GoldenPlains
WIND FARM MANAGEMENT PTY LTD

Golden Plains Wind Farm

Appendix C.4: Ground Water Impact Assessment

Golden Plains Wind Farm Groundwater Impact Assessment

Golden Plains Wind Farm Management Pty Ltd

15 December 2020

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EXECUTIVE SUMMARY

After receiving State and Federal approval of the Golden Plains Wind Farm (the Project) for the development of up to 228 wind turbine generators (WTGs) near Rokewood, Victoria, Golden Plains Wind Farm Management (GPWFM) requested Water Technology to review the risk assessment included in the Project's Environment Effects Statement (EES) for a 215 WTG layout.

Information in the approval documentation (the State and Federal permits) provided additional information regarding the hazards posed by the activity. Additional geotechnical, salinity and biodiversity information also provided insight into the relationships between the proposed activity and the risk of consequences to groundwater receptors.

Water Technology is satisfied that the risk profile of the 215 WTG layout is comparable with the risk profile of the 228 WTG layout. The principal reasons for this finding are:

1. The habitat and impact on significant Groundwater Dependant Ecosystem (GDE) species have been assessed by Nature Advisory during extensive ecological surveys;
2. The potential for the findings of this assessment to be referenced in the Environmental Management Plan (EMP); and
3. The hydrogeological models are better constrained due to geotechnical investigations which inform the EMP.

This report considers the risks based on consequences to receptors. While additional infrastructure is now proposed within mapped salinity management overlays, the salinity risks to agriculturalists associated with tracks has been significantly reduced due to the reduction of at-risk tracks from ~2,000 m to 375 m. GPWFM are required to complete final salinity investigations that satisfy the DELWP Environment Portfolio.

The risks to bore users has not significantly changed and significant species can either be effectively protected or offset as allowed by the approvals.

Water Technology concludes that the groundwater impacts from tracks, hardstands, transmission line poles and WTGs are:

- generally in accordance with the AWE (2018) assessment undertaken for the EES and the planning permit application; and
- noting the potential for variable groundwater inflow rates, groundwater risks can be appropriately and effectively managed via existing conditions in Planning Permit PA1700266.

The findings from this report can be used to guide the application of the conditions within the approval documentation, such as the development of the EMP.

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1 PROJECT BACKGROUND

The Golden Plains Wind Farm Project (the Project) involves the establishment of a wind energy facility including wind turbines and associated electrical infrastructure on 16,723 ha to the West, South and South East of Rokewood, a small rural town in the Shire of Golden Plains; approximately 60 km North West of Geelong. The site is located on land that is primarily used for agricultural purposes and has been substantially modified over time due to agricultural operations such as broad acre cropping and livestock grazing.

Following an Environment Effects Statement (EES) and Planning Panel process, the Victorian Minister for Planning issued Planning Permit PA1700266 (Permit) for the Project, giving approval for a wind energy facility with a maximum of 228 Wind Turbine Generators (WTGs) together with associated infrastructure. The Commonwealth also issued an Approval under the EPBC Act 1999 (EPBC 2017/7965) on 01 August 2019. Both approvals were conditional.

Water Technology, trading as Australian Water Environments (AWE), provided a report on groundwater and salinity matters to support the Project's EES (AWE, 2018). AWE (2018) addressed the EES Objectives by providing an evaluation of the conditions on site and the Project's potential impacts on groundwater. AWE (2008) also provided a set of Environmental Performance Requirements (EPRs) to mitigate groundwater risks identified in the assessment.

Golden Plains Wind Farm Management Pty Ltd (GPWFM) revised the Project's layout in response to various environmental constraints on site and developed a new 215 WTG layout. The project timeline is shown in Figure 1-1.

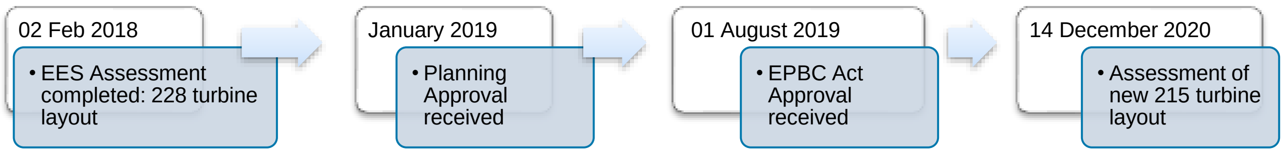

FIGURE 1-1 GROUNDWATER ASSESSMENT PROJECT TIMELINE

This December 2020 update is intended to be included as an appendix in a Planning Approval Amendment application.

2 OBJECTIVE

The objective of this report is to assess the new 215 WTG layout against the 228 WTG Ground Water Impact Assessment (AWE, 2018) included in the Project's EES. This is achieved by comparing the impacts on Salinity Management Overlays (SMOs) and receptors including groundwater dependent ecosystems (GDEs) considering WTG's, tracks and hardstands. Through detailed referencing of the relevant sections and methodologies used in the EES, conclusions are drawn as to whether the new layout is:

1. Generally in accordance with the assessment undertaken for the EES; and
2. Whether the impacts can be appropriately and effectively managed via the conditions in PA1700266.

Importantly, this assessment also enables the development of an effective Environmental Management Plan (EMP) by providing detailed maps of activities planned near identified hazards.

This assessment does not reproduce information that was included in the previous groundwater report while considering the revised Project layout. This assessment also references the following information gathered since 2018:

a. Planning Permit PA1700266

b. Commonwealth approval EPBC 2017/7965

c. Additional geotechnical investigations commissioned by GPWFM (Golder, Dec 2019)

d. Additional salinity investigations commissioned by GPWFM (Golder, Jan 2020)

e. Additional ecological investigations commissioned by GPWFM (Nature Advisory, Mar 2020)

3 REVIEW APPROACH

Water Technology's approach to the objective is to compare the risk profile of the 215 WTG layout to the EES 228 WTG risk profile by considering the activity's relationship to receptors which:

- have beneficial uses for groundwater; and/or
- are affected by groundwater salinity.

> *The refined definitions of both the activity and hazards are both key tools used to assess the revised risk profile.*

3.1 Limitations

The following matters are outside the scope of this report:

- Consideration of an onsite quarry, wastewater or hazardous chemical storages;
- Consideration of Micro-Siting, which will be handled under subsequent studies;
- Consideration of legislation put in place since 2018;
- Assessment of corrosion on infrastructure, use of explosives, geotechnical matters and infrastructure stability;
- Estimates of changing groundwater levels due to changing land use;
- Cumulative impacts from other wind farm developments outside the Project area; and
- Design of monitoring programs.

Further important assumptions used in this report are provided in Appendix A, with the layout described in the next Section.

4 215 WTG LAYOUT

The revised 215 WTG layout shown in Figure 4-1 involves:

- 215 wind turbines, each with a tip height of up to 230 metres and a rotor diameter up to 165 metres.
- Turbine foundations consisting of concrete gravity foundations within an excavation depth of 3.5 metres below natural surface (BNS) and a diameter between 20 and 27 metres that are open for two weeks before dewatering and filling: 215 areas of 529 m^2 (turbine foundation) totalling 11.4 ha.;
- 215 semi-permeable hardstand and laydown areas associated with each wind turbine, comprising:
  - 215 areas of 1,612 m^2 of permanent hardstand totalling 34.7 ha;
  - An additional 5,609 m^2 of temporary construction work areas associated with the 215 turbines (121 ha.) that are rehabilitated after construction;
- 81 overhead transmission towers with foundations up to 10 m deep and up to 3 m in diameter that may be open for up to a week before dewatering and filling;
- One terminal station (up to 370 m x 450 m) with shallow foundations; and
- <185 km of permeable access tracks with an area of ~340 ha.

Under Permit PA1700266, Micro-Siting of turbines, tracks and hardstands is permitted to enable construction of infrastructure within 100 m of the mapped location according to site conditions. This risk assessment considers the risk profile of the turbine mast locations as mapped.

The key differences between the 228 WTG layout and the 215 WTG layout are considered in this assessment are:

- the removal of 13 WTGs and hardstands;
- the relocation of turbines and hardstands;
- an increase in the surface area, but not the depth of turbine foundations;
- the realignment of tracks and transmission line poles to service the new WTG layout; and
- a delineation between the permanent hardstand and adjacent temporary construction areas that will be rehabilitated to pre-existing conditions after the turbine is constructed. Appendix A has details on the assumptions used in this assessment.

The locations and layouts of operations and maintenance facilities, the terminal station and collector stations have not changed significantly since the 228 turbine EES assessment (GPWFM pers. comm. 24 Nov 2020). The names of the shapefiles considered in this assessment are included in Appendix D, Table D-1.

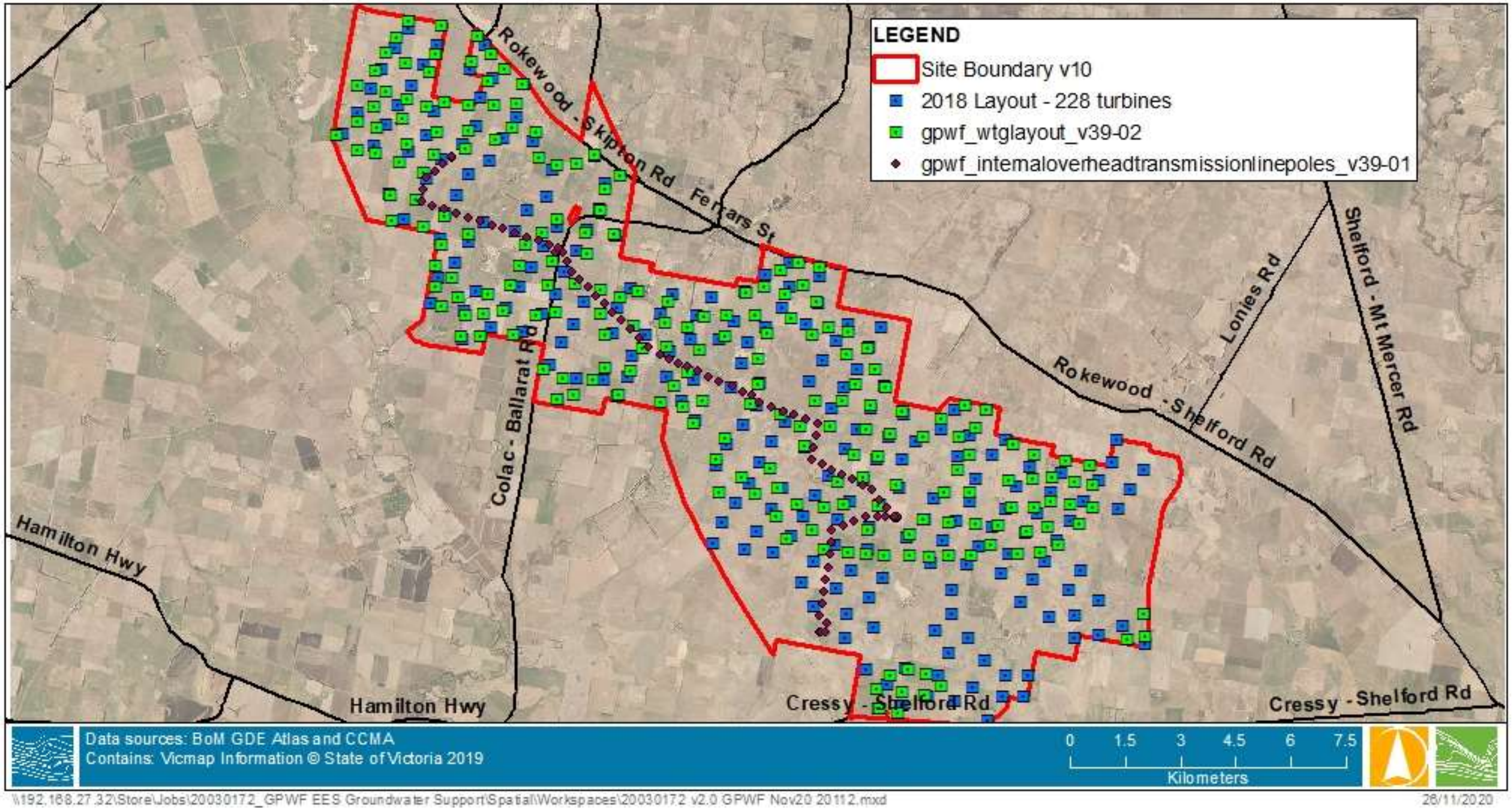

FIGURE 4-1 228 WTG LAYOUT (BLUE) COMPARED TO THE NEW 215 WTG LAYOUT (GREEN)

5 BENEFICIAL USES OF GROUNDWATER

Beneficial uses of groundwater (Appendix A, Figure A-2) are protected by legislation. As required by condition 64 of the Permit, this report considers SEPP (Groundwaters of Victoria) and other legislation in the Permit and the EES in 2017. Regarding background material, information is provided on the evaluation objectives in Table 2.1 of AWE (2018), the EES Scoping requirements (Table 2.2) and the applicable legislation (Table 3.1 in AWE, 2018). These are used to define the framework for assessing acceptable activities regarding the 215 WTG layout.

The assessment criteria considering impacts to receptors are listed in AWE (2018) are reproduced in Table 5-1.

TABLE 5-1 ASSESSMENT CRITERIA

Draft Evaluation Objectives	Assessment criteria
Biodiversity. To avoid, minimise or offset potential adverse effects on native vegetation, habitat, listed threatened species and ecological communities, migratory species, and other protected flora and fauna.	• Consideration of the impact of impervious areas on groundwater recharge • Assurance of a safe distance from potential groundwater dependent ecosystems
Catchment values. To maintain the functions and values of aquatic environments, surface water and groundwater including avoiding adverse effects on hydrology and protected beneficial uses including downstream biodiversity values and their habitat.	• Assurance that any dewatering will be appropriately treated • Assurance of a sufficient distance from potential groundwater dependent ecosystems
Land use and Socio-economic. To manage potential adverse effects and benefits for the community, businesses and associated land uses.	• Confirmation that turbines lie outside of saline zones to protect arable land

6 METHODOLOGY

Section 4 of this report identified the activities to be assessed and Section 5 identified the objectives and beneficial uses of groundwater. Following the Activity>Consequence>Likelihood>Risk approach, this section describes how receptors access these beneficial uses then considers the likelihood of a consequence occurring via some pathway between activities and receptors. Planned activities include the construction, operation and decommissioning of infrastructure (e.g. turbines, tracks and hardstands). This enables comparison of the revised 215 turbine layout with the 228 WTG risk profile presented in Section 7.

6.1 Receptors

Linkages are documented in AWE (2018) Section 6.2.4 and summarised below:

6.1.1 Groundwater dependent ecosystems (GDEs):

- While much of the Project area has been modified for agriculture, the locations of potential GDEs are mapped by the states and published by the Bureau of Meteorology. Two datasets are considered when identifying receptors:
- The GDE Atlas that maps potential ecosystem habitats
- Surveys of significant ecosystems undertaken on the site (shapefiles provided by Nature Advisory)

Where the receptor datasets overlap (e.g. pole W4), the survey map is used. In both cases, the direct interference with ecosystems, for example by clearance, are considered under the offset provision. The risk hierarchy (EPA Victoria, 2018) prioritises eliminating a hazard over engineering controls. The best approach to avoiding impact is to relocate turbines in areas of concern.

To allow for the indirect interference by modifying the local quality or quality of groundwater available to ecosystems, a 100 m buffer for large infrastructure from mapped potential or surveyed habitat is allowed in line with the EES assessment (AWE, 2018). Power poles are only considered in areas of shallow groundwater due to their limited surface area as discussed in Section 6.2.

Generally, receptors with beneficial uses of groundwater (or impacted by groundwater salinity) in the Project area are likely to be groundwater bore users, ecosystems or agriculturalists. These are defined in Section 6.2.4 of AWE (2018). Nature Advisory (2020) note that significant ecological fauna receptors include Yarra Pygmy Perch (YPP), Striped Legless Lizard (SLL), Growling Grass Frog (GGF) and Golden Sun Moth (GSM). These species are protected under the EPBC and FFG Acts. No deep rooted vegetation are noted in the Project area (Nature Advisory, April 2020).

Aquatic GDEs are those that depend on the surface expression of groundwater, while terrestrial GDEs may be deep rooted vegetation such as Swamp Scrub, Red Gum or Manna Gum found in GEWVVP that rely on the subsurface expression of groundwater.

6.1.2 Groundwater users:

Interference with the quality or quantity of groundwater in an area can affect shallow groundwater bore operators.

6.1.3 Agriculturalists and salinity:

The land may be affected by salinisation. Salinity Management Overlays (SMOs) prepared by the Corangamite Catchment Management Authority (CCMA) map potentially affected areas. Proposed infrastructure may interfere with groundwater to impact saline land in three main ways, depending on the local hydrogeology and land use:

- If saline groundwater expresses to surface and evaporates, building impermeable infrastructure within salinised land will expand the area of salinised land.
- Interrupting any natural lateral flow of saline groundwater with infrastructure may cause groundwater to express to surface and evaporate, salinising the land.
- If salinity is caused by evapo-concentration of rainfall, for example in a topographic low, infrastructure may expand the area of salinised land as infrastructure run-off spreads to a wider area and evaporates.

Salinisation by any of these three processes may affect the suitability of land for agriculture. Where works are proposed within mapped areas of potential salinity (SMO’s), GPWFM has commissioned assessments of the salinity present and the preliminary results have informed this assessment. The final results and any relevant mitigation measures will be included in the Project’s Salinity Management Plan (see Section 8).

6.1.4 Summary

Table 6-1 summarises receptors with a beneficial use for groundwater, provides an example of a receptor, and the form of potential consequences.

TABLE 6-1 RECEPTORS

Receptor	Example	Consequence
Significant aquatic GDE	Creeks that may support significant aquatic species such as the Yarra pygmy perch (YPP).	Impact to groundwater quality or quantity
Significant terrestrial GDE	Groundwater dependent grassland that may also support significant species such as the striped legless lizard (SLL).	Impact to groundwater quality or quantity
Shallow groundwater bore groundwater user	Domestic or stock bore use	Impact to groundwater quality or quantity
Agriculturalist	Land health	Land salinisation

The next section discusses how planned activities may impact receptors by discussing the pathway linking the activity and the receptor.

6.2 Activities associated with a risk to receptors

Receptors can be directly impacted by activities such as the removal of a bore or clearance of significant ecosystems. These direct consequences are managed by either avoiding the receptor or invoking the offset mechanism under the *Permitted clearing of native vegetation – Biodiversity assessment guidelines* (DEPI, 2013). Section 7.2.1.4 explores the planned application of the offset mechanism for the access tracks to address direct consequences to groundwater receptors.

GDEs rely on a given quality and quantity of groundwater which may be altered by the Project's activities. For example, dewatering groundwater inflows to excavations may deprive GDEs of water or increased recharge around a foundation may alter salinity in the vadose zone. These are examples of indirect consequences to groundwater receptors.

The specific activity pathways, receptors and consequences are shown in Table 6-2. This risk reference number is also used in Table 7-2 for each planned activity of concern. This assessment and the associated risk reference numbers are consistent with the approach in AWE (2018).

TABLE 6-2 ACTIVITIES, CONSEQUENCES AND RISK NUMBERS

Activity	Receptor(s)	Consequence	Risk Reference Number
Subsidence under infrastructure compresses the aquifer	GDEs, bore users, agriculturalists	Less aquifer storage capacity which raises the water table, impacts GDEs and decreases bore yields	GW001
Impervious foundations intersecting shallow water table alters groundwater flow	GDEs, agriculturalists	Permanent damage to GDE health due to a change to groundwater flow	GW002

Activity	Receptor(s)	Consequence	Risk Reference Number
Replacement of vegetation with infrastructure within Salinity Management Overlay areas	Agriculturalists	Decreased transpiration from zones of groundwater discharge or drop in evaporation causes an increase in salinised land area.	GW003
Dewatering of groundwater inflows from excavations is released to waterways or wetlands	Terrestrial GDEs	Temporary damage to aquatic ecosystems.	GW004
Dewatering of groundwater inflows lowers the water table	GDEs, bore users	GDEs and shallow groundwater bore users may experience temporarily lower groundwater supply.	GW005
Decreased groundwater recharge due to impermeable surface infrastructure	GDEs, bore users, agriculturalists	Lower water table damages GDE health or bore yield	GW006

Some of these activities have greater potential to impact groundwater than others. Specifically, excavating 3.5 m deep foundations for turbines has the potential to interrupt the local hydrogeology if groundwater is encountered (GW002, GW004, GW005). The local hydrogeology, and in particular the hydraulic conductivity of weathered basalt in areas of shallow water table, determines the significance of groundwater interference. While uncertainty in the water table level exists as discussed in AWE (2018), turbine locations and lithology where groundwater may be less than 3.5 m below natural surface (BNS) are presented in Appendix C. In this assessment, Water Technology has considered these mapped areas specifically and adopted the 100 m buffer recommendation in other locations.

Other risks may be of less severe consequence. Compaction of the aquifer (GW001) and salinisation (GW003) are likely to have small to negligible areas of effect.

