevent process pollutants (e.g. oils such as coolants) from contaminating stormwater runoff. This may include bunding and containment of identified sources. The need for other structural measures to protect from contamination of the stormwater (e.g. oil separation interceptor pits) may be considered as a further backup mechanism.
- Treatment of stormwater discharging from site - Stormwater quality treatment measures for stormwater runoff generated from the site (i.e. excess runoff from roof areas and runoff from other hardstand areas). This is expected to include the vegetated swales- such as those proposed within the site and downstream of basins- and sediment traps to be sized to meet the treatment objective.

Each lined basin will have an overflow weir. The impact of improperly designed drainage to take flow away once flow spills over the weir includes local erosion downstream of the basins and undermining of the overflow weir and perimeter bunds. The overflow weir should not concentrate flows in a way that could cause erosion at the base of the weir, or erosion as the flow makes its way to the unnamed waterway.

Formalised flow paths will be necessary to carry overflow from each basin to the waterway. Whilst the rainwater storages and swales are not shown on the Masterplan, each lot will need to provide its own rainwater storage and swale and associated drainage connection to the sediment ponds.

A potential concern regarding the lined basins is the position of the basins within the floodplain. As noted in the *Annual Runoff Volumes* section above, there may be one storage basin at the end of each greenhouse. Referring to the masterplan in Appendix A, page A-1, this could result in 14 lined basins. Each basin is expected to be positioned at the end of each greenhouse gable within each site; however they are not expected to impact the unnamed waterway along the northern site boundary. As previously discussed, the basins as part of the rainwater harvesting scheme will help mimic the existing hydrologic regime.

Any disturbed area of the broad floodplain will have to be reinstated properly in a way which does not impede flow. Impacts of inappropriate reinstatement of the soil and channel profile include erosion of the channel, impeding the natural flow through the soil profile and mobilisation of sediments.

Stabilisation of waterways and erosion protection impacts should be considered during the following activities:

Construction

- Stabilisation of temporary water treatment measures (temporary sedimentation basins).
- Stabilisation of channel banks when laying sewer or other utility across drainage line.
- Remediation of channel post trenching for utilities.

  Construction of a trench and removal of topsoil to lay utilities should occur in dry conditions when it can be anticipated there will be insignificant surface flow.

- Protection of Right Of Way for construction machinery from erosion.

  Heavy machinery and compaction of the ROW area may cause ponding of water and sedimentation should a rainfall event occur.

Operation

- Stabilisation of formal internal drainage within the precinct.

  Given fast reaction to peak, velocities of will be higher across smooth concreted surfaces than open paddocks. This could result in erosion along drainage lines.

7.2.2 Impact to Werribee River

As discussed in the existing conditions assessment in Section 5, the existing unnamed waterway running along the northern boundary of the Project Area, which drains the immediate catchment of the Project Area, is not a high value waterway. Conversely, the downstream receiving waterway (Werribee River) is significant on both a local and state level and is the focus of numerous policies and legislations. Not only should the impact of the proposed works within the Project Area in relation to the unnamed waterway be considered, but also the impact to the Werribee River.

Peak Runoff Characteristics

The change to peak runoff characteristics or increase in peak flows from the site will have a negligible impact on the Werribee River. The relative change in peak flow volumes and timing is relatively minor in the context of the overall Werribee River catchment. As discussed the rainwater harvesting scheme may absorb some peak flows and the existing unnamed waterway may potential further buffer or absorb peak runoff events from site.

Peak flows coming to the Werribee River are not directly connected to the site. The Werribee River is effectively “buffered” by the unnamed waterway including the existing online dams.

Annual Runoff Volumes

Figure 7, page 31 depicts the catchment which contains the Project Area and also an approximation of the greater Werribee River catchment upstream of the confluence of the unnamed waterway and the Werribee River.