The decreased groundwater recharge due to the installation of impermeable surface infrastructure (GW006) requires further clarification as discussed below.

6.3 Change in groundwater recharge and ecological receptors (GW006)

The shallow aquifer on site appears to be unconfined and recharged by local rainfall events. Watercourses are likely to be variously gaining and losing to the aquifer along their length and seasonally dependent. Risk GW006 considers consequences to both aquatic and terrestrial ecosystems.

6.3.1 Terrestrial ecosystems

Planned activities will modify the groundwater recharge around infrastructure such as buildings and turbines in both the shallow vadose zone and the deeper water table. The water table is often found more than 3.5 m below natural surface (BNS) under the project site. Interference with the vadose zone may cause localised salinisation and inundation but can be managed using suitable drainage as planned under the CEMP.

Both GEWVVP and NTGVVP are protected under the Permit and may also sustain significant listed species. The listed flora species in GEWVVP and NTGVVP have shallow root systems and are not reliant on groundwater (Nature Advisory pers. comm. 10 Dec 20). While suitable drainage is planned, the turbines and power pole foundations within 100 m of protected ecosystems (GEWVVP, NTGVVP and EVC132_61) that provide habitat for significant fauna (SSL, GGF, GSM) are identified in this report for drainage planning purposes (CCMA, 2020).

There may also be minor indirect impacts on agriculturalists and ecosystems due to modified groundwater recharge from the interception of rainfall by turbines under the prevailing wind conditions. In general, there would be no impact of this altered recharge to Plains Grassland (EVC132_61) that sustains significant species

(Nature Advisory, pers. comm. 10 Dec 20). Similarly, impacts to agriculturalists from altered rainfall is assumed to be negligible.

Verification of the existence of significant groundwater dependent ecosystems around proposed infrastructure was surveyed by Brett Lane and Associates (now Nature Advisory) for GPWFM in 2017, 2018, 2019 and 2020. The area of NTGVVP identified by Nature Advisory under the FFG was slightly larger than under the EPBC.

6.3.2 Aquatic ecosystems

Discharge of dewatered groundwater from deep excavations to waterways may impact aquatic ecosystems, but these impacts can be managed from an appropriate Sediment, Erosion and Water Quality Management Plan (PA1700266 Condition 64).

7 GROUNDWATER ASSESSMENT

This section summarises the detailed assessment of the 228 turbine layout completed in 2018 for the EES and then assesses the new 215 turbine layout. Section 9 compares the risk profile of the two assessments.

The legislation, values, local environment and hydrogeological conceptualisation are presented in AWE (2018) and not reproduced here. Federal permit EPBC 2017/7965 has since improved the definition of hazards to significant groundwater dependent ecosystems (GDEs). Additional detail on these hazards relevant to this updated groundwater assessment is provided in the updated Nature Advisory mapping, geotechnical investigations and salinity testing (Nature Advisory, Mar 2020), (Golder, Jan 2020), (Golder, Dec 2019).

7.1 Groundwater Assessment of the 228 WTG Layout

AWE (2018) considered links between receptors and activities for each of the 228 turbine layout in the EES. While activities were well defined, the risk pathway and receptors were not. Field studies conducted by Brett Lane and Associates (now Nature Advisory) concluded that some areas of *potential* significant ecosystem habitat/GDE were actually unsuitable for habitation. This removed the risk posed by the construction and decommissioning of infrastructure for several locations by confirming no receptors were present (BL&A, 2017).

Table 7-1 (Figure 6-15 of AWE, 2018) shows the turbines and the risks identified in 2018. In preparing the 228 WTG layout, GPWFM minimised impacts by relocating infrastructure away from potential receptors, however, eleven foundations were mapped within areas where the water table is less than 3.5 m below natural surface (mBNS).

TABLE 7-1 AREAS OF RISK IN EES 228 WTG LAYOUT

Area	<100 m from potential Aquatic GDE	< 100 m from potential Terrestrial GDE	Agriculturalist or shallow bore user	Local area and dewatering risk from excavations: water table less than 3.5 m BNS
GP173	No	No	No	Yes
GP175	No	No	No	Yes
GP176	No	No	No	Yes
GP180	No	No	No	Yes
GP182	No	No	No	Yes
GP185	No	No	No	Yes
GP191	No	No	No	Yes
GP207	No	No	No	Yes
GP221	No	No	No	Yes
GP222	No	No	No	Yes
GP227	No	No	No	Yes

In AWE (2018), where turbine foundations could be Micro-Sited to within 100 m of a potential GDE habitat, a plan to manage the risk of encountering the potentially more permeable saprolith was to be included in an Environmental Management Plan (EMP).

7.2 Groundwater Assessment of the 215 WTG Layout

The layout of the 215 WTG layout is presented in Section 4 and local scale figures are provided in Appendix C and Appendix D for planning purposes.

Water Technology has reviewed the turbines, hardstands and tracks in the revised 215 WTG layout. Table 7-2 shows the infrastructure close to potential receptor areas as well as areas where excavations may encounter groundwater. A 2017 site visit by AWE/Water Technology noted saprolith (potentially high groundwater flows) at high elevations and clayey pedolith (potentially low groundwater flows) at low elevations around Mia Mia Creek. The presence of clayey pedolith is supported by geotechnical investigations conducted in 2019. Appendix C has further discussion and the location of geotechnical hole TH166 around Mia Mia Creek is shown as Figure C-9.

Table 7-2 also increases the definition of the receptors and the significant GDEs and the species relying on the habitat provided in these ecosystems in particular. For example, significant species such as the striped legless lizard (SLL) and growling grass frog (GGF) may be found within the mapped Natural Temperate Grassland of the Victorian Volcanic Plains (NTGVVP). Important information provided by Nature Advisory relevant to the risk assessment is included in a dedicated column. This assessment of the 215 WTG layout also considers power transmission poles and the terminal station. The relevant risk numbers from Table 6-2 are included for reference and the locations are shown as referenced figures in Appendix D.

TABLE 7-2 AREAS RELEVANT TO GROUNDWATER IN THE NEW 215 WTG LAYOUT

Area	Within 100m of potential aquatic GDE	Within 100m of potential terrestrial GDE	Within mapped SMO	Local area risk from excavations: possible water table <3.5mBNS	Relevant Nature Advisory advice (I. Kulik, Nature Advisory, pers. comms. 10 Dec 20)	Conclusions and reference to location map figure
WTG003, 007, 010, 025, 028, 083, 085, 087, 102, 106, 108, 109, 110, 111, 112, 113, 114, 115, 117, 118, 119, 120, 122, 125, 126, 129, 132, 134, 135, 136, 137, 140, 142, 143, 147, 148, 149, 150, 155, 159, 166, 169, 184, 193, 195, 198, 205, 209, 211, 214. EVC132_61 also found at WTG077, 096, 105 124, 161, 164, 167, 172, 173, 177, 182, 182, 200, 201 & 206		Turbine foundation, hardstand & temporary construction works area (GW006)			Nature Advisory (Apr 2020) notes that habitat for significant terrestrial GDEs (SLL, GSM, GGF) - is intersected and labelled as Natural Temperate Grassland of the Victorian Volcanic Plain (NTGVVP) or Plains Grassland (EVC132_61). A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-1 (WTG003, 007, 010 & 028) Figure D-2 (WTG025) Figure D-4 (WTG083, 085) Figure D-3 (WTG087) Figure D-8 (WTG110 & WTG112) Figure D-9 (WTG102) Figure D-10 (WTG106) Figure D-11 (WTG108, 111, 113 & 125) Figure D-13 (WTG140, 148 & 155) Figure D-14 (WTG109 & 117) Figure D-15 (WTG115, 126, 132, 134, 136 & 143) Figure D-16 (WTG118 & 119) Figure D-18 (WTG135, 142, 147 & 149) Figure D-19 (WTG114, 120, 122, 129 & 137) Figure D-20 (WTG150) Figure D-21 (WTG159 & 166) Figure D-22 (WTG169) Figure D-23 (WTG193 & 195) Figure D-24 (WTG184, 198, 205, 209, 210, 214) Figure D-25 (WTG211) If groundwater is not encountered, significant impact to significant species is not anticipated.
WTG100, 101, 189, 190, 207, 212		Temporary construction works area (GW006)			Nature Advisory (Apr 2020) notes that habitat for significant terrestrial GDEs (SLL, GSM, GGF) - is intersected and labelled as Natural Temperate Grassland of the Victorian Volcanic Plain (NTGVVP) or Plains Grassland (EVC132_61). A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-9 (WTG100) Figure D-10 (WTG101) Figure D-23 (WTG189 & 190) Figure D-24 (WTG212) Figure D-25 (WTG207)
WTG188		Permanent hardstand and temporary construction works area (GW006)			Nature Advisory (Apr 2020) notes that habitat for significant terrestrial GDEs (SLL, GSM, GGF) - is intersected and labelled as Natural Temperate Grassland of the Victorian Volcanic Plain (NTGVVP) or Plains Grassland (EVC132_61). A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-24 Significant impact to significant species is not anticipated.
WTG061		Turbine foundation, hardstand & temporary construction works area (GW006)			Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP) surveyed within 100 m of the planned foundation excavation may depend on groundwater. A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-6 If groundwater is not encountered, significant impact to significant species is not anticipated.

Area	Within 100m of potential aquatic GDE	Within 100m of potential terrestrial GDE	Within mapped SMO	Local area risk from excavations: possible water table <3.5mBNS	Relevant Nature Advisory advice (I. Kulik, Nature Advisory, pers. comms. 10 Dec 20)	Conclusions and reference to location map figure
WTG099		Temporary construction works area (GW006)			Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP) surveyed within 100 m of the planned foundation excavation may depend on groundwater. A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-7 (WTG099) Significant impact to significant species is not anticipated
WTG104	Turbine foundation & Temporary construction works area (GW006)	Turbine foundation, hardstand & temporary construction works area (GW006)			Significant aquatic GDEs include the Yarra Pygmy Perch (YPP). YPP would only occur in larger rivers, lakes or ponds. Small and temporary interruption to groundwater inflows to the creek would be unlikely to impact any YPP. NTGVVP within 100 m of the planned foundation excavation may depend on groundwater. A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-10 If groundwater is not encountered, significant impact to significant species is not anticipated.
WTG121, 190	Temporary construction works area (GW006)				Significant aquatic GDEs include the Yarra Pygmy Perch (YPP). YPP would only occur in larger rivers, lakes or ponds. Small and temporary interruption to groundwater inflows to the creek would be unlikely to impact any YPP.	Figure D-17 (WTG121) Figure D-23 (WTG190) GDE: No aquatic species identified (Nature Advisory, Mar 2020) Significant impact to significant species is not anticipated
WTG133				Turbine and hardstand (GW002, GW004)		Figure C-1 WTG133 is located in a likely area of saprolith with reference to the test pit TP115 (Figure C-2). Dewatering will need to be considered in case of fractures in the basalt, however, bore log BH115 (Figure C-3) no groundwater inflows were recorded to a depth of 20 m. Although there is potential for high inflow rates if fractures are encountered, the dewatering risk can be managed under Sediment, Erosion and Water Quality Management Plan (PA1700266 Condition 64)
WTG134 & 143				Turbine and hardstand (GW002, GW004)		Figure C-4 WTG134 & 143 are located in a likely area of saprolith. When drilled to a depth of 20 m, BH122 did not encounter groundwater (Figure C-5). Although there is potential for high inflow rates if fractures are encountered, the dewatering risk can be managed under Sediment, Erosion and Water Quality Management Plan (PA1700266 Condition 64)
WTG182, 188, 190 195				Turbine and hardstand (GW002, GW004)	The high potential terrestrial GDE ~100 m to the west has been cleared for agriculture.	Figure C-10 Figure D-26 (WTG190) Dewatering: area of pedolith hydrogeology; any inflows are expected to be easily managed under the Sediment, Erosion and Water Quality Management Plan (PA1700266 Condition 64)
WTG087			Temporary construction works area (GW003)			Figure D-3 Golder (2020) returned spot test sample EM1919208-032 with EC of 25 µS/cm- non saline; see Appendix B-2 for more discussion. Any impact of these temporary works is likely to be too small to measure.

Area	Within 100m of potential aquatic GDE	Within 100m of potential terrestrial GDE	Within mapped SMO	Local area risk from excavations: possible water table <3.5mBNS	Relevant Nature Advisory advice (I. Kulik, Nature Advisory, pers. comms. 10 Dec 20)	Conclusions and reference to location map figure
WTG104	Turbine foundation & Temporary construction works area (GW006)	Turbine foundation & Temporary construction works area (GW006)			Nature Advisory (Apr 2020) notes that habitat for significant terrestrial GDEs (SLL, GSM, GGF) - is intersected and labelled as Natural Temperate Grassland of the Victorian Volcanic Plain (NTGVVP) or Plains Grassland (EVC132_61). A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-10 If groundwater is not encountered, significant impact to significant species is not anticipated.
WTG183, 190			Temporary construction works area (GW003)			Figure D-26 Salinity: Golder (2020) returned sample EM1919208-029 of 38 µS/cm, from 5 samples: non-saline; see Appendix B-2 for more discussion. Any consequence of these temporary works is likely to be too small to measure. The temporary nature of the interference is not expected to have a measurable impact on the salinised land area. Considering the areas (50 m²) significant impacts are not anticipated.
Terminal	Planned and maximum terminal area (GW006)				Yarra Pygmy Perch would only occur in larger rivers, lakes or ponds; unlikely to be habitat for fish due to small size and potential for drying. Small and temporary interruption to groundwater inflows to the creek would be unlikely to impact the Pygmy Perch.	Figure D-12 Significant impact to significant species is not anticipated
Central Collector		Planned and maximum terminal area (GW006)			GDE habitat (NTGVVP) within 100 m may depend on groundwater. A small interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-12 Significant impact to significant species is not anticipated
Poles W12, W13A&B		Pole excavations (GW006)		Pole excavations (GW002, GW004)	GDE habitat (NTGVVP) within 100 m may depend on groundwater. A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure C-4, Figure D-15 W12 and W13A&B are likely within saprolith in an area of mapped shallow groundwater. Although there is potential for high inflow rates if fractures are encountered, the dewatering risk can be managed under Sediment, Erosion and Water Quality Management Plan (PA1700266 Condition 64)
Pole N8	Pole excavation (GW006)				Yarra Pygmy Perch would only occur in larger rivers, lakes or ponds; unlikely to be habitat for fish due to small size and potential for drying. Small and temporary interruption to groundwater inflows to the creek would be unlikely to impact the Pygmy Perch.	If groundwater is not encountered, significant impact to significant species is not anticipated.
Poles S8, S9, S10, S14, S15, S16, W10A&B, W11, W14, W15, W16, W17, W18, W22, W24, W28, W33, W34, W35, W36, W41, N6, N14, N15, N16, N18		Pole excavations (GW006)			GDE habitat (NTGVVP) within 100 m may depend on groundwater. A small and temporary interruption to groundwater flows would not have a significant impact on this habitat as they are more reliant on surface water.	Figure D-1, Figure D-15 If groundwater is not encountered, significant impact to significant species is not anticipated. Area mapped with NTGVVP (SLL habitat) that can be considered under the offset program.

Additional information on the assessment is provided in the following sections.

7.2.1.1 GDE mapping

A December 2016 ecological survey (BL&A, 2017) commissioned by GPWFM confirmed that some areas with unclassified GDE potential from regional studies (BoM Atlas) were unsuitable habitat (email from BL&A, 4/10/17). Using this survey, many proposed turbines in the new 215 WTG layout are not near areas suitable to sustain a wetland derived ecosystem. Nature Advisory (I. Kulik, Nature Advisory, pers. comms. 10 Dec 20) further advised that any impacts to significant species from groundwater changes are unlikely and thus the risks to GDEs are likely to be acceptable.

The most recent Nature Advisory mapping of ecosystems protected under the EPBC Act 1999 (EPBC) and the Flora and Fauna Guarantee Act 1988 (FFG) are shown in Appendix D.

7.2.1.2 Salinity mapping

Salinity Management Overlay (SMO) mapping implies that there is an increased salinity risk from the construction of three temporary construction works areas within SMOs (WTG087, WTG183 & WTG190), however, preliminary salinity surveys by Golder (Jan 2020) indicate that these are areas of low salinity. As the mapped construction areas are temporary, the areas are small and the salinity low (Golder, Jan 2020), the risk of this activity is likely to be acceptable. More detail is provided in Appendix B-2 and further investigations are planned to satisfy the relevant permit conditions (S. Clifton, GPWFM pers. comm. 3/4/20).

7.2.1.3 Excavations where the water table is less than 3.5 mBNS

In order to evaluate local area risks to receptors (GDEs, bore users and agriculturalists) posed by excavations, it is useful to consider the likely arrangement of regolith and pedolith and its impact on near-surface groundwater and vadose zone flows. Previously, eleven turbines were planned in areas of shallow groundwater. Table 7-2 shows there are now seven (WTG133, WTG134, WTG143, WTG182, WTG188 WTG190 and WTG195) where mapping implies that excavations could encounter groundwater. It is important to note that more shallow groundwater locations may exist due to uncertainties in the water table mapping (see AWE, 2018 Section 6.2.3.2). The seven turbines identified to date are discussed further below. In relation to comparing the updated risk profile to the previously approved risk profile, all turbines are in the same geological unit as the eleven previously assessed (the Newer Volcanics). Further geotechnical work has been conducted that allows more consideration of the risk of groundwater inflows as discussed below.

WTG 182, WTG 188, WTG 190 and WTG195 are located near Mia Mia Creek. As noted in Section 7 and Appendix C, works in this area are expected to have low levels of groundwater inflows through a pedolith and therefore minimal impacts.

WTG133, WTG134 and WTG143 are in locations that may have higher groundwater inflows through a saprolith which is presented in Appendix C. No large nearby watercourses that might weather the rock to impermeable clay are evident. Inspection of the topography shows that infrastructure is planned on the flanks of scoria ridges. Volcanic basalts on the flanks can be fractured and potentially highly permeable under certain weathering and stress conditions; termed an ‘open’ fracture. Open fractures can form high flow conduits, leading to unpredictable groundwater impacts during dewatering. However, if the site is barely weathered and basalt is intact and massive, it can also form a low permeability confining layer (Dahlhaus, Evans, Nathan, Cox, & Simmons, 2010). Furthermore, if the present stress regime causes the fractures to be closed, Water Technology anticipates minimal groundwater impacts.

The excavations for 8-10 m deep power pole foundations are also found in probable saprolith locations, however, as these are only up to three metres in diameter and typically sealed with concrete within seven days (S. Clifton, GPWFM, pers. comm. 8/4/20), the risk of interfering with the groundwater regime is limited. This is because the chance of encountering high groundwater flow rates decreases with decreased infrastructure diameter. The groundwater dewatering risk can be managed under Sediment, Erosion and Water Quality Management Plan (PA1700266 Condition 64) if the plan considers the potential for high volumes of water inflows (see AWE, 2018).

WTG194 and WTG183 are within 20 m of an area of mapped shallow groundwater, however, only WTG194 (Figure C-10) is on the flank of a scoria ridge with potentially high inflow rates if groundwater was encountered.

7.2.1.4 Access tracks

The risks from access tracks are considered separately in this section because the tracks are permeable and thus of a lower risk profile than hardstands or turbine foundations.

Risks from tracks may be direct via removal of GDEs or indirect via an impact to groundwater that sustains the GDE. The risk of directly damaging GDEs by constructing tracks through areas where GDEs may exist is mitigated by site surveys. GPWFM has identified the presence of significant species that may be impacted by access track construction.

The removal of any GDE’s will be mitigated by the Project’s offset mechanism:

> *Planning Permit PA1700266 requires GPWFM to offset the Project’s impacts on native vegetation (including EVCs) to the satisfaction of DELWP Environment. GPWFM is in the process of securing suitable offsets for the Project and these will be in place prior to the removal of any native vegetation.*

(pers. comm. Kyle Sandona, GPWFM, 24 September 2020)

Indirect risks also exist from track construction. Water Technology recommends that compaction is minimal as our risk assessment considers tracks to be permeable. If tracks are impermeable then, in a similar way to turbines, they will inhibit the discharge and evaporation of groundwater flowing to surface in areas of salinised land. For example, 350 m of access track is proposed within a mapped SMO near WTG183 (Figure D-26).

As heavy equipment will traverse the tracks (S. Clifton WestWind Energy pers. comm. 23 Feb 18) some impact to permeability is possible. Evapotranspiration to reduce salt deposits at surface can be achieved using deep rooted vegetation if regional groundwater systems are considered (Dahlhaus P. , 2006).

Generally, for all impermeable subsurface infrastructure, there may also be a risk to agriculturalist receptors due to the interruption of lateral groundwater flow. If tracks impede this lateral movement, vadose waters may evaporate and leave salt in the soil. A site-verified hydrogeological conceptual model that considers the hydrogeology and land use in the area would be able to confirm local processes. Nonetheless, it is possible to design infrastructure to minimise the interference with shallow groundwater flows by using appropriate drainage. As per Table 7.1 of AWE (2018), undertaking works in accordance with the Catchment Salinity Management Plan (Dahlhaus, Nicholson, Anderson, Shovelton, & Stephens, 2005) can effectively manage this risk by considering the nature and management of any salinisation.