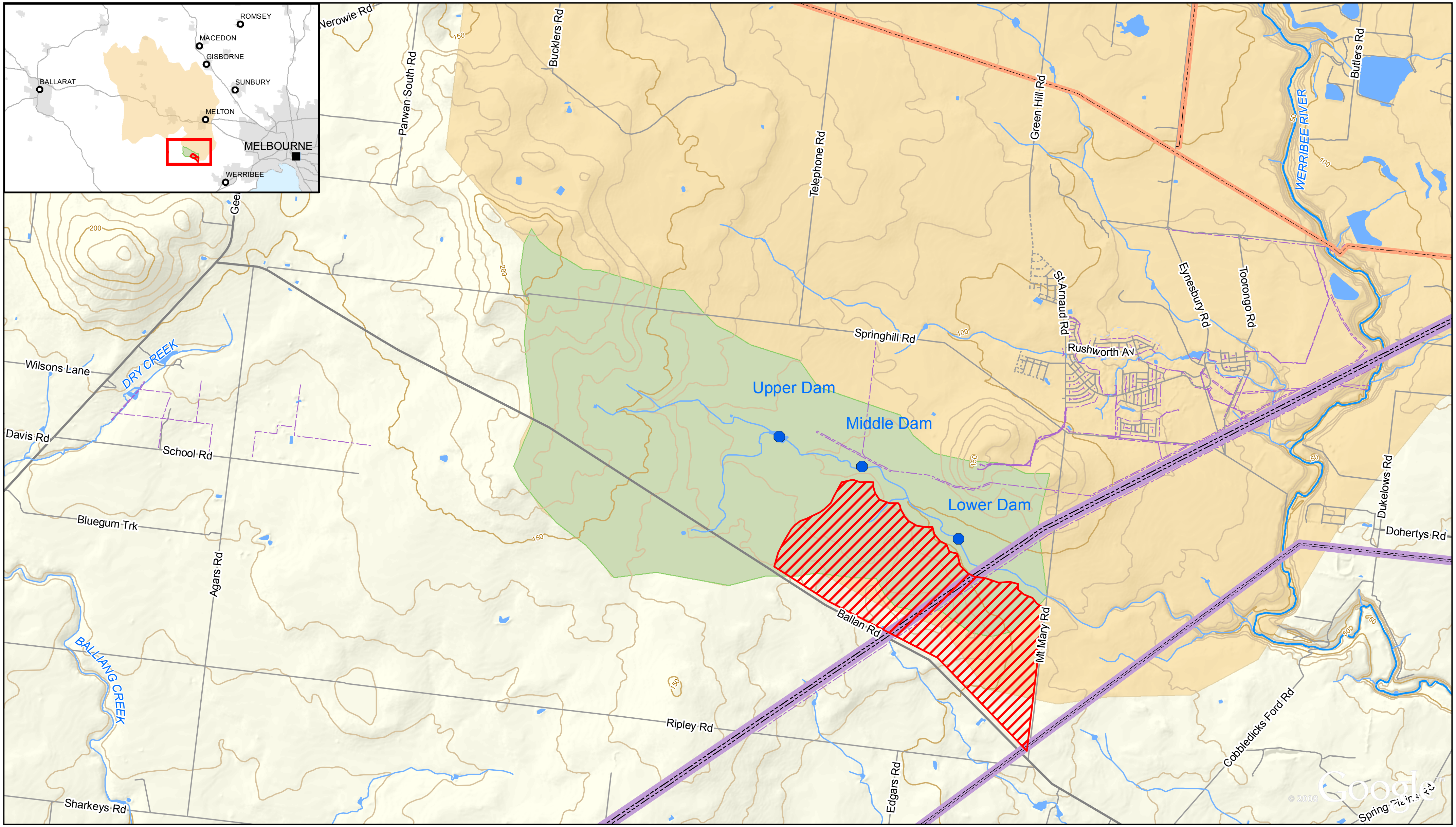
The area of the Project Area that drains to the Werribee River is approximately 3.95 km^2. The area of the Werribee River upstream of the unnamed waterway is approximately 1300 km^2 (inset, Figure 7, page 31). The Project Area accounts for 0.3% of the catchment area contributing to the Werribee River at the point of the confluence of the Werribee River and the unnamed waterway.

By considering a simple conceptual model where volume of runoff is proportional to the catchment area, the runoff produced by the Project Area and drained by the unnamed waterway is an insignificant volume of flow of the Werribee River at the confluence. Considered in this relative-contribution model, the capture of runoff from the project site is deemed to not have a significant impact on the volume of flow making its way to the Werribee River.

This is a very simplistic model. It does not take into account the regulated flows that are released from Melton Reservoir. However it provides an understanding of the impact of retention of flows on site. Notably, runoff from the Project Area that reaches the unnamed waterway upstream of the lower dam will be impacted by the dam and therefore will limit the contribution to flows in the Werribee River.