7.3 Summary of changes to risk profile

When considering Table 7-1 and Table 7-2, the following changes are noted between the 228 WTG layout and the current 215 WTG layout

1. Infrastructure is now planned within areas mapped with receptors; however, direct impacts can be managed through the Project’s offset scheme.
2. Impacts from planned power transmission line pole foundations are likely to be acceptable.

3. While the mapping of the location of shallow groundwater is not precise (see AWE, 2018 Section 6.2.3), planned turbine excavations are near several receptors where groundwater is less than 3.5 mBNS. If required, a Micro-Siting Plan to move turbines by up to 100 m would be assessed by a suitably qualified ecologist (per Conditions 6 of Permit PA1700266) combined with a hydrogeologist to reassess the impact (S. Clifton pers. comm. 03 Apr 20). This assessment of high groundwater inflows and dewatering can be informed by this report. Water Technology notes that higher flows can be managed through the EMP and associated Construction Environment Management Plan.
4. The lower permeability permanent hardstand areas cover a combined 46 ha (<0.3% of the Project area). This area could reduce rainfall recharge to the aquifer if standing water is allowed to evaporate. Appropriately designed drainage that considers the groundwater dependence of nearby receptors, as required by condition 85 of the Permit, can mitigate much of the risk posed by impermeable foundations.
5. Changes to the WTG surface area that intercepts rainfall by up to 10% will have minimal groundwater impacts, if properly drained under condition 85 of the Permit considering nearby receptors.
6. 66 turbine and 29 pole foundations are within 100 m of habitat for SLL, GGF and GSM (Table 7-2). These foundations may increase the area of habitat impacted by water table rise or fall. Nature Advisory has stated that SLL in particular are more reliant on surface water and this impact is expected to be negligible (I. Kulik, Nature Advisory, pers. comm. 3/4/20). Nature Advisory is satisfied that risks to significant ecosystems from groundwater changes will be avoided (Nature Advisory, 10 Dec 20). If suitable drainage is installed, significant risks are not anticipated.

The risk profile of the revised layout is generally in accordance with the risk profile of the original 228 turbine layout. Maps of locations of concern are included in Appendix D for use in the Environmental Management Plan (EMP).

8 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

Environmental Performance Requirements (EPRs) document the requirements for approved activities. All EPRs recommended in (AWE, 2018) remain valid and in conjunction with the conditions in the Permit and EPBC Approval, can be used to manage the Project's impacts. Water Technology acknowledges that many of the management plans required under permit PA1700266 are to be prepared in consultation with DELWP Environment. This will ensure the plans are developed and implemented appropriately, in particular:

- Permit Condition 69 requires a Salinity Assessment Report and Management Plan to be developed in consultation with DELWP Environment Portfolio.
- Permit condition 64 requires a Sediment, Erosion and Water Quality Management Plan that adequately considers the values of beneficial uses/receptors in the water courses which may be impacted by dewatering from excavations for WTG133, 134, 143 and W10, 11 & 12. Water Technology notes that weathering of basalt is highly variable, and the plan should consider appropriate dewatering for highly variable rates. Effective measures to monitor dewatering rates in the Construction Environmental Management Plan (CEMP) can consider the presence of nearby unregistered bores and the method and location of discharge of dewatering. Should such measures be implemented, the risks associated with excavations can be suitably managed by the CEMP.

9 SUMMARY

This work benefitted from additional information about site hazards since the preparation of the EES. Water Technology is satisfied that the risk profile of the 215 WTG layout is comparable with the risk profile of the 228 WTG layout. The principal reasons for this finding are:

1. The habitat and impact on significant GDE species have been assessed by Nature Advisory during extensive ecological surveys;
2. The potential for the findings of this assessment to be referenced in the EMP; and
3. The hydrogeological models are better constrained due to geotechnical investigations which informs the EMP.

Considering receptors, the salinity risks to agriculturalists associated with tracks has been significantly reduced due to the reduction of at-risk tracks from ~2,000 m to ~375 m. GPWFM are ensuring that final SMO investigations satisfy the DELWP Environment Portfolio (S. Clifton, GPWFM pers. comm. 03 Apr 20). The risk profile to bore users has not changed and significant GDE species can either be effectively protected or offset as allowed by the approvals. Water Technology concludes that the groundwater impacts from tracks, hardstands, poles and turbines is:

- generally in accordance with the AWE (2018) assessment undertaken for the EES and the planning permit application; and
- can be appropriately and effectively managed via existing permit conditions, noting the potential for variable groundwater inflow rates.

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APPENDIX A
ASSUMPTIONS USED IN THE ASSESSMENT

Water Technology considers these assumptions when assessing risks related to groundwater from the proposed project.

- Decommissioning would occur ~25 years after construction, with foundations left in the ground and minimal other groundwater impact. The top section of concrete will be removed to allow for agricultural practises to resume.
- The total duration for construction of all 3.5 m deep foundations may take two to four years, however, each individual foundation would take:
  - Two days to dig without blasting then be capped with impervious screed over a clean, blinding layer;
  - Infilled with concrete within two weeks; then
  - Covered with a thin soil/crushed rock layer.
- Foundations 20-27 m diameter and are shaped to allow rainwater to run-off and recharge the aquifer (see Figure A-1) and are located >100 m from GDEs and public infrastructure;

FIGURE A-1 CONCEPTUAL DESIGN OF TURBINE FOUNDATION

- GPWFM's treatment of any dewatered groundwater from excavations would make it fit for end use;
- Rock base would be used for roads; thus they are permeable and subsidence is negligible;
- If a turbine is to be Micro-Sited into an area where GPWFM do not have survey information, GPWFM will undertake additional baseline surveys. This will address indirect impacts to ecosystems and ensure no material adverse impact to significant species per Condition 5 d. of PA1700266;
- Approvals to interfere with ecosystems directly e.g. ecosystem removal (including those dependent on groundwater) will be considered under the flora and fauna assessment;
- Mapped hardstands comprise both permanent and temporary areas (Section 4). The permeability of temporary areas is reinstated to pre-activity conditions within two months of WTG installation;

- Hazardous substances may include lithium ion or other battery technology, fixed diesel tanks and portable diesel tanks for temporary generators at hardstand areas during construction, sewage and fire-fighting chemicals. As the types, concentrations and quantities of these substances are not available for this preliminary assessment, Water Technology assumes that the hazardous substances located at the Project will be typical of this type of wind farm development and will be appropriately designed and managed using plans developed under relevant legislation and guidelines;

- Water Technology's assessment is based on 2017 land use, groundwater usage and hydrogeology (AWE, 2018). Water Technology assumes that GPWFM will conduct a separate risk assessment and make good any negative impact on groundwater receptors from the Project if a significant drought or other major impact on groundwater conditions occurs during construction.

The beneficial uses of groundwater are shown in Figure A-2 (page 8 of State Environment Protection Policy – Groundwaters of Victoria 17 Dec 1997 under Environment Protection Act 1970).

Beneficial Uses	Segments (mg/L TDS) A1 (0-500)	A2 (501-1,000)	B (1,001-3,500)	C (3,501-13,000)	D (greater than 13,000)
1. Maintenance of ecosystems	✓	✓	✓	✓	✓
2. Potable water supply:					
desirable	✓				
acceptable		✓			
3. Potable mineral water supply	✓	✓	✓		
4. Agriculture, parks and gardens	✓	✓	✓		
5. Stock watering	✓	✓	✓	✓	
6. Industrial water use	✓	✓	✓	✓	✓
7. Primary contact recreation (eg. bathing, swimming)	✓	✓	✓	✓	
8. Buildings and structures	✓	✓	✓	✓	✓

FIGURE A-2 BENEFICIAL USES, OUTLINING APPLICABLE SEGMENT (C)

The definition of Protected matters provided in the Planning Approval are shown in Figure A-3.

Proposed final layout means the area within the **project site** encompassing the proposed possible and final location of, all project activities and infrastructure, as proposed at the date of this approval notice including a 20 meter wide buffer.

Protected matters means the following listed threatened species and ecological communities protected under a controlling provision in Part 3 of the **EPBC Act:**

- Button Wrinklewort (*Rutidosis leptorhynchoides*)
- Clover Glycine (*Glycine latrobeana*)
- Fragrant Leek-orchid (*Prasophyllum suaveolens*)
- Golden Sun Moth (*Synemon plana*)
- Grassy Eucalypt Woodland of the Victorian Volcanic Plain

- Growling Grass Frog (*Litoria raniformis*)
- Large-headed Fireweed (*Senecio macrocarpus*)
- Natural Temperate Grassland of the Victorian Volcanic Plain
- Plains-wanderer (*Pedionomus torquatus*)
- River Swamp Wallaby-grass (*Amphibromus fluitans*)
- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
- Small Golden Moths (*Diuris basaltica*)
- Spiny Rice-flower (*Pimelea spinescens* subsp. *spinescens*)
- Striped Legless Lizard (*Delma impar*)
- Swamp Everlasting (*Xerochrysum palustre*)
- Swamp Fireweed (*Senecio psilocarpus*)
- Swift Parrot (*Lathamus discolor*)
- Trailing Hop-bush (*Dodonaea procumbens*)
- White Sunray (*Leucochrysum albicans* var. *tricolor*)
- Yarra Pygmy Perch (*Nannoperca obscura*)

FIGURE A-3 PROTECTED MATTERS (EPBC 2017/7965)

In case of any conflict, Water Technology considers these assumptions over others presented in (AWE, 2018) when reviewing risks related to groundwater from the proposed project.

APPENDIX B
RELEVANCE OF NEW INFORMATION

From a review of Federal permit EPBC 2017/7965, the definition of hazards to significant groundwater dependent ecosystems (GDEs) has been improved.

B-1 Improved definition of hazards

- EPBC 2017/7965 provides a list of significant species (Water Technology notes that the published threats to the following significant species are not attributed to groundwater:
  - Swift Parrot (*Lathamus discolor*) (DoE, 2007)
  - Golden Sun Moth (*Synemon plana*) (DEWHA, 2009)
  - Plains-wanderer (*Pedionomus torquatus*) inhabit sparse grasslands but cannot persist in an agricultural landscape (DoE, 2015)

  Verification of the existence of habitat for several potential groundwater dependent ecosystems was conducted by Brett Lane and Associates (now Nature Advisory) for the 228 turbine layout in December 2016 and is supplemented by additional surveys in response to design changes (Nature Advisory, Mar 2020).

  Threats to significant terrestrial GDEs depend on deep rooted vegetation which is usually evident at surface such as Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP). The habitat of the listed Striped Legless Lizard (*Delma impar*) is native grasslands and woodlands (DSEWPC, 2011).

  Note that NTGVVP used to drying and wetting, thus not dependent on groundwater. SLL is not wholly dependent on grassland and can live in degraded habit (Nature Advisory pers. comm. Apr 2020).
- Nature Advisory surveyed areas described as v25-01 in figures such as Figure D-23. The shapefiles show only those locations where listed species, or unlisted native vegetation, were found (GPWFM pers. comm. 27/3/20). These shapefiles are referenced in Appendix B and C. Where the shapefile lists N/A for a surveyed area, it means that no significant species were identified in the survey and that the survey lies within a DELWP wetland (GPWFM pers. comm. 27/3/20).
- Threats to significant aquatic GDEs focus on the Yarra Pygmy Perch. These include altered temperature or availability of water for breeding or damage to riparian or aquatic vegetation (DoE, 2019), however, drainage of wetlands and agricultural practices are the major threats. Nature Advisory have reviewed the threats to the Yarra Pygmy Perch and conclude:

> *"Impacts on GEWVVP, Spiny Rice-flower, Trailing Hop-bush and habitat for Growling Grass Frog, Plains Wanderer and Yarra Pygmy Perch have been avoided in accordance with the EPBC Approval by locating works ad infrastructure outside areas of concern, and by providing suitable buffer zones around areas of concern.*
>
> ***The 215 layout satisfies EPBC Approval conditions 1e, 1f and 2 for impacts to listed ecological communities."***

(Nature Advisory biodiversity assessment, Apr 2020, p.5)

Water Technology anticipates that Nature Advisory has not considered dewatering of excavations in this conclusion. Aquatic ecosystem threats relevant to groundwater include sedimentation (Saddlier & Hammer,

2010) from dewatering and all ecosystems may be affected by seasonal changes in water level if they are groundwater supported. No updated information on groundwater levels has been considered since 2018.

B-2 Improved definition of salinity

Water Technology notes the salinity investigations reviewed (Golder, Jan 2020) did not follow the guidelines (DJPR, 2008). An effective plan referencing (Dahlhaus, Nicholson, Anderson, Shovelton, & Stephens, 2005) would consider the appropriate application of perennial pastures, trees and shrubs and drainage (both surface and sub-surface) and the cause of the salinisation. If saline groundwater is to be drained, then an appropriate means of disposal would be valuable to discuss.

Golder (Jan-20) provided a preliminary investigation on the mapped SMOs which have been used to target future investigations. Preliminary results did not consider recent rainfall and assumed that saline groundwater is permanently discharging, which is an alternative model to transient salinity documented in literature (DJPR, 2008), (VRO, 2020). 73% of mapped salinity in the Corangamite region is semi-permanent or permanently saline wetlands and the remainder is saline land (Dahlhaus, Evans, Nathan, Cox, & Simmons, 2010).

Considering the groundwater discharge conceptual model for the cause of land salinisation and noting that no turbines were proposed within mapped SMOs, Golder sampled within the top 0.1 m of the soil profile on the 7 November 2019. Within mapped SMOs, Golder took 4-5 samples and analysed one from each using the $EC_{1:5}$ method. The guidance is to take 7-10 representative samples, combine the soils and analyse one sample using the more rigorous EC_{se} method. Guidance is also to consider the cause of the salt and sample when rainfall / evapotranspiration conditions are appropriate (DJPR, 2008).

By considering these preliminary results, GPWFM is progressing targeted investigations to prepare an appropriate Salinity Management Plan (S. Clifton, GPWFM, pers. comm. 3/4/20).

B-3 Improved definition of hydrogeology

To understand the likelihood of a consequence from a groundwater related activity, an understanding of the hydrogeology is required. In the volcanic terrain underlying the site, it is useful to consider the transition from fresh volcanic rock through to its weathered form. This has implications for land salinisation, and groundwater flows relevant to the 215 turbine configuration which are discussed in Section 6. The detailed discussion in Appendix C concludes that the local rock can behave either as an aquitard or an aquifer that can permit high rates of groundwater influx, depending on the degree of rock weathering. Due to the modified layout of the turbine and pole foundations, this has implications for the new 215 turbine risk profile.

APPENDIX C
HYDRAULIC CONDUCTIVITY OF WEATHERED BASALT

This section discusses the nature of the hydrogeology in more detail.

In a volcanic terrain (Newer Volcanics), rock becomes fractured (fresh to slightly weathered) to form a saprolith which is massive rock with variably linked secondary fracture porosity (slightly weathered to moderately weathered). This secondary porosity may enable high rates of groundwater flow to behave like an aquifer or be infilled with clay material that inhibits groundwater flow (aquitard). Weathering of basalt is highly variable. Once basalt weathers to a clay matrix, possibly containing boulders or gravel (heavily weathered to extremely weathered – see Figure C-2), this weathered part of the profile is termed the pedolith.

The pedolith encompasses lithological Unit 1 and the saprolith (see Figure C-7) encompasses lithological Unit 2a/b/c described in Golder (Dec 2019).

The pedolith does not permit high groundwater flow rates (an aquitard) and thus dewatering of excavations is a very low to negligible risk. For illustration, an example of the non-conductive nature of the clay is shown in Appendix D, Figure C-8.

The risk of encountering significant groundwater inflows to excavations will vary around the Project area. For this reason, it is important to consider how many excavations may result in large groundwater impacts.

The location of wetting and drying cycles around watercourses will tend to increase the rate of weathering, and secondary porosity in the saprolith can become filled with weathered clay (Das, Krishnaswami, Sarin, & Pande, 2005) which reduces groundwater flows through the fractures. Whether a fracture is open depends on the current (and historical) stress regime. An open fracture will transmit large amounts of groundwater until the basalt weathers to clay which may then seal the fracture or retain some permeability.

Consideration of groundwater flow is important as infrastructure can block natural groundwater processes. It can also contribute to sedimentation if groundwater inflows to turbine foundation excavations are discharged to waterways with significant aquatic ecosystem habitat. These risks can be handled under appropriately informed EMP and CEMP required by the permits. Further information is presented in AWE (2018) Section 6.2.3.

In general, it is reasonable to assume that the high elevation areas (scoria ridges WTG122 and WTG138 in Figure C-1) are more likely to exhibit saprolith or fresh rock characteristics. Figure C-7 shows the shallow saprolith in BH12 which is drilled on the flank of a scoria ridge in a similar topography to WTG122, 138 and 133. This log shows slight weathering. A 27 m diameter excavation will encounter more fractures than a borehole and have a greater chance of encountering an open fracture. BH12 was reported as having no groundwater inflows to a depth of 20 m. Thus, either the water table mapping is very unreliable, the drilling technique attracts uncertainties in groundwater inflow estimation, or the borehole failed to encounter one of the open fractures. GPWFM has undertaken detailed geotechnical investigations across the site which support the assumption of fractured and slightly to moderately weathered basalt around the scoria ridges (away from large waterbodies) and pedolith aquitards on flatter, low lying land around waterways Figure C-8 and Figure C-9. Considering this, the potential for highly variable groundwater flow rates can be considered and effectively managed in the EMP and CEMP.

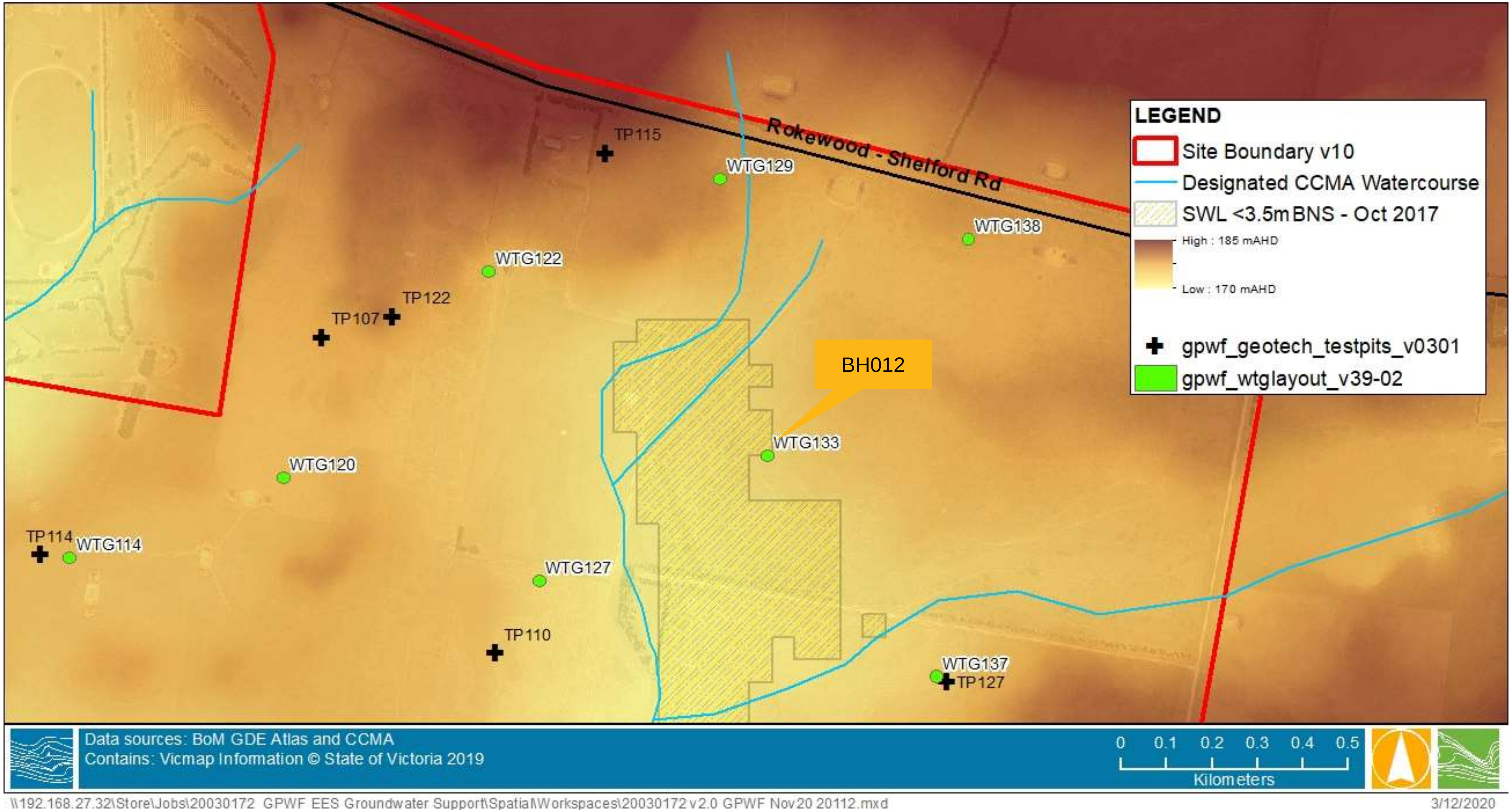


FIGURE C-1 GROUND ELEVATION AND BORES NEAR WTG133

FIGURE C-2 TP 115 SHOWING SHALLOW ROCK

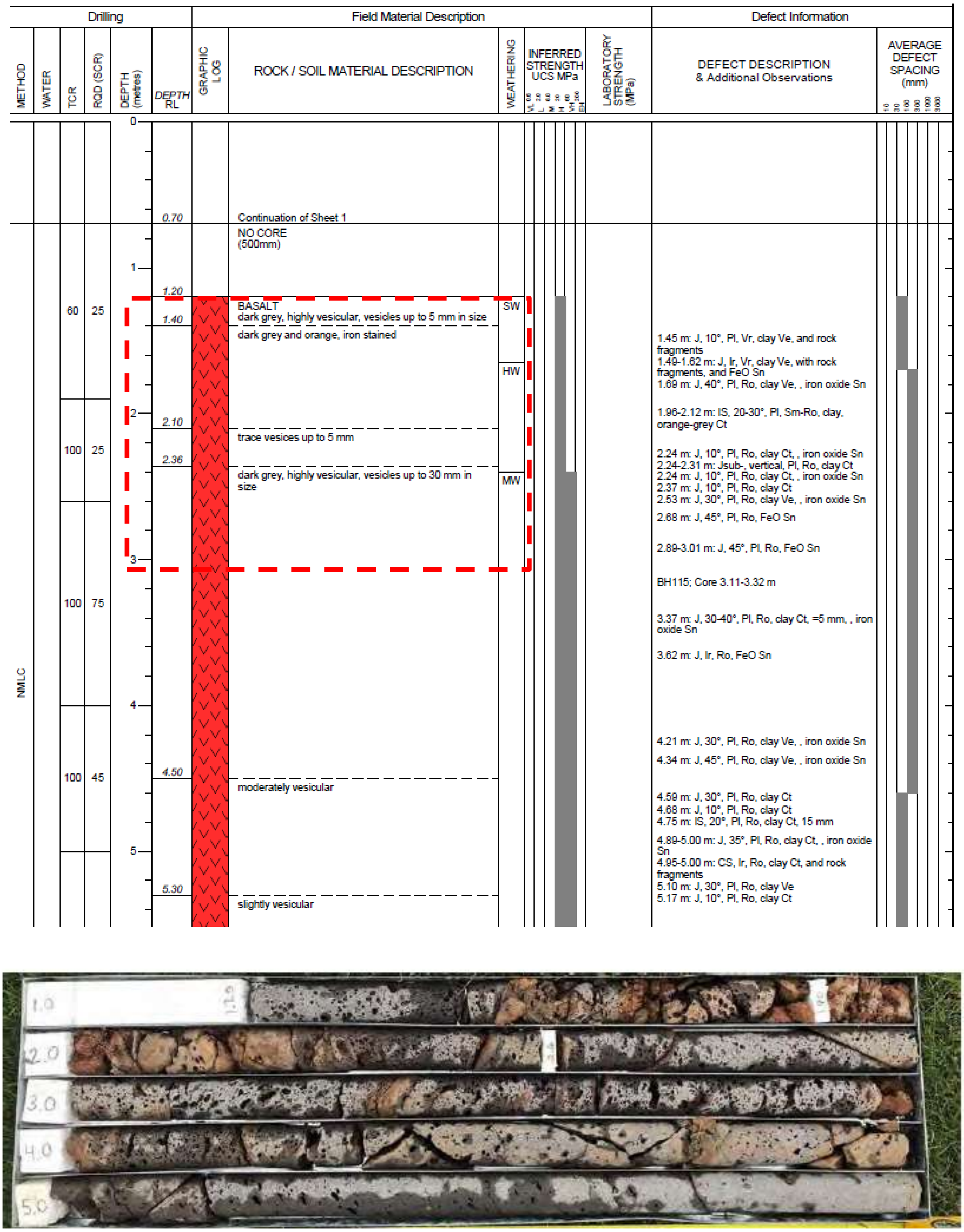


FIGURE C-3 BH115 LITHOLOG WHERE GROUNDWATER WAS NOT ENCOUNTERED TO A DEPTH OF 20 M, INDICATING A LACK OF PERMEABILITY IN THE BORE (GOLDER, DEC 2019)

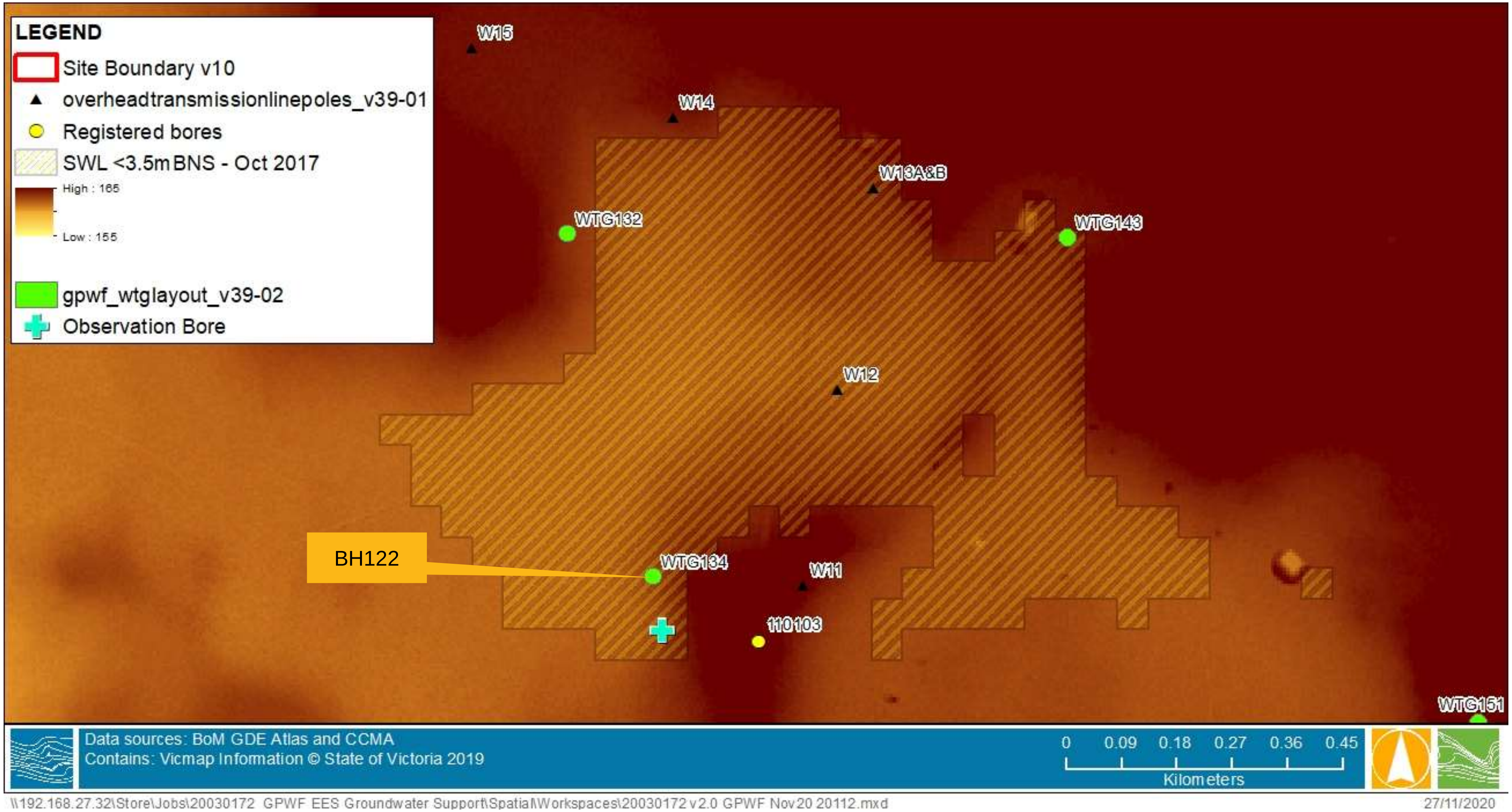


FIGURE C-4 WTG134 AND WTG143 TURBINE LOCATIONS AS WELL AS POWER POLES W12 AND W13 IN POTENTIALLY SHALLOW GROUNDWATER AREA GEOTECHNICAL BOREHOLE BH122 IS SHOWN NEXT TO WTG134 ON THE EDGE OF A RIDGE

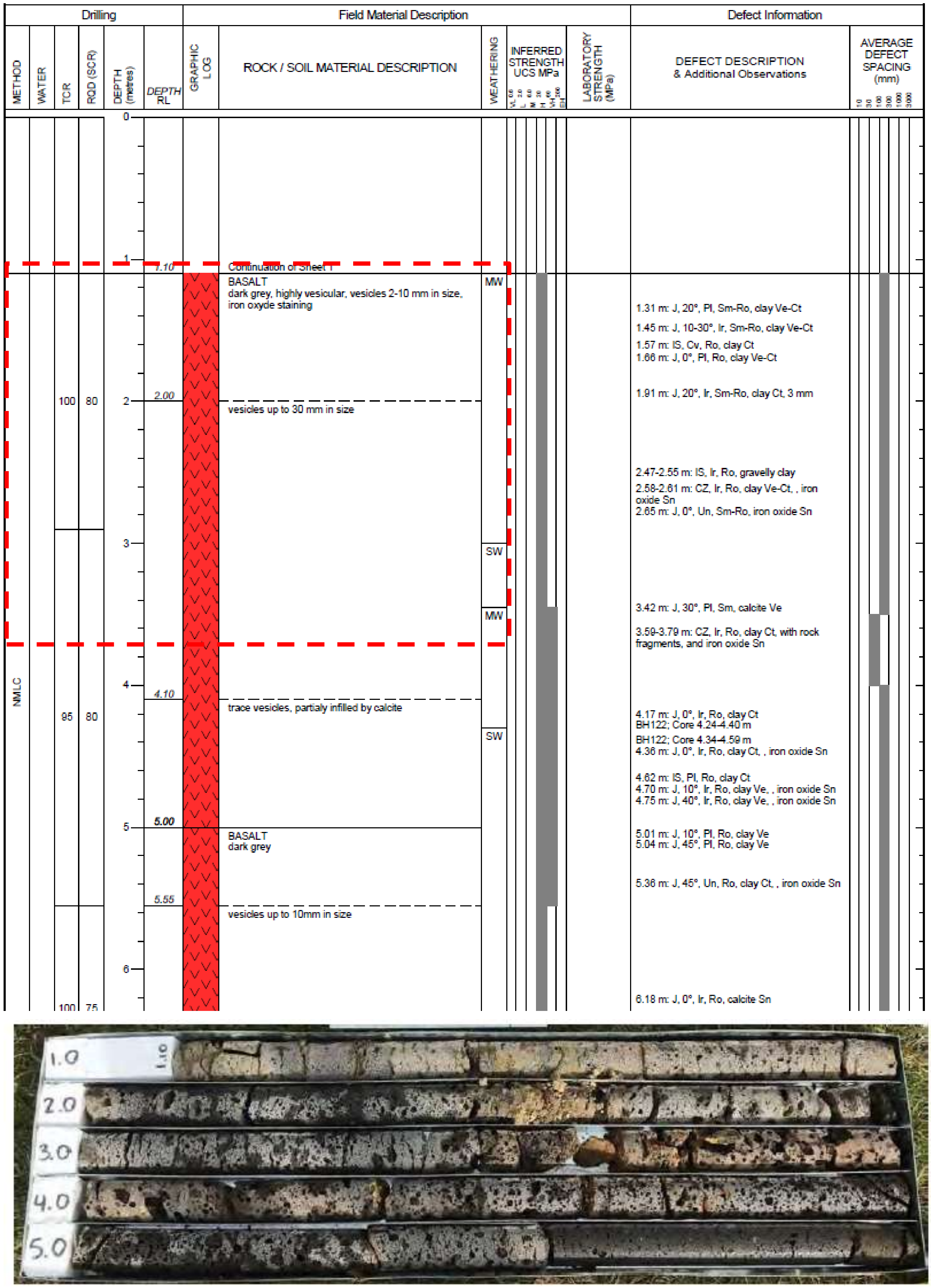


FIGURE C-5 BH122 LITHOLOG (GOLDER, DEC 2019)

The following section provides information on the pedolith distribution at the site.

FIGURE C-6 TP110A – CLAY WITH BOULDERS TO 2.5 METRES (GOLDER, DEC 2019)

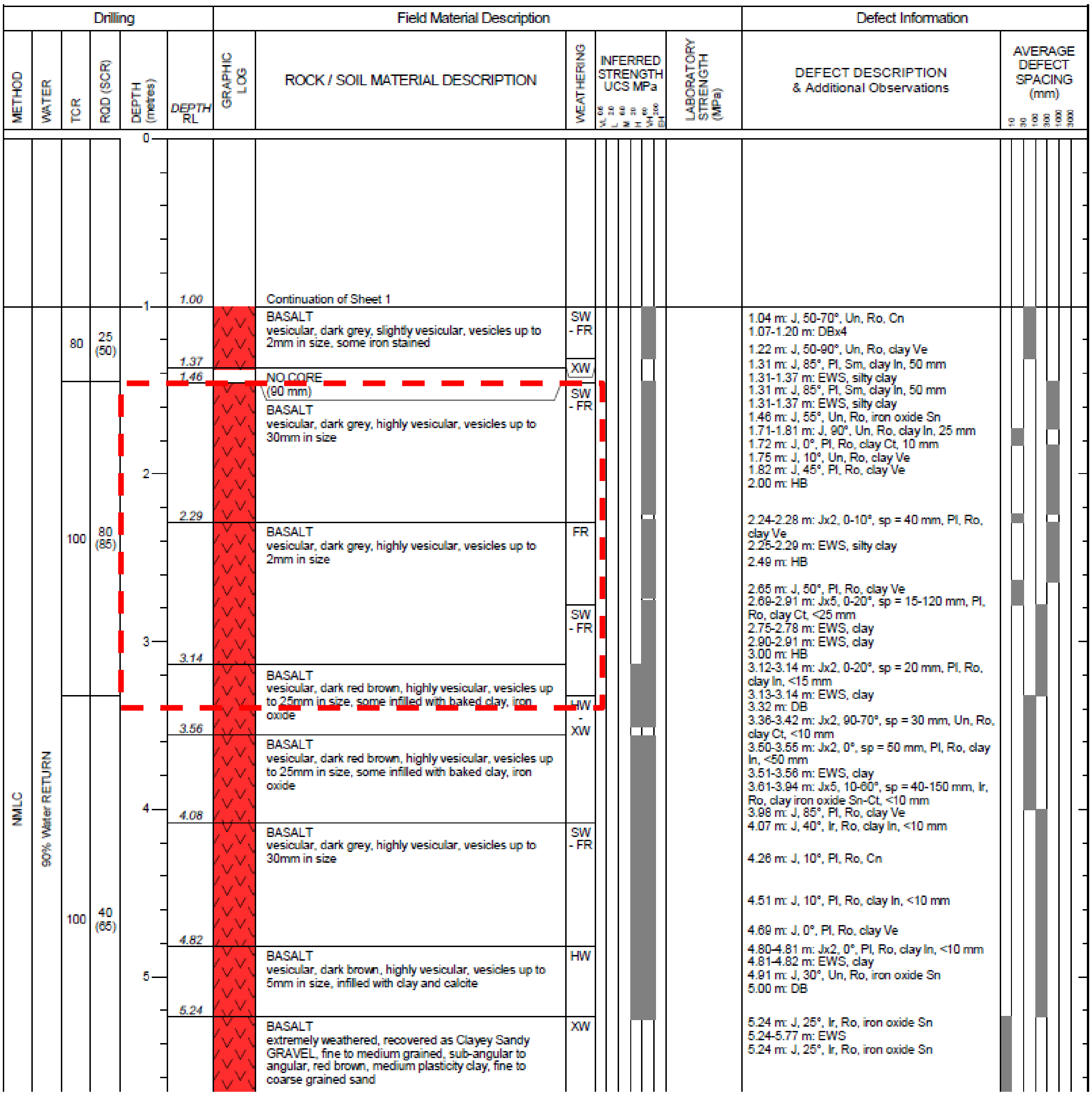


FIGURE C-7 LITHOLOG AND CORE IN BH012 (GOLDER, DEC 2019) LOCATED IN THE FAR NORTH OF THE SITE. FIGURE C-1 SHOWS THE LOCATION OF THE SAPROLITH NEAR WTG133

1

2

FIGURE C-8 PEDOLITH AREA AT TP165 NEAR MIA MIA CREEK SHOWING STANDING WATER THAT DOES NOT RAPIDLY INFILTRATE TO THE WATER TABLE

FIGURE C-9 TP166 SHOWING WEATHERED PEDOLITH NEAR MIA MIA CREEK

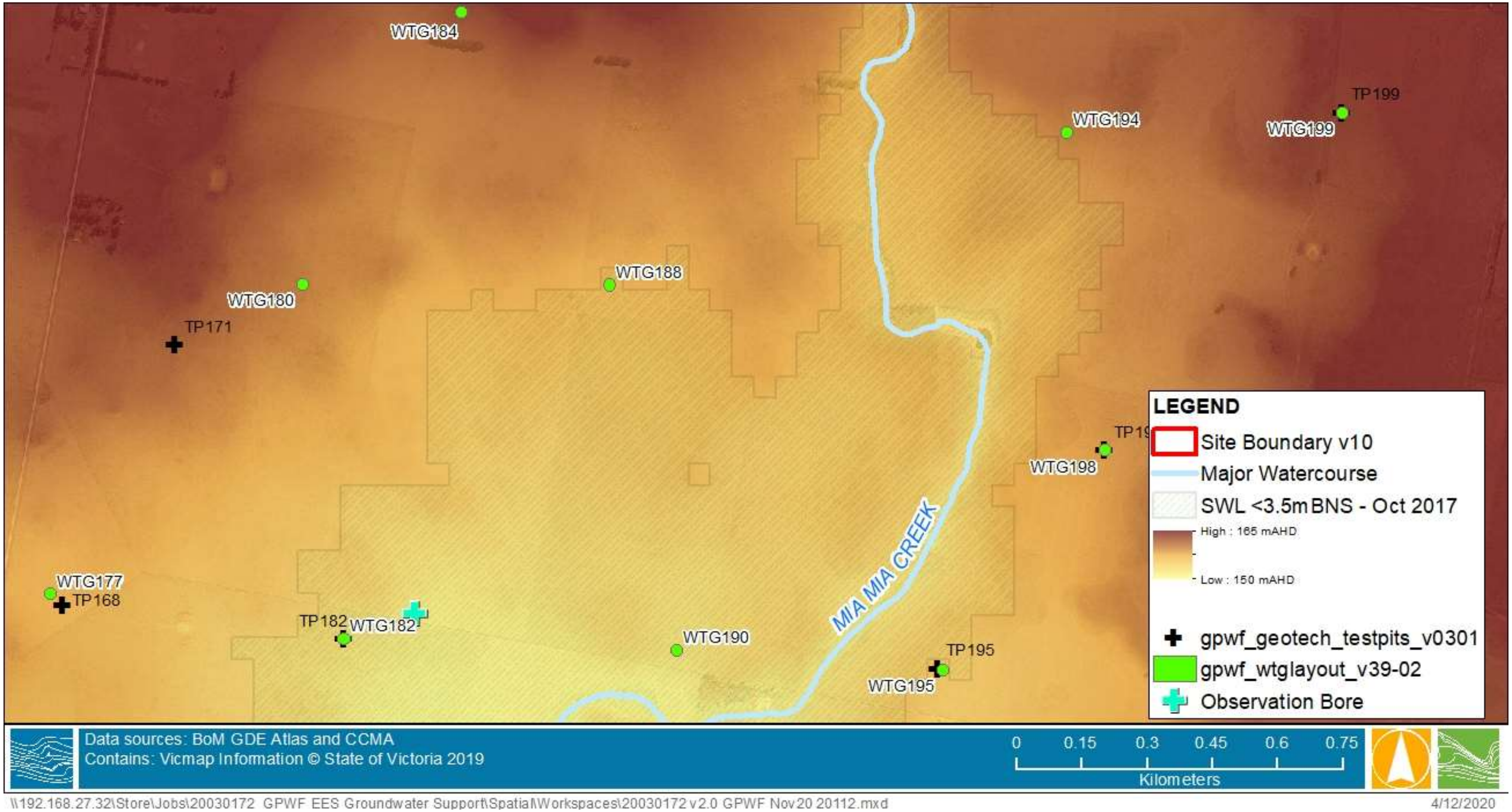


FIGURE C-10 WTG 188 AND WTG182 IN LOW-LYING AREAS OF LIKELY PEDOLITH NEAR MIA MIA CREEK

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

APPENDIX D
AREAS OF CONCERN

TABLE D-1 DESCRIPTIONS OF SHAPEFILES USED IN MAPS

Shape file name	Description	Source
gpwf_Investigationarea_v25-01	An area surveyed for significant species intended to form a 20 m buffer around proposed infrastructure. Version 25-01	Nature Advisory (Nature Advisory, Mar 2020)
gpwf_investigationarea_nv_v25-01	Locations where significant species were surveyed, or native vegetation quality was mapped or areas of DELWP mapped wetlands (marked as N/A in the shapefile). Version 25-01	Nature Advisory (Nature Advisory, Mar 2020)
gpwf_wtglayout_v39-02	The planned new 215 turbine layout. Version 39-02	GPWFM (pers. comm)
gpwf_hardstands_v39-01	Maximum dimensions of permanent and temporary hardstand. Turbine foundations may be 20-27 m. 25 m turbine diameters are plotted. Shapefile version 39-01	GPWFM (pers. comm.)
GPWF_Wetland_V01-01	DELWP mapped wetlands.	GPWFM (pers. comm)
gpwf_geotech_boreholes_v03-01	Location of geotechnical bore holes	Golder (Golder, Dec 2019)
gpwf_internaloverheadtransmissionlinepoles_v39-01	Locations of planned power poles. Version 39-01	GPWFM (pers. comm.)
gpwf_accesstracks_v39-02	Locations of planned access tracks. Version 39-02	GPWFM (pers. comm.)