Water Quality Runoff

The possible impact to the water quality of the unnamed waterway, as defined in Section 7.2.1 above, also apply to the Werribee River. The Werribee River is less directly affected by the runoff generated on the Project Area as poor quality runoff from the Project Site will be buffered by the unnamed waterway. The runoff from site that discharges to the Werribee River is not directly connected and will effectively be “buffered” (i.e. absorbed and filtered) by the unnamed waterway including the existing online dams. Runoff volumes are expected for the most part to be relatively low (during both construction and operation of the Project), with the exception of the scenario when the rainwater storage basins spill. However the sediment and nutrient pollution of site runoff could be relatively high. Lower percentile runoff flows from the Project Area are not expected to impact the volume or quality of flow in the Werribee River. As noted in Section 5.2, the catchment receives low annual rainfall.



1:60,000	Paper Size A4

0 0.5 1 2
Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Project Area
Catchment Boundary
Werribee Catchment
Water Area
River
Stream
Drain/Channel/Other
Arterial
Collector
Proposed
Minor Contours (10m AHD)
Major Contours (50m AHD)
gas belowground
transmission line 500KV
transmission line 220KV
transmission line <66kV
Dam Locations

Woodhouse Pastoral Company
Eynesbury Precinct Hydrology Assessment

Job Number	31-31238
Revision	0
Date	19 Mar 2014

Catchment Boundaries

Figure 7

G:\31\31238\GIS\Maps\Working\31_31238_003_CatchmentArea_A4L.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Data source: DSE Vicmap (Jan 2014), Google Eath Pro (Image captured 13/02/2013) Created by:jlloyd

7.3 Assessment of impacts – groundwater

To assess the potential impacts of the proposed development, a process partly based on that described by the EPA (2006) source – pathway – receptor model, was applied to groundwater.

7.3.1 Contamination of groundwater

As required by the Environment Protection Act (1970), and the SEPP (Groundwaters of Victoria), groundwater has defined beneficial uses dependent on its salinity. The groundwater quality must be protected to preserve the identified beneficial uses. Potential groundwater quality changes may arise from both the construction and on-going operation of the site:

- Spillage, improper handling, storage and application of hazardous materials.
- Disposal of fluids or waste to groundwater.

The background groundwater quality of the water table aquifer is unknown, but regional data suggests that it is likely to be saline, ranging from Segment C (refer Table 2, page 6) or greater. It is a reasonable assumption that site environmental management plans could be implemented to reduce the risk of such events occurring.

7.3.2 Reduction in aquifer recharge

One of the principle mechanisms of recharge to unconfined aquifers such as the Newer Volcanic basalt is through infiltrating rainfall. The infiltration and subsequent groundwater accessions can be influenced by:

- Topography and gradients
- Site drainage
- Vegetation
- Surface conditions and run-off character

Commonly recharge rates on the volcanic cones are greater than those on the flatter topographies, as soil cover it thinner (to absent), and fracturing of the rock, as a result of explosive volcanic eruptions, is greater. It is noted that the proposed development plans site infrastructure on the flatter topographies remote from Green Hill.

The size of the greenhouses is small relative to the overall size of the intake area for the unconfined basalt aquifer system. Accordingly the risk of site development altering groundwater recharge is considered negligible.

7.3.3 Leakage for water storage lagoons

Graeme Smith Consulting (2014b) provided a concept design of the water retention storages to be constructed on the site. These basins dimensions were not quantified, however they were noted as being lined, with an estimated storage capacity of 20 m^3 to 30 m^3. These storages were to be constructed to hold rainwater harvested from greenhouse rooftops. The dams would be created as ‘turkey nests’, with embankments above grade to prevent in the ingress of overland flow/run-off.

It is noted that the rainwater quality is better than the expected regional groundwater quality and therefore vertical leakage through the base of the lagoons is not likely to pose a risk to groundwater beneficial uses.

7.3.4 Groundwater accessions from irrigation

Graeme Smith Consulting (2014b) notes that annually approximately 0.2 ML of wastewater would need to be disposed annually using land irrigation methods. The use of this effluent for irrigation use needs to comply with the EPA Industrial Waste Resource Guidelines 632 (2009).