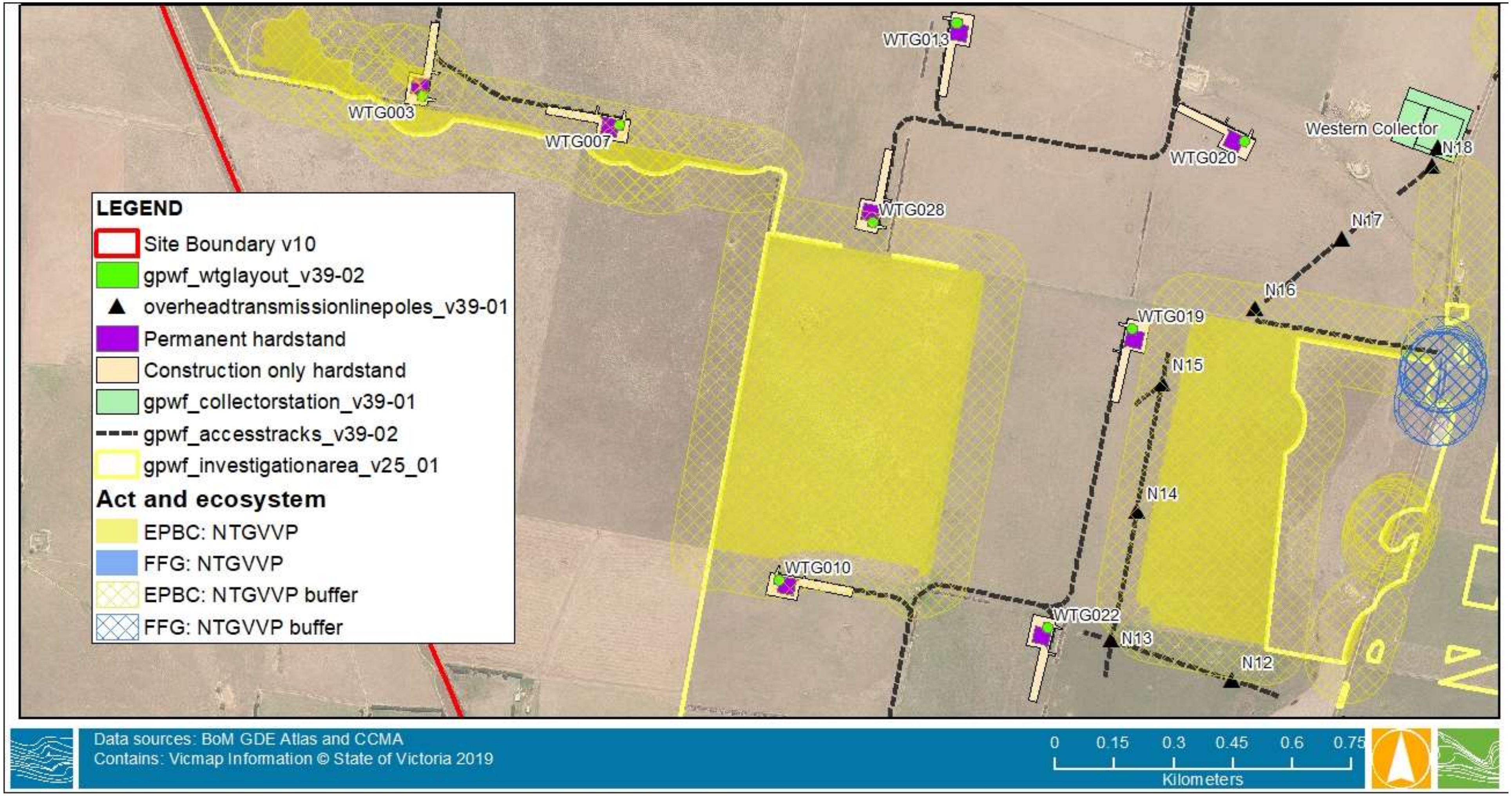


FIGURE D-1 WTG003, WTG007, WTG010, WTG028, HARDSTANDS, N12, N14, N15, N16 WITHIN 100 M OF NTGVVP

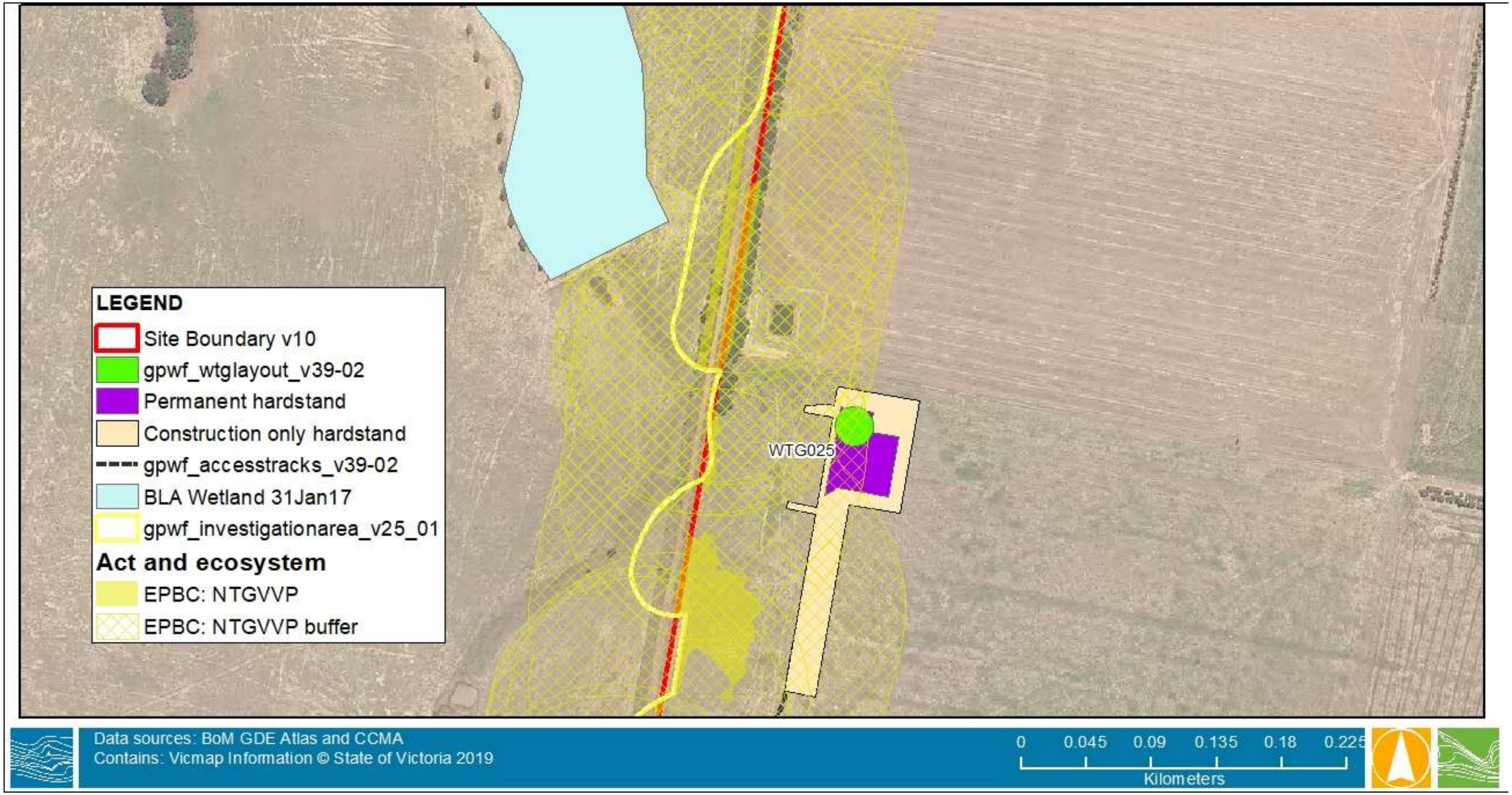


FIGURE D-2 WTG025 WITHIN 100 M OF NTGVVP

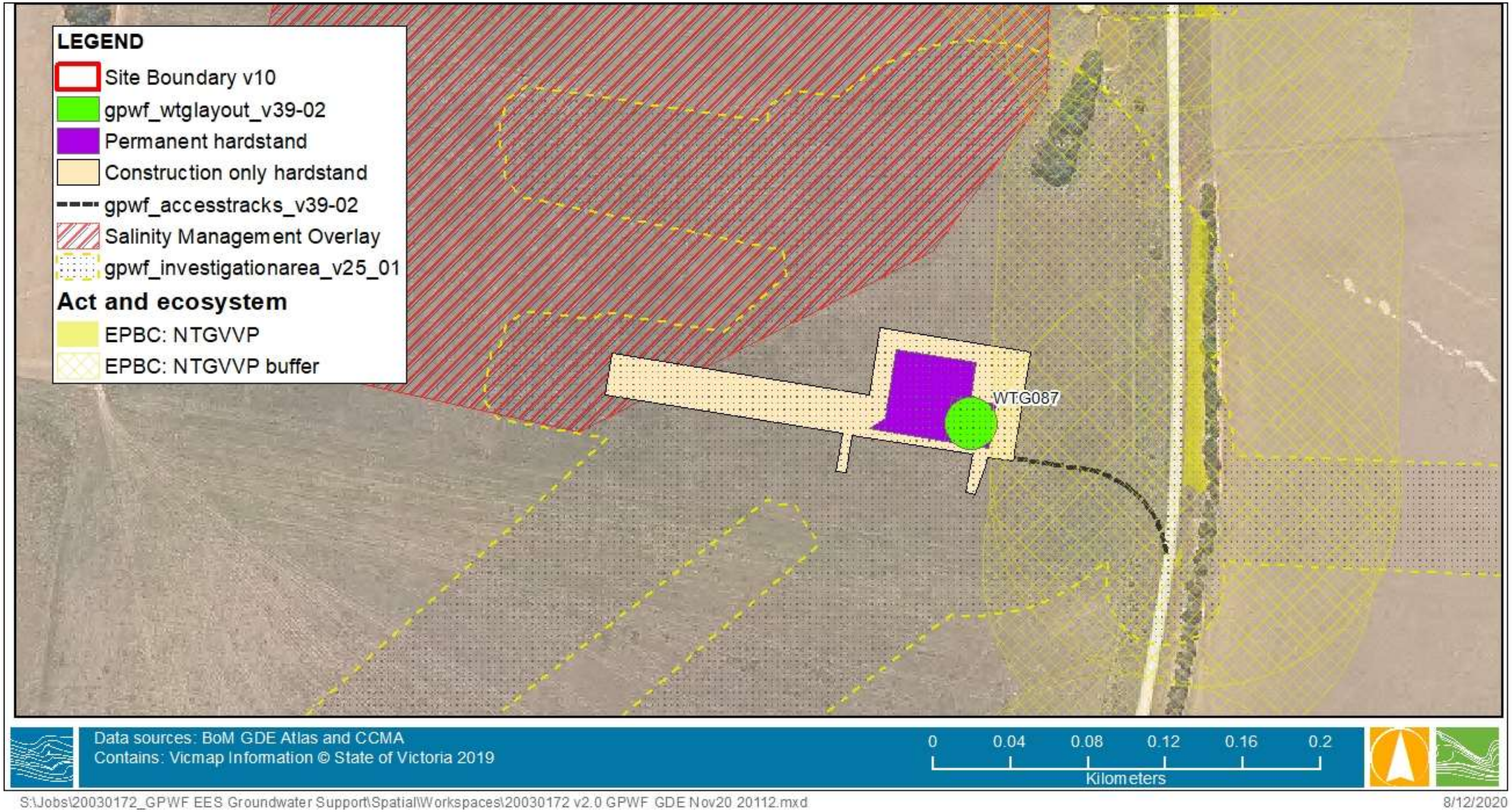


FIGURE D-3 WTG087 WITHIN SMO AND 100 M OF NTGVVP

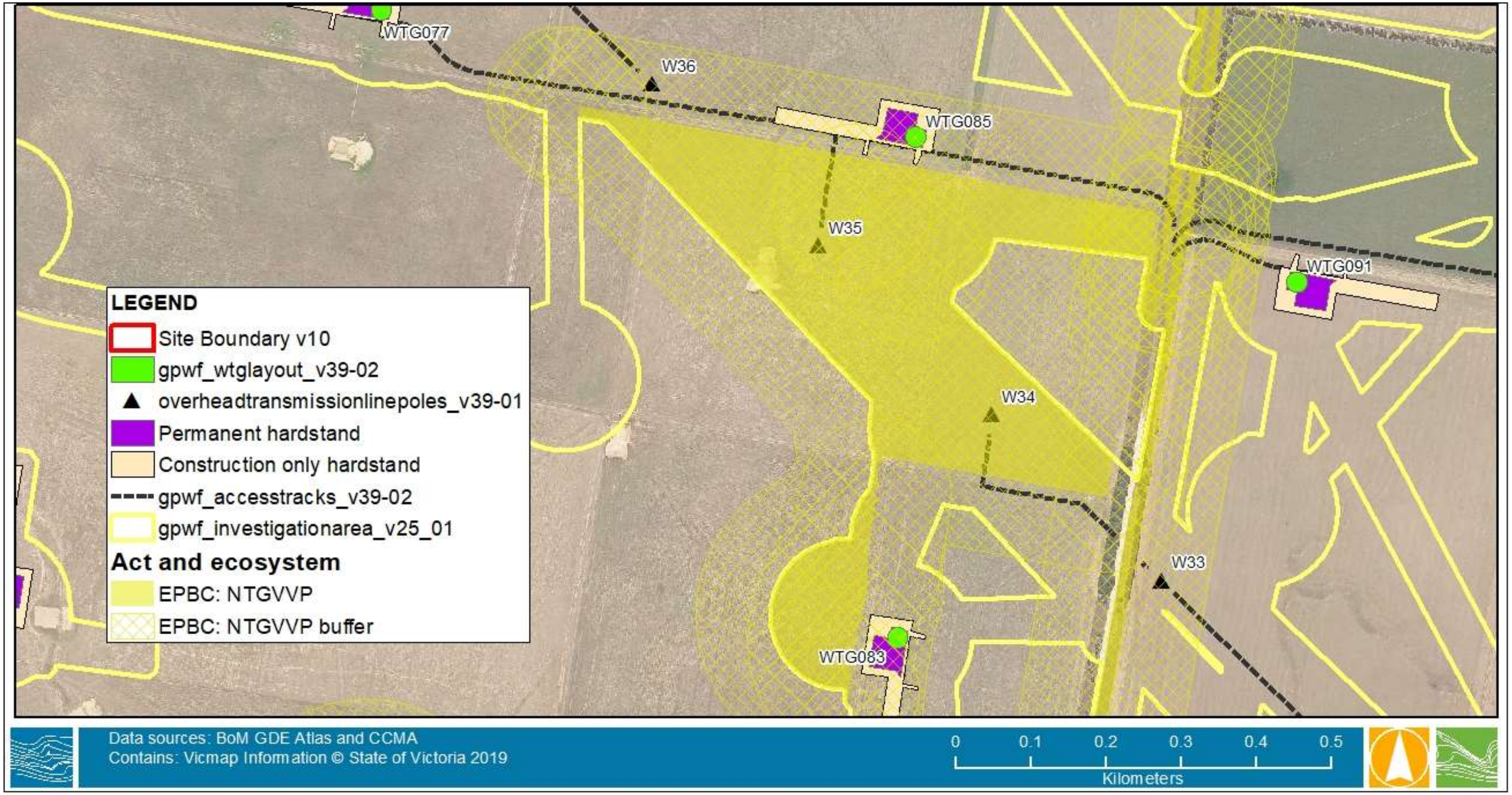


FIGURE D-4 WTG083, WTG085 AND W33, W34, W35 AND W36 WITHIN 100 M OF NTGVVP

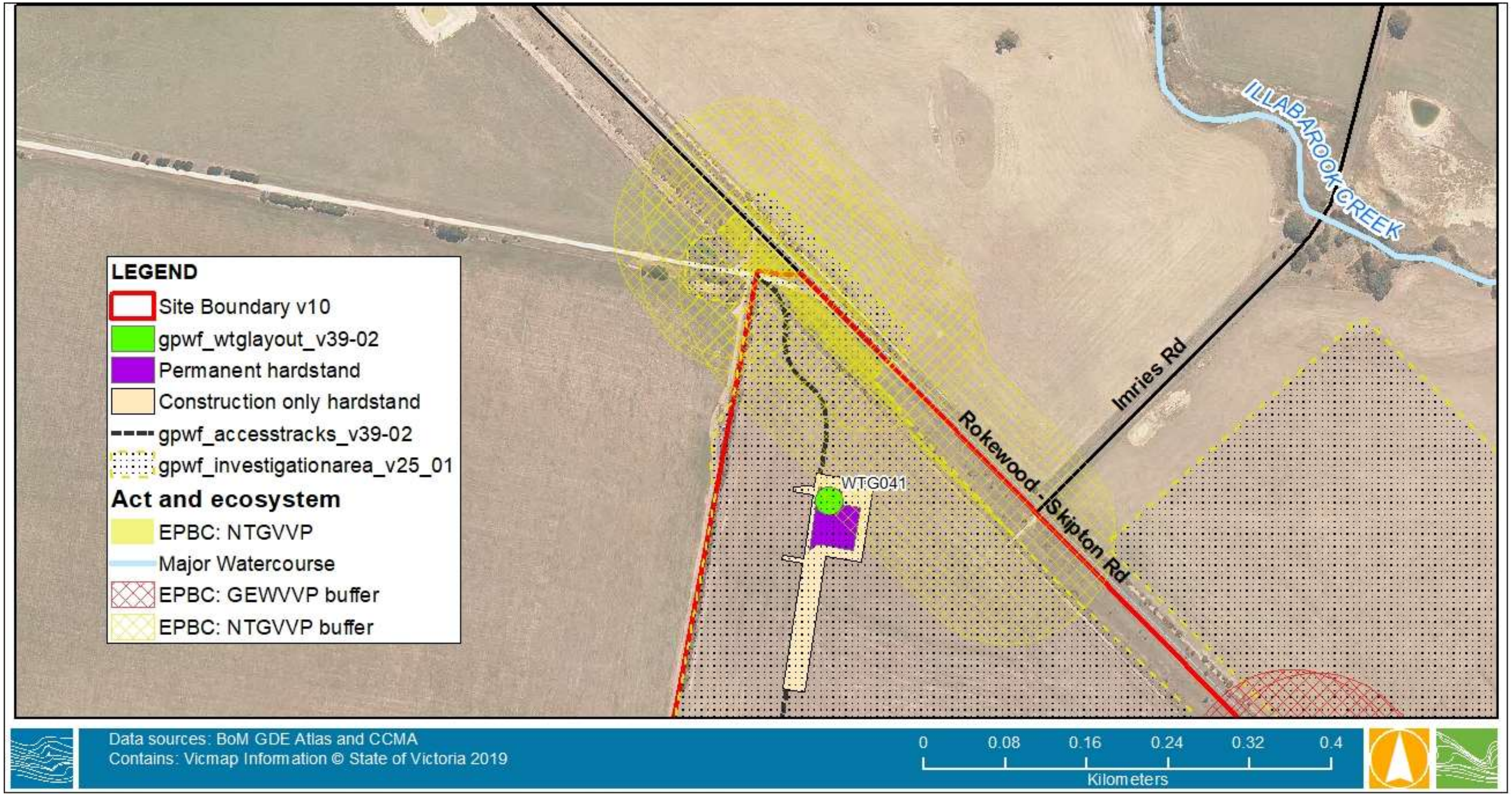


FIGURE D-5 WTG041 WITHIN 100 M OF MAPPED NTGVVP

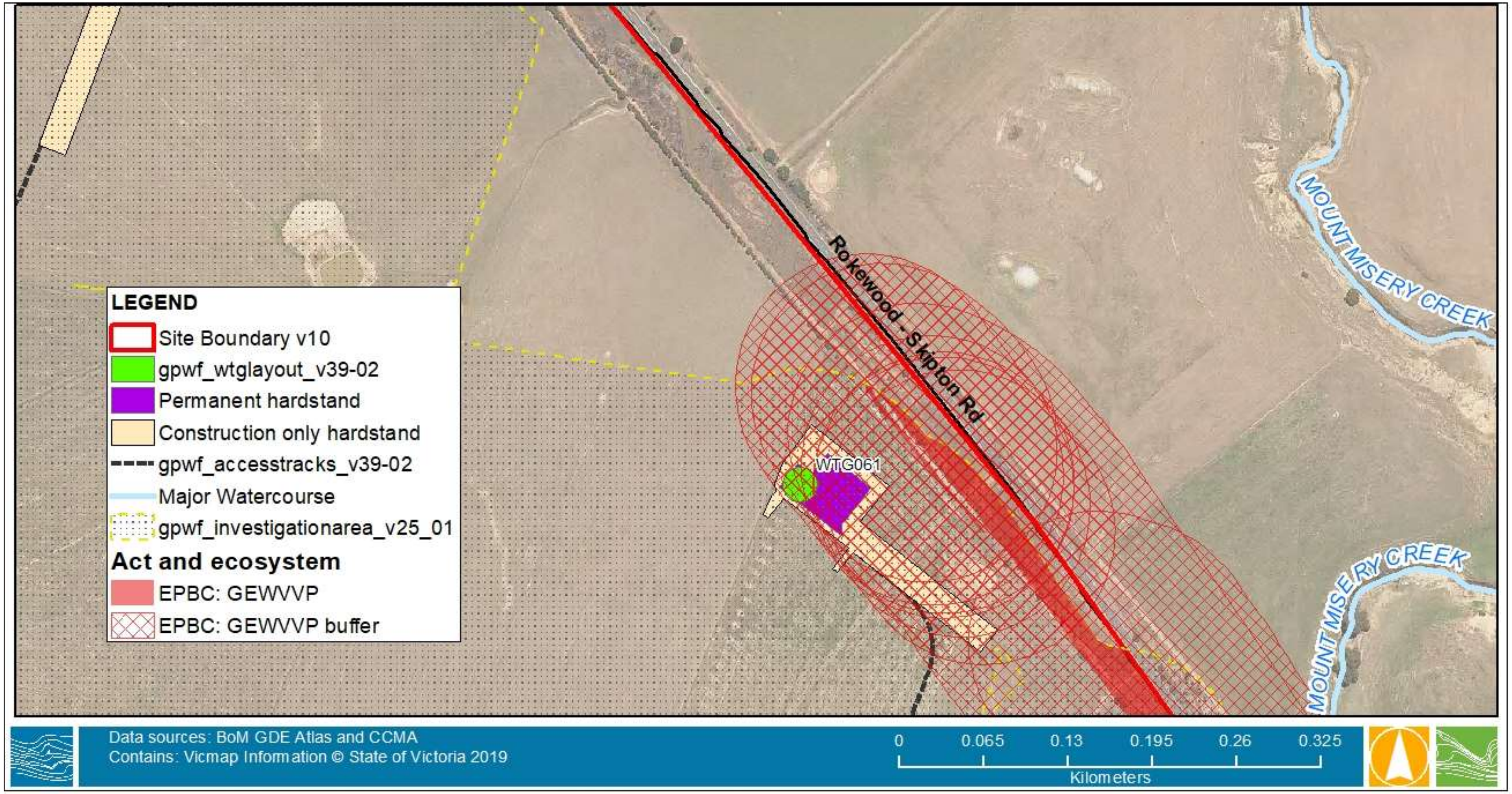


FIGURE D-6 WTG061 WITHIN 100 M OF MAPPED GEWVVP

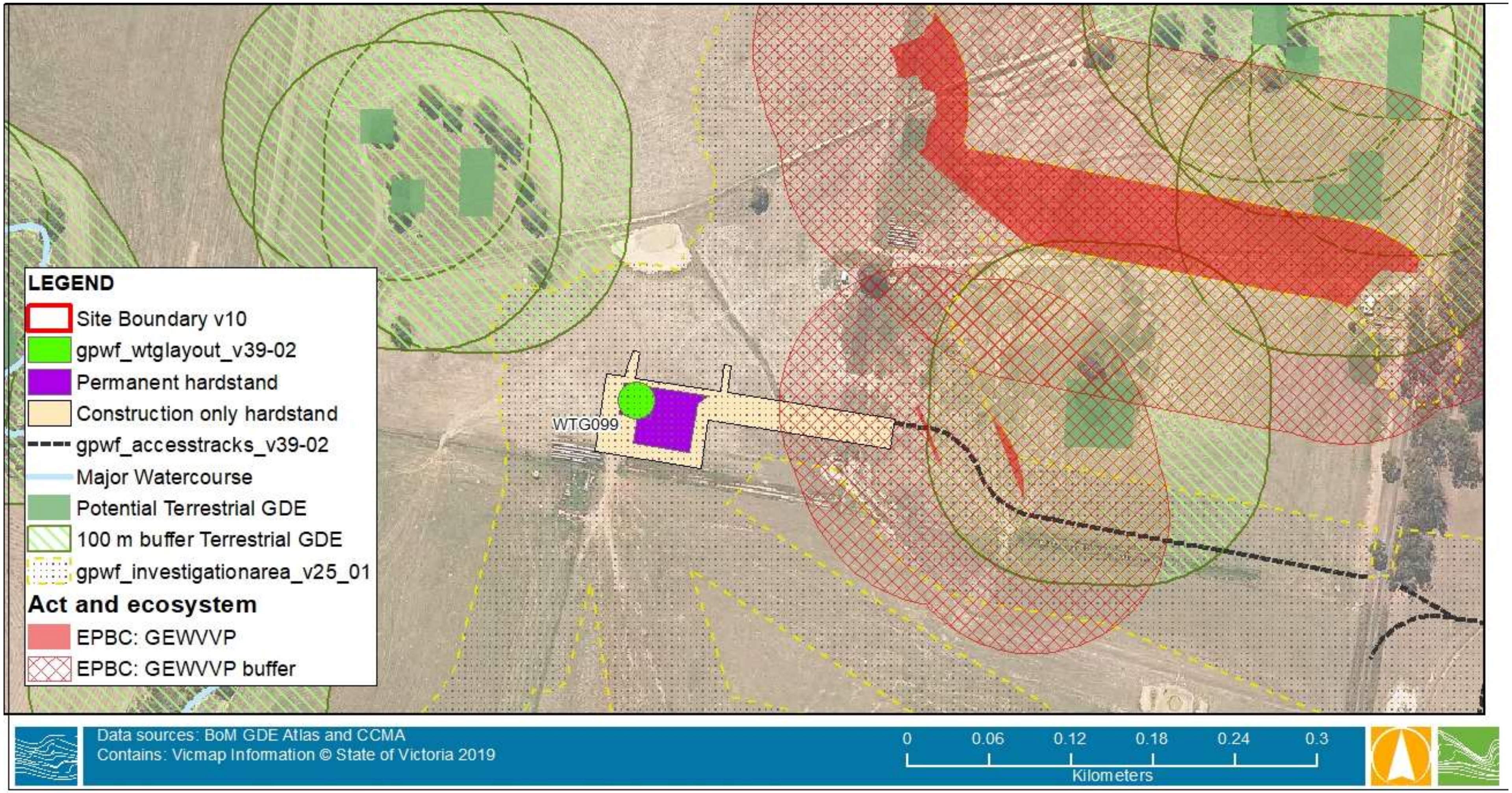


FIGURE D-7 WTG099 WITHIN 100 M OF MAPPED GEWVVP

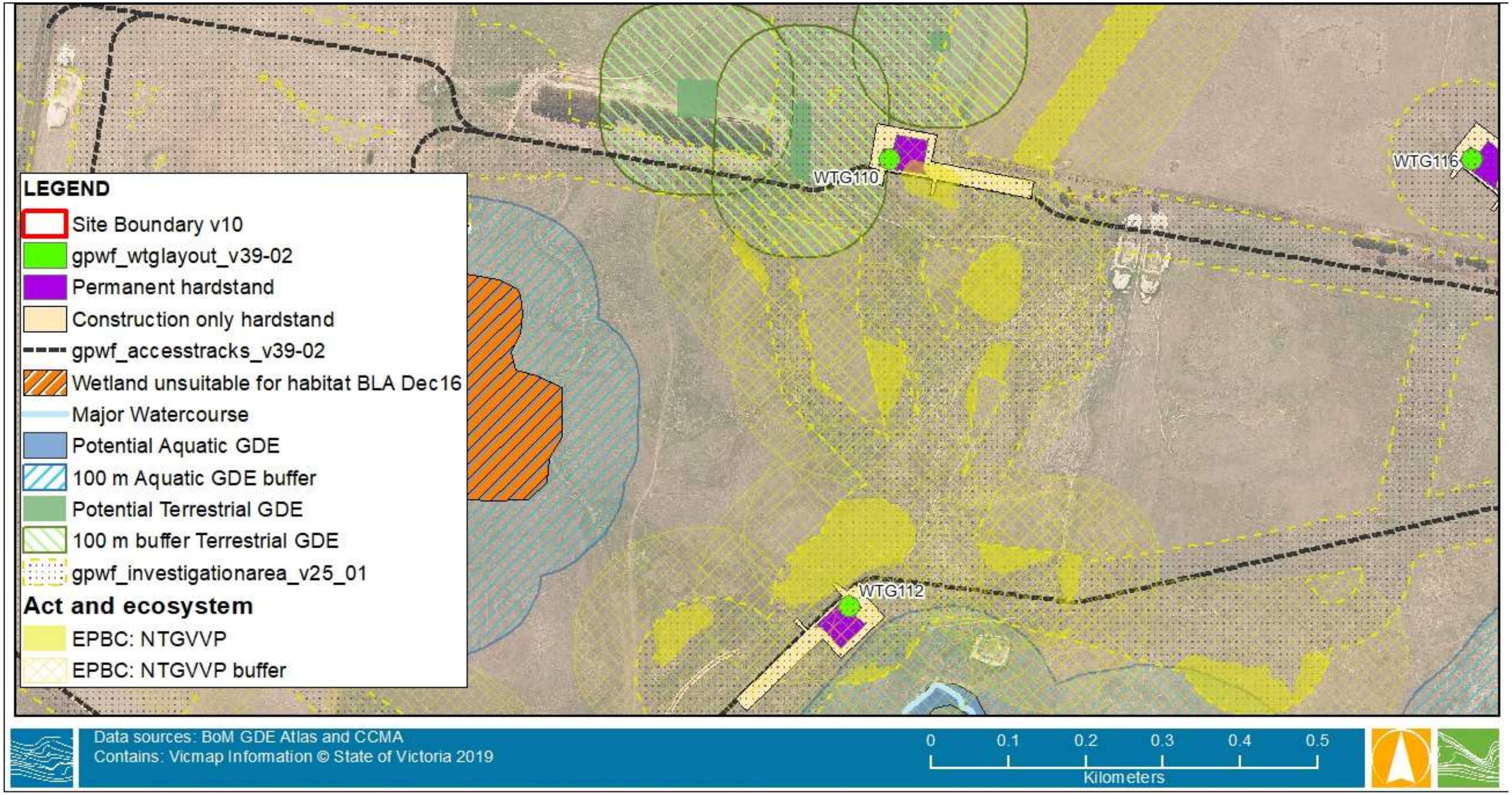


FIGURE D-8 WTG110 AND WTG112 WITHIN 100 M OF NTGVVP

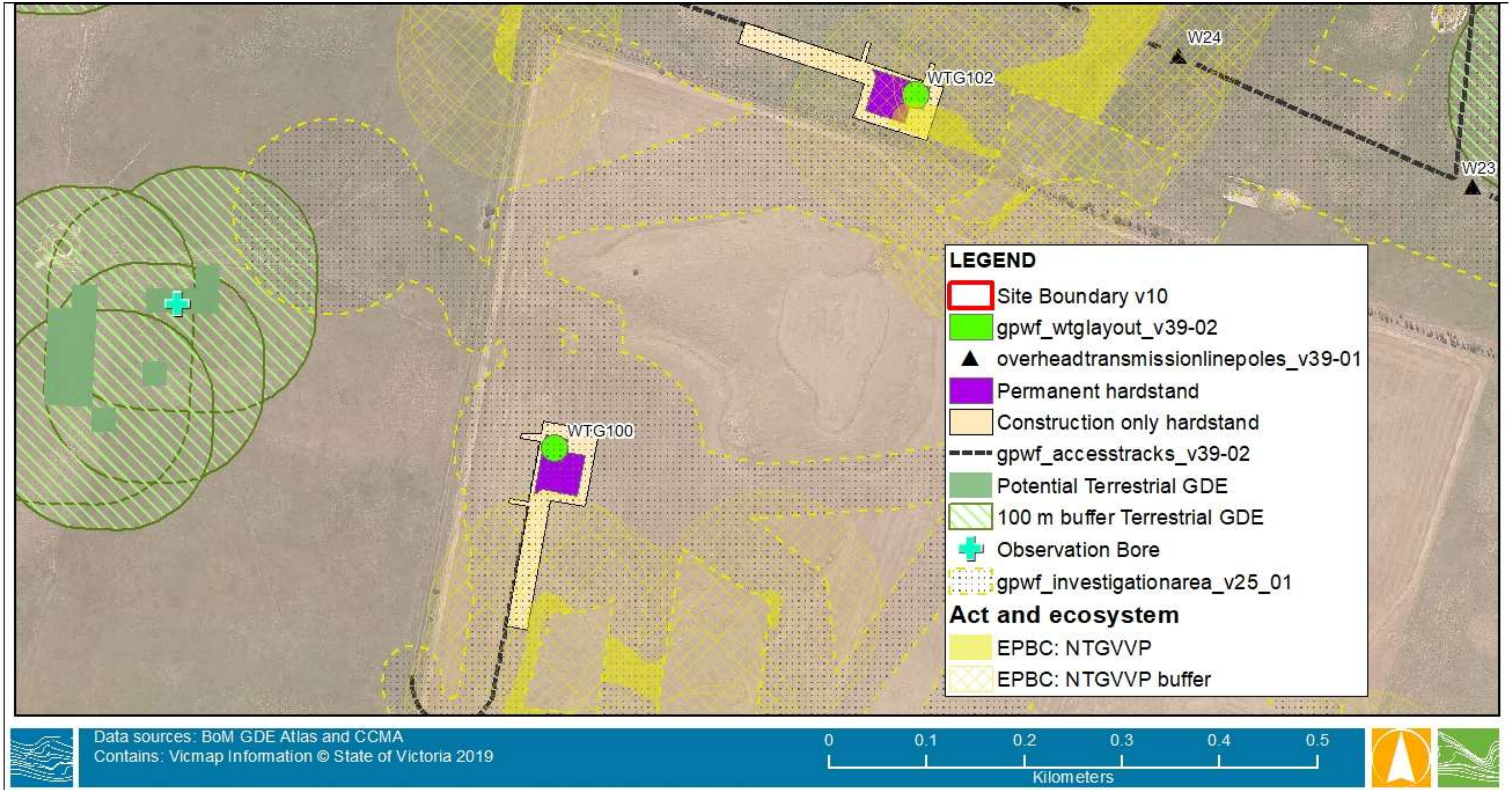


FIGURE D-9 WTG100 AND WTG102 WITHIN 100 M OF NTGVVP

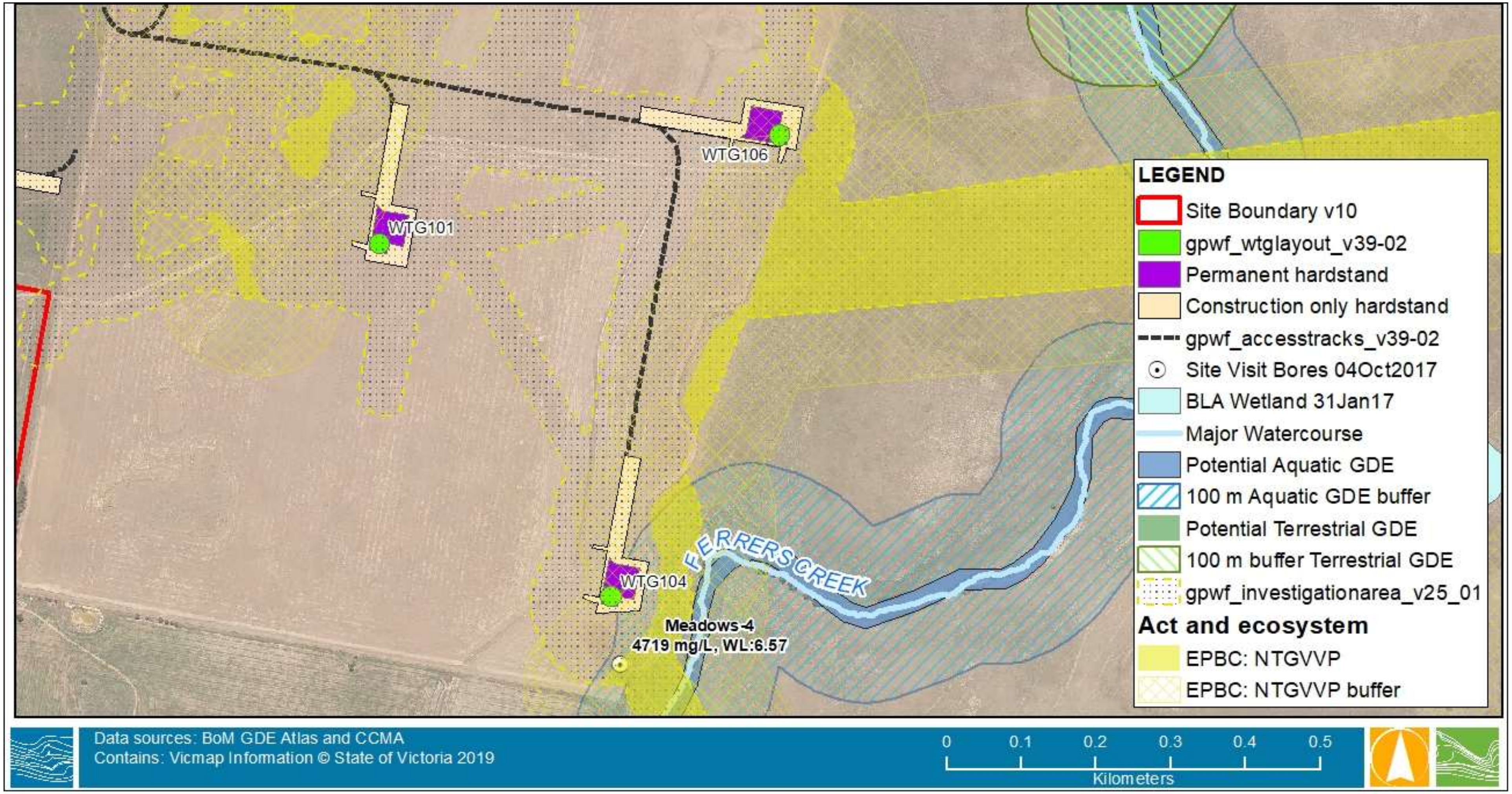


FIGURE D-10 WTG101, 104 & 106 WITHIN 100 M OF NTGVVP

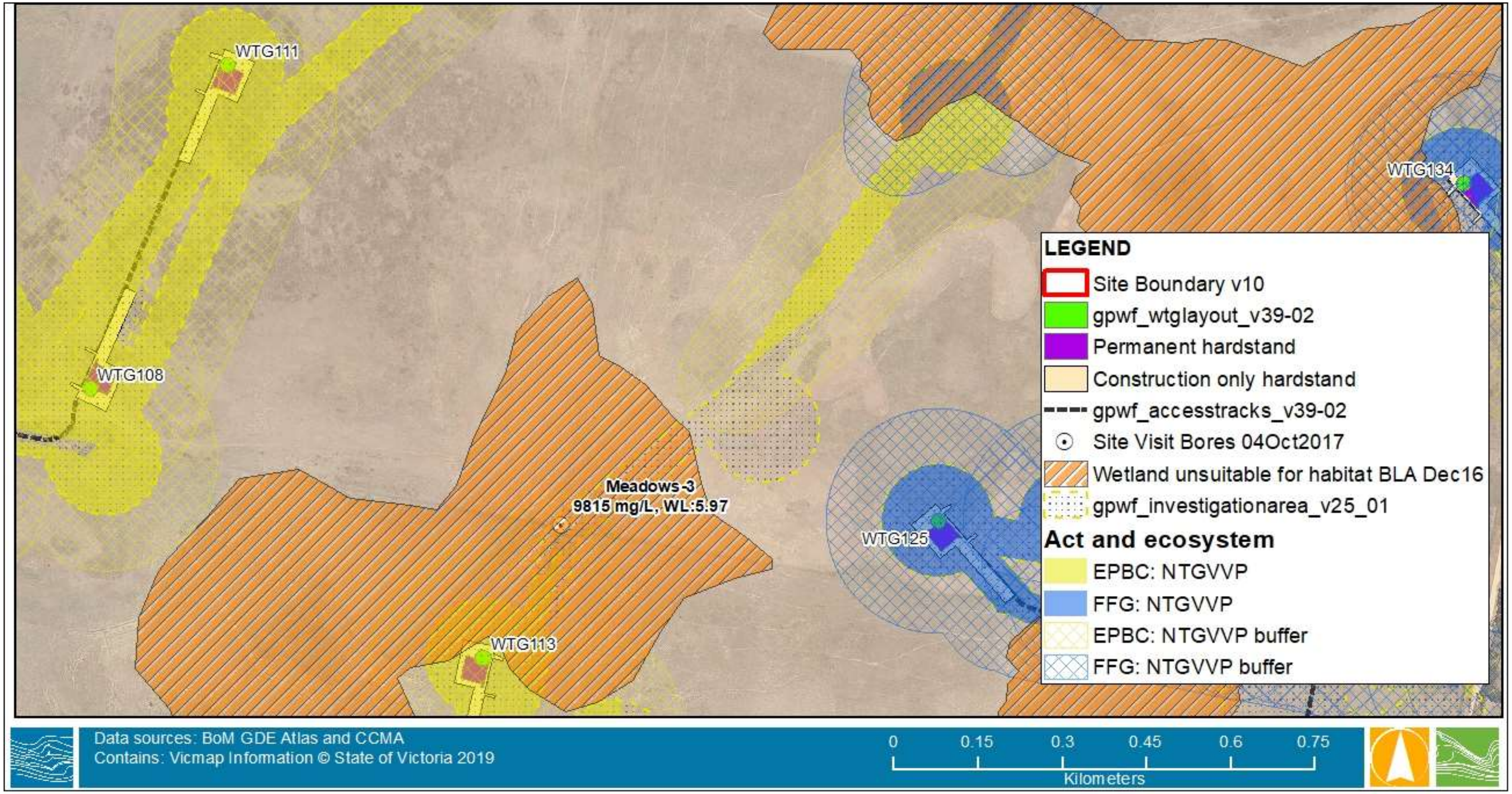


FIGURE D-11 WTG108, 111, 113 AND 125 WITHIN 100 M OF NTGVVP