Irrigation in excess of plant uptake could result in groundwater accessions, i.e. irrigation waters infiltrating through the unsaturated profile to the groundwater table. The low volumes of effluent estimated to be generated would suggest that irrigation volumes would be low. The likelihood of adverse impact to the groundwater beneficial uses is estimated to be low, based on the assumption that the groundwater quality within the basalt aquifer is saline.

8. Conclusion

Hydrology

Existing surface water conditions adjacent to the Project Area present as an unnamed ephemeral drainage line with three on-line dams. This ephemeral waterway drains east to the Werribee River. There is also a number of other waterways in the vicinity of the Project Area. The volume of runoff generated from the Project Area that does not make it to the aforementioned unnamed waterway is thought to be negligible.

The unnamed waterway along the northern boundary of the Project Area is not identified as significant by Melbourne Water - the catchment management authority. However the receiving waters of Werribee River are significant and the focus of multiple policies and are subject to state legislations.

Major impacts on surface water hydrology of the proposed works of the Project have been reviewed in terms of the unnamed waterway and the Werribee River. These impacts focused on peak runoff characteristics, runoff volumes and water quality. The greatest impacts identified revolve around impacts to water quality.

The capture of rainwater on site does not pose a significant impact to the unnamed waterway. Existing conditions do not exhibit connected flow along the waterway as flow is trapped by three dams. The relative impact of capturing rainwater on site accounts for less than 1% of the total flow contributing to Werribee River at the point of discharge of the unnamed waterway.

Groundwater

The proposed site lies upon the Newer Volcanic Basalt, an approximately 100 m thick, fractured rock aquifer. Little information regarding the character and existing conditions of the basalt aquifer could be obtained, however regional information suggests that the groundwater quality is poor and Segment C or greater. The lack of bore installations in the region is a line of evidence that supports the presence of poor groundwater quality.

Information provided by JAC Land of the proposed development of the Project Area suggests that the following pathways for potential adverse impact to the groundwater environment:

- Spills from hazardous materials handling.
- Leakage from water storage basins.
- Accessions to groundwater from effluent irrigation.

A site environmental management plan documenting appropriate systems and processes could be implemented to reduce the risk to the groundwater environment. Leakage from lined water storage basins, or effluent irrigation are not expected to pose a significant risk, based on the regional saline groundwater quality.

9. Recommendations

The following recommendations are made to minimise potential disturbance to the hydrologic and hydrogeologic regimes and reduce adverse impacts that may arise through works and operations associated with the proposed Project.

- Consultation with the Melbourne Water and the Environmental Protection Authority should precede finalisation of the Site Environmental Management Plan. These organisations will be responsible for administering *Works on Waterways* permit and possible EPA licensing for discharging to waterways.
- Development of an Environmental Management Plan for the proposed Project that addresses hydrologic and hydrogeological issues, including:
  - Procedures for the safe handling, storage and management of hazardous materials.
  - Procedures for the management of groundwater and surface bypass water, should active dewatering be required for trench or construction purposes.
  - Procedures for the monitoring of salinity and turbidity of bypass water should dewatering be required and appropriate control and mitigation measures.
  - Procedures for the treatment of sediments and pollutants in runoff generated on site.
- Formalised flow paths from drainage of hardstand areas and overflow from all basins.
- Management of runoff from the site should include integrated water management treatment methods to prevent impacts to and contamination of water quality, such as:
  - Preventative measures including separation of process activities from stormwater runoff.
  - Treatment measures including vegetated swales downstream of storage basins and sediment traps sized to meet treatment objectives.
- The position of lined basins should not infringe on the unnamed waterway; an appropriate buffer distance should be set out, to be determined in consultation with Melbourne Water.
- Monitoring of water of the dams is recommended to understand the water quality characteristics of any flow that may spill into the unnamed waterway. Some baseline data is available (as shown in Figure 4, page 13) for statistical analysis of impacts of the project.
- Planned works should not impact upon Melbourne Water's Healthy Waterway Strategy. Any alteration to the existing channel or riparian zone should be done in consultation with the appropriate Melbourne Water contact and adhere to the Environment Protection Authority Victoria's SEPP policies.
- Remediation of disturbed waterways areas should be in an appropriate manner so as to not inhibit the hydraulics of the channel or groundwater. Methods such as rock stabilisation and vegetating the site may be necessary to limit erosion.
- Trench backfill materials should be comprised of inert, clean fill. Maintaining equivalent porosity in the fill material is essential in inhibiting the development of a preferential flow path along the alignment of the trench.
- Best practice construction methods should ensure proper sediment control occurs during construction and clean-up of the site.
- Release into the catchment of effluent from filter cleaning and sterilisation operations, and from refreshing of nutrient recycling tanks, should be assessed against SEPP objectives and should not directly impact the water quality of the receiving waters of the Werribee River.