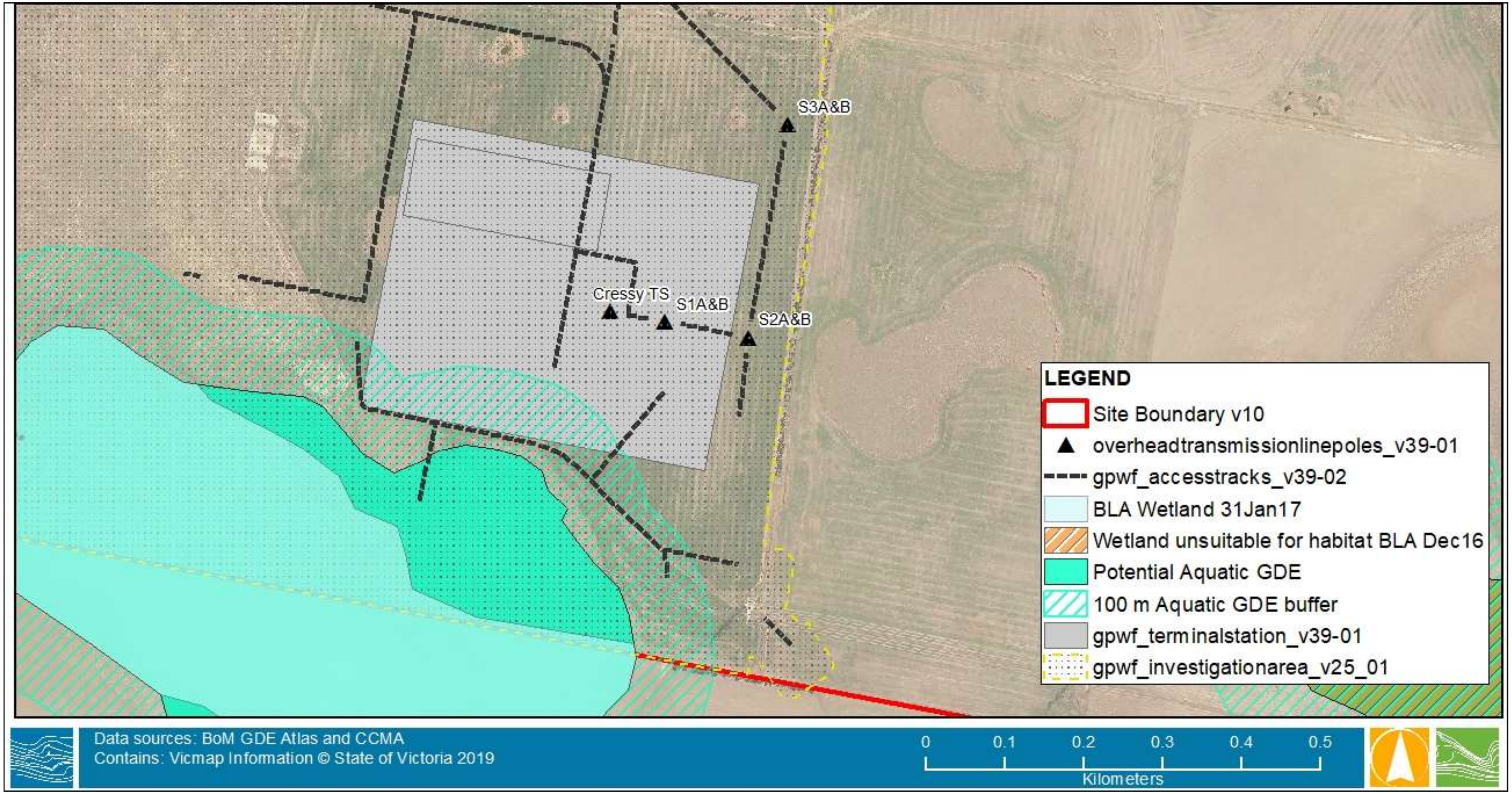


FIGURE D-12 TERMINAL STATION WITHIN 100 M OF POTENTIAL AREA FOR AN AQUATIC GDE

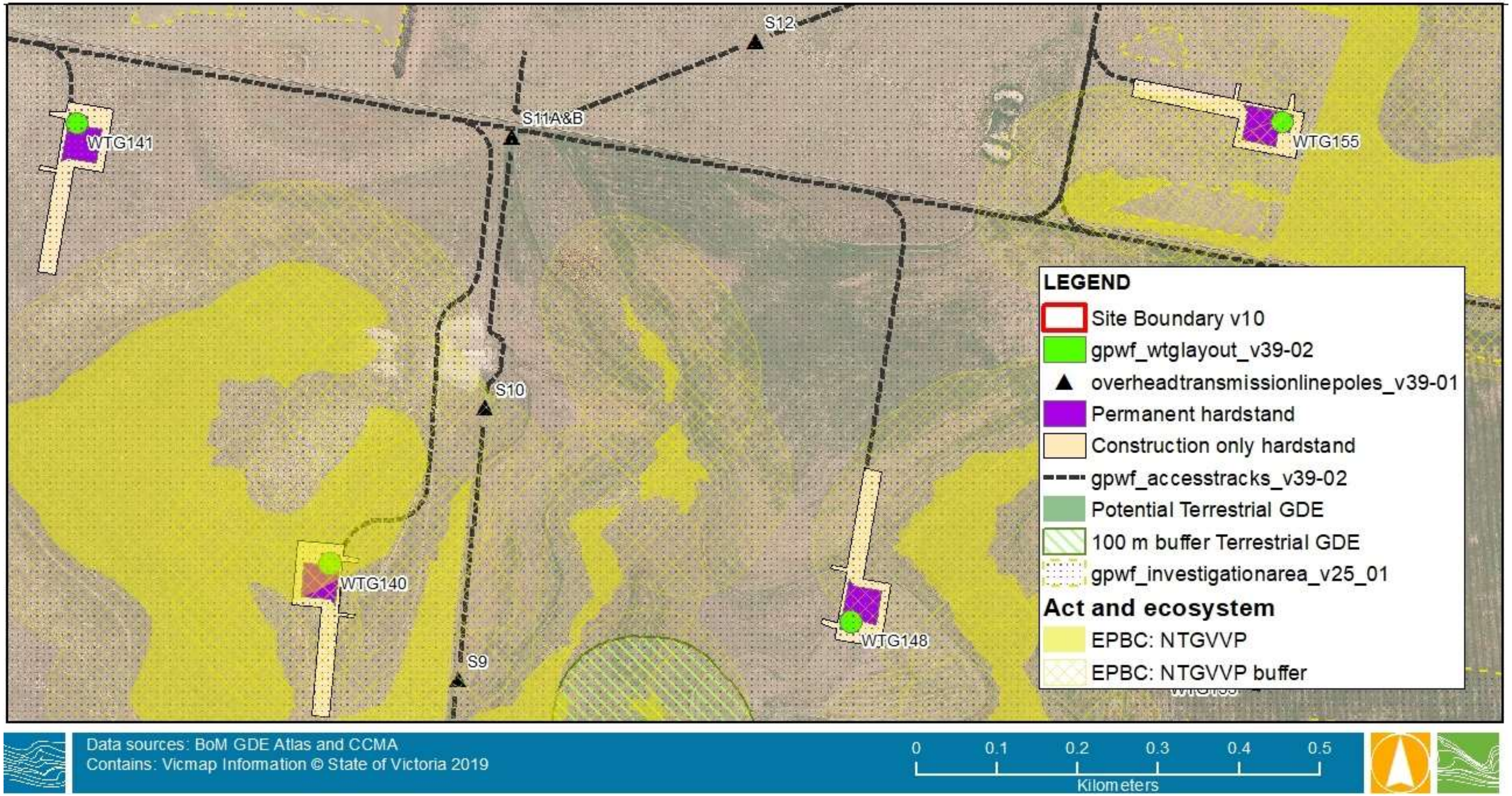


FIGURE D-13 WTG140, WTG148 AND WTG155 WITHIN 100 M OF NTGVVP

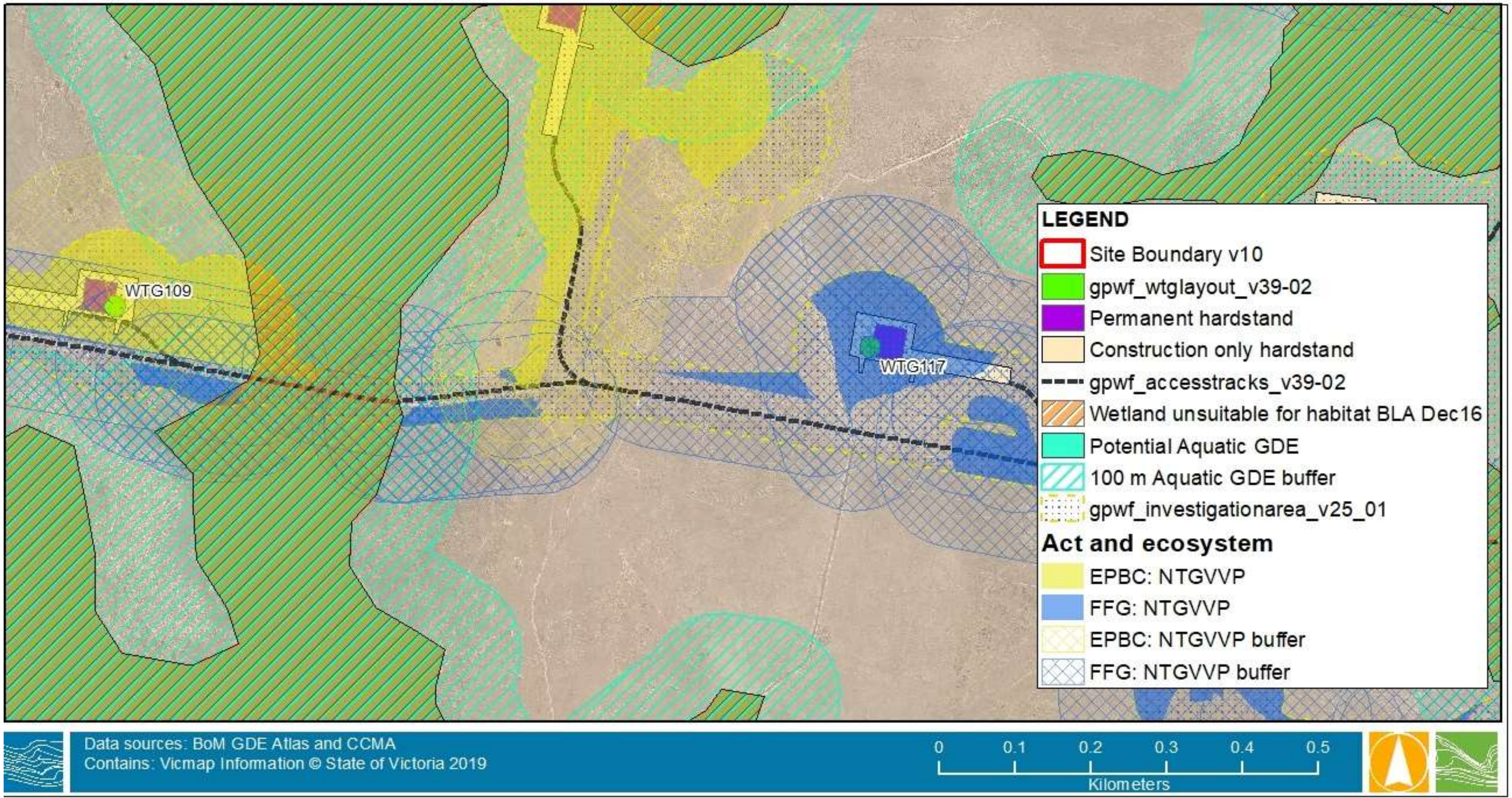


FIGURE D-14 WTG109 AND 117 WITHIN 100 M OF NTGVVP

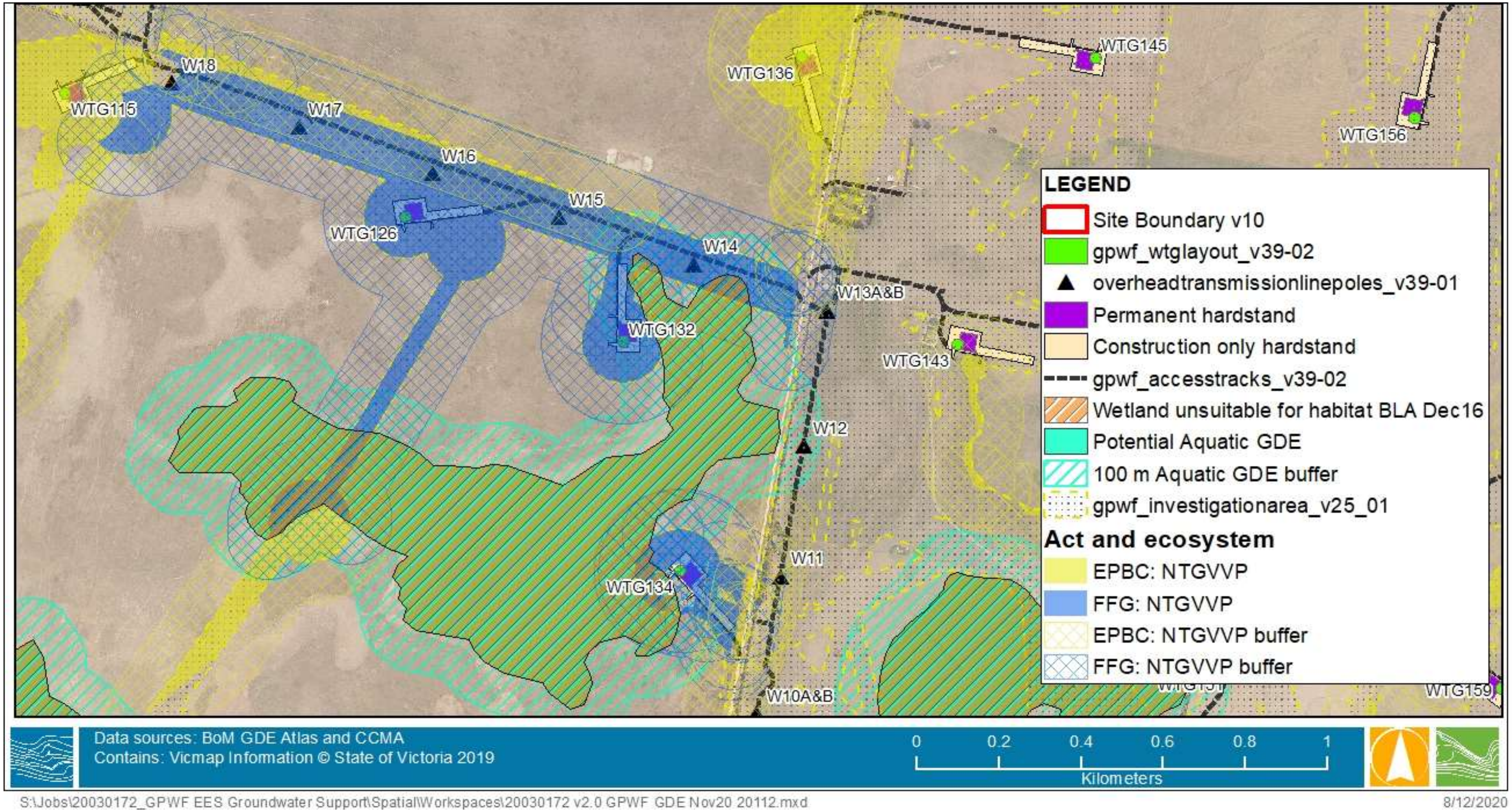


FIGURE D-15 WTG115, WTG126, WTG132, WTG134, WTG136 AND WTG143 WITHIN 100 M OF NTGVVP

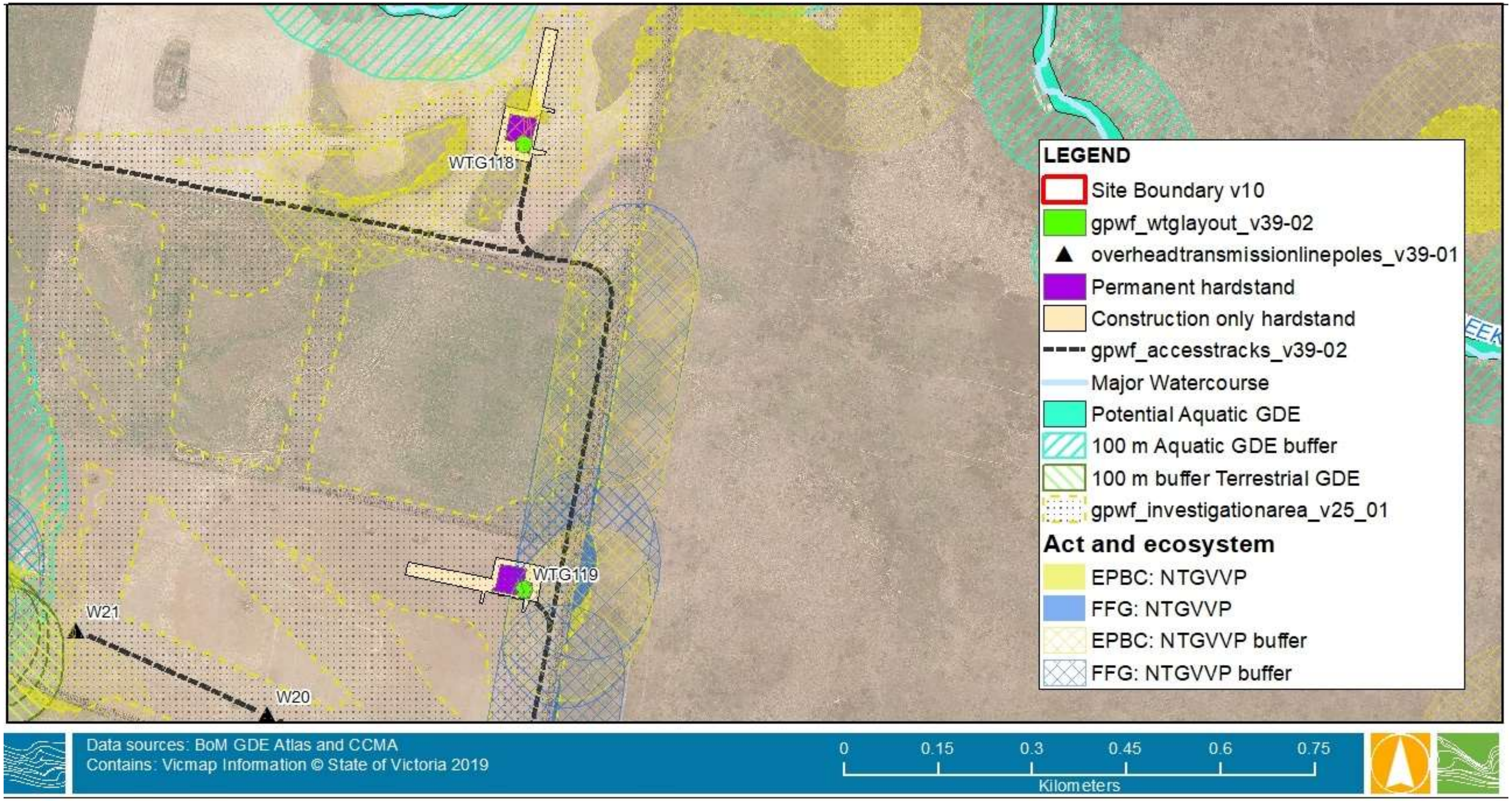


FIGURE D-16 WTG118 AND WTG119 WITHIN 100 M OF NTGVVP