10. Limitations

This report has been prepared by GHD for JAC Land and *may only be used and relied on by JAC Land for the purpose agreed between GHD and the JAC Land as set out in Section 1 of this report.*

GHD otherwise disclaims responsibility to any person other than JAC Land arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by JAC Land and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has not been involved in the preparation of the existing Referral Application Form and has had no contribution to, or review of the existing Referral Application Form. GHD shall not be liable to any person for any error in, omission from, or false or misleading statement in, any other part of the Referral Application Form.

11. References

Berkman, D.A., 2001: *Field Geologists' Manual* (Fourth Edition). Carlton, Victoria, Australia (Australasian Institute of Mining & Metallurgy: Monograph 9), 395 pp.

Bureau of Meteorology [BOM] 2014. *Climate Data Online* http://www.bom.gov.au/climate/data/?ref=ftr, accessed 11 Feb 2014

Bureau of Meteorology [BOM] 2012. Groundwater Dependent Ecosystem (GDE) Atlas http://www.bom.gov.au/water/groundwater/gde/index.shtml Accessed February 28, 2014

Commonwealth Scientific and Industrial Research Organisation [CSIRO] 2014. Australian Soil Resource Information System (ASRIS), http://www.asris.csiro.au Accessed March 13, 2014

Dahlhaus, P.G., Heislers, D.S., Brewin, D., Leonard, J., Dyson, P., and Cherry, D., 2004: *'Port Phillip and Westernport Groundwater Flow Systems'* Port Phillip and Westernport Catchment Management Authority, Melbourne, Victoria

Department of Conservation and Natural Resources [DCNR], 1995: *Victorian Groundwater Beneficial Use Map Series. South Western Victoria Water Table Aquifers*

Department of Environment and Primary Industries [DEPI] 2014a. *Water Management Information System*, http://data.water.vic.gov.au/monitoring.htm, accessed 11 Feb 2014

Department of Environment and Primary Industries [DEPI] 2014b. *Index of Condition System*, http://ics.water.vic.gov.au/ics/, accessed 11 Feb 2014

Department of Environment and Primary Industries [DEPI] 2014c. Groundwater Resource Reports, http://www.water.vic.gov.au/monitoring/groundwater/groundwater-resource-reports, accessed 17 Feb 2014

Department of Environment and Primary Industries [DEPI] 2014d. State Groundwater Management System, http://www.vvg.org.au/cb_pages/gms.php, accessed 17 Feb 2014

Department of Sustainability and Environment [DSE] 2005. *Index of Stream Condition: The Second Benchmark of Victorian River Condition,* http://ics.water.vic.gov.au/ics/files/ISC_The_second_benchmark_of_condition.pdf, accessed 28 Feb 2014

Environment Protection Authority [EPA] 1997: 'State Environment *Protection Policy (Groundwaters of Victoria)*' Victorian Government Gazette No.S 160

Environment Protection Authority [EPA] 2006: *Hydrogeological Assessments (Groundwater Quality) Guidelines*. Publication No. 668

Environment Protection Authority [EPA] 2009: 'Industrial Waste Resource Guidelines Industrial Water Reuse'. IWRG Publication 632

Environment Protection Authority [EPA] 2014. *Water Legislation,* water-related policies, http://www.epa.vic.gov.au/about-us/legislation/water-legislation/water-related-policies, accessed 28 Feb 2014.

Graeme Smith Consulting [GSC] 2014a. *Initial Eynesbury Greenhouse Precinct Feasibility Report*, produced for JAC Land, 2014

Graeme Smith Consulting [GSC] 2014b. *Eynesbury Greenhouse Precinct Hydrology Report*, produced for JAC Land, 3 March 2014

Melbourne Water Corporation [MWC] 2013. *Healthy Waterways Strategy*, November 2013

Port Phillip and Westernport Catchment Management Authority [PPWCMA] 2010: *Port Phillip and Western Port Salinity Report*

Victorian Government 2003. Variation to State Environment Protection Policy (Waters of Victoria), Special Gazette No. S107, Gazette 4/6/2003