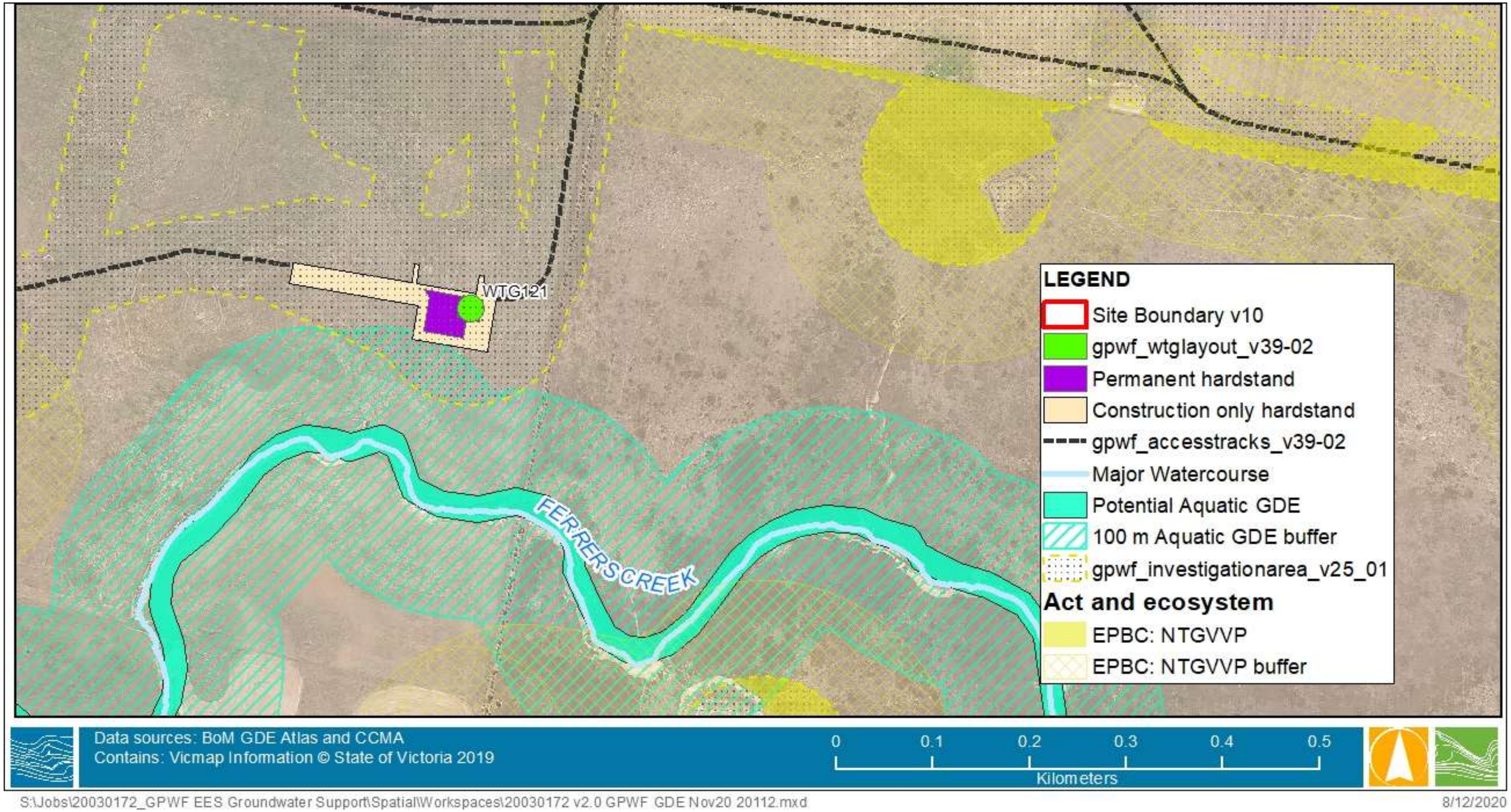


FIGURE D-17 WTG121 TEMPORARY CONSTRUCTION AREA WITHIN 100 M OF POTENTIAL AQUATIC GDE

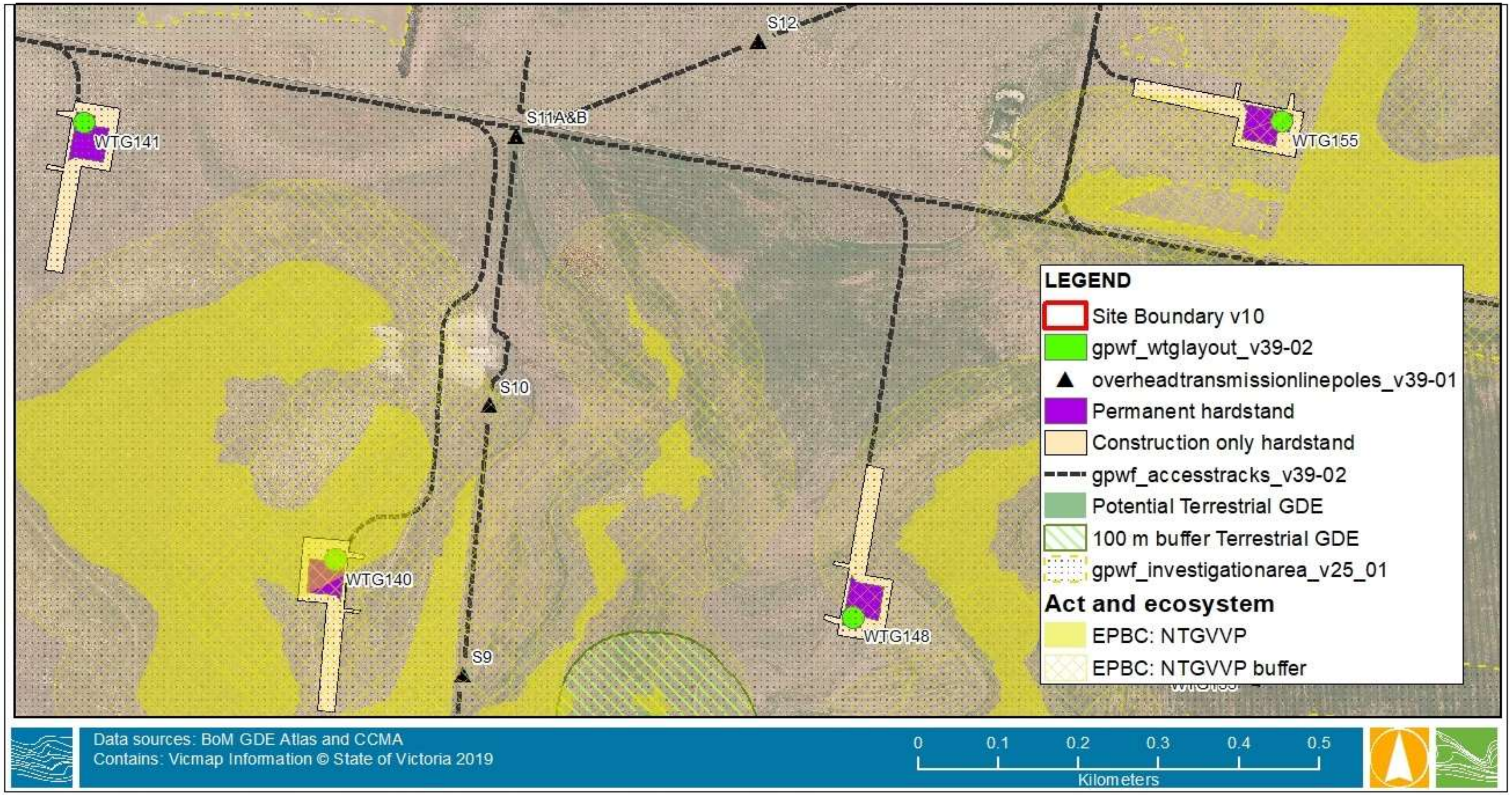


FIGURE D-18 WTG135, WTG142, WTG147 AND WTG149 WITHIN 100 M OF NTGVVP

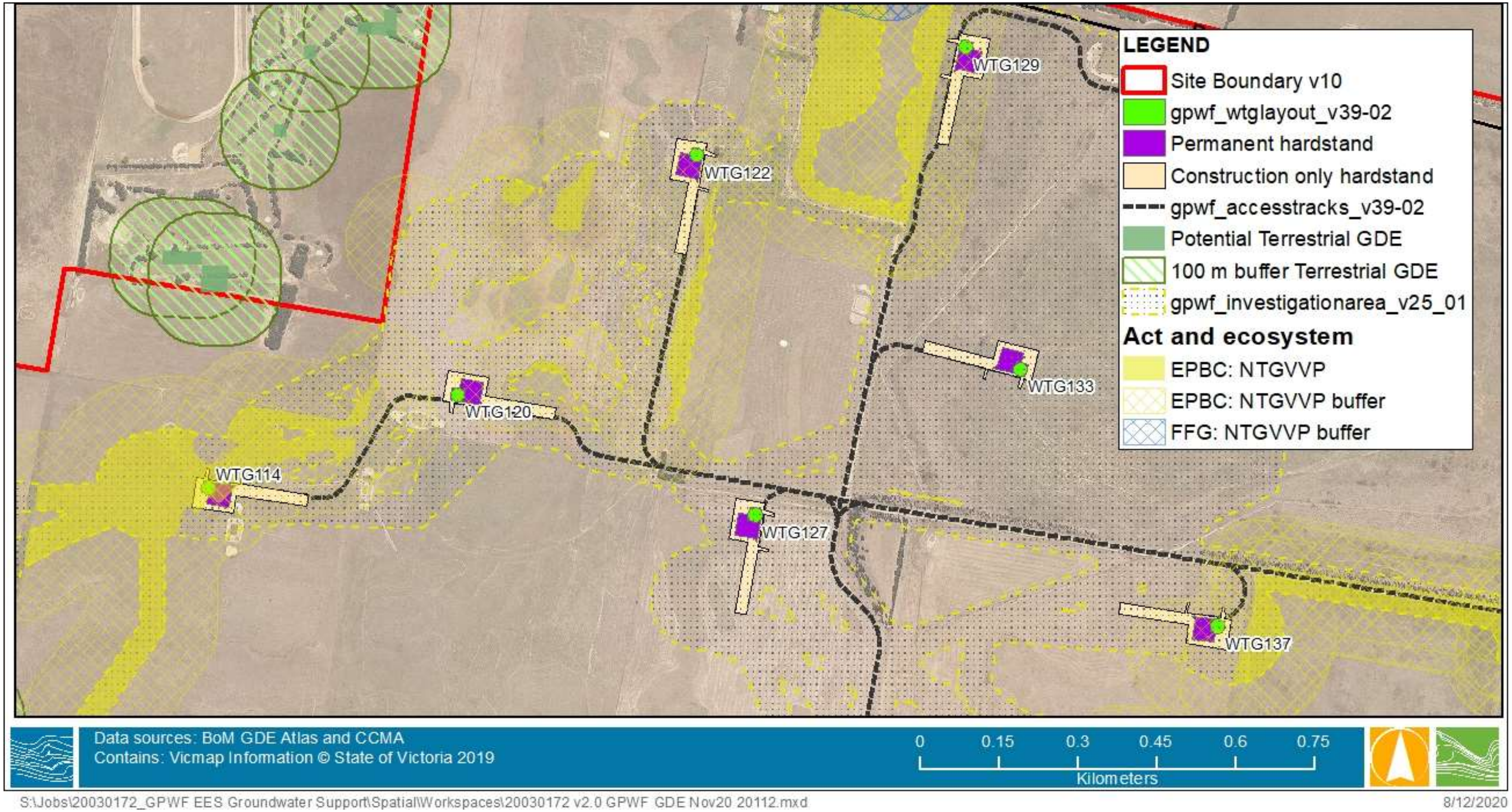


FIGURE D-19: WTG114, WTG120, WTG122, WTG129 AND WTG137 WITHIN 100 M OF NTGVVP

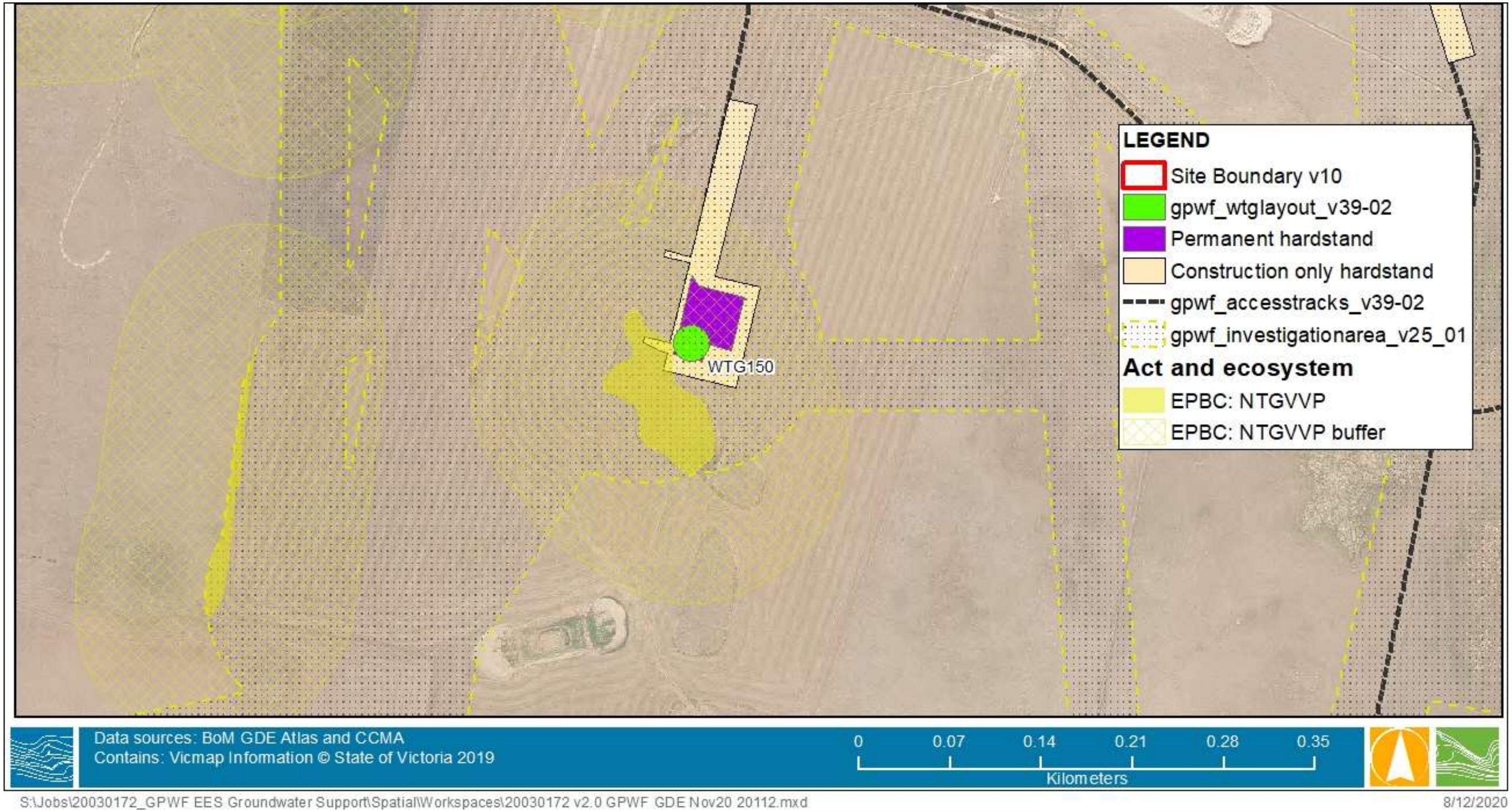


FIGURE D-20 WTG150 WITHIN 100 M OF NTGVVP

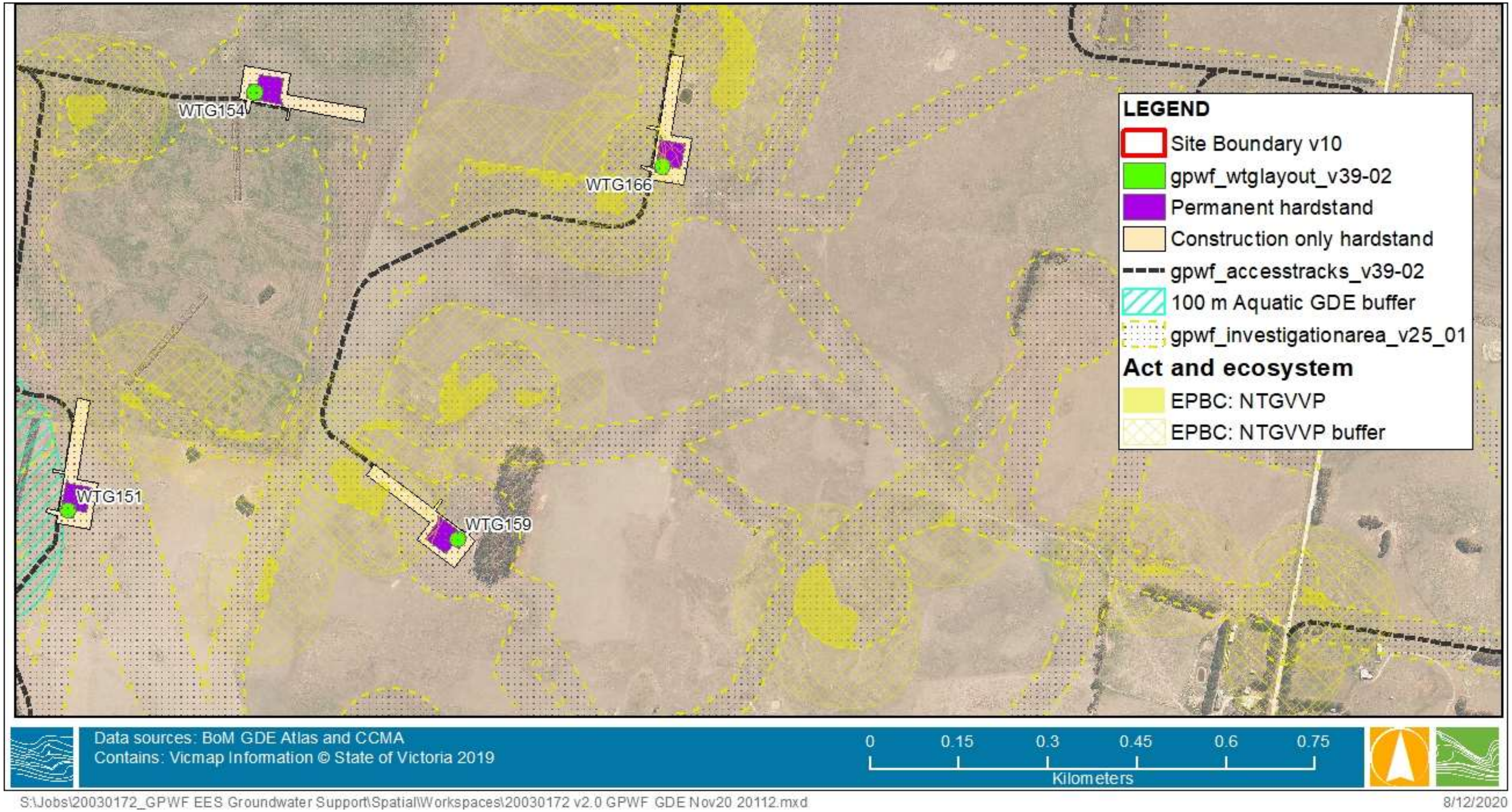


FIGURE D-21 WTG159 & WTG166 WITHIN 100 M OF NTGVVP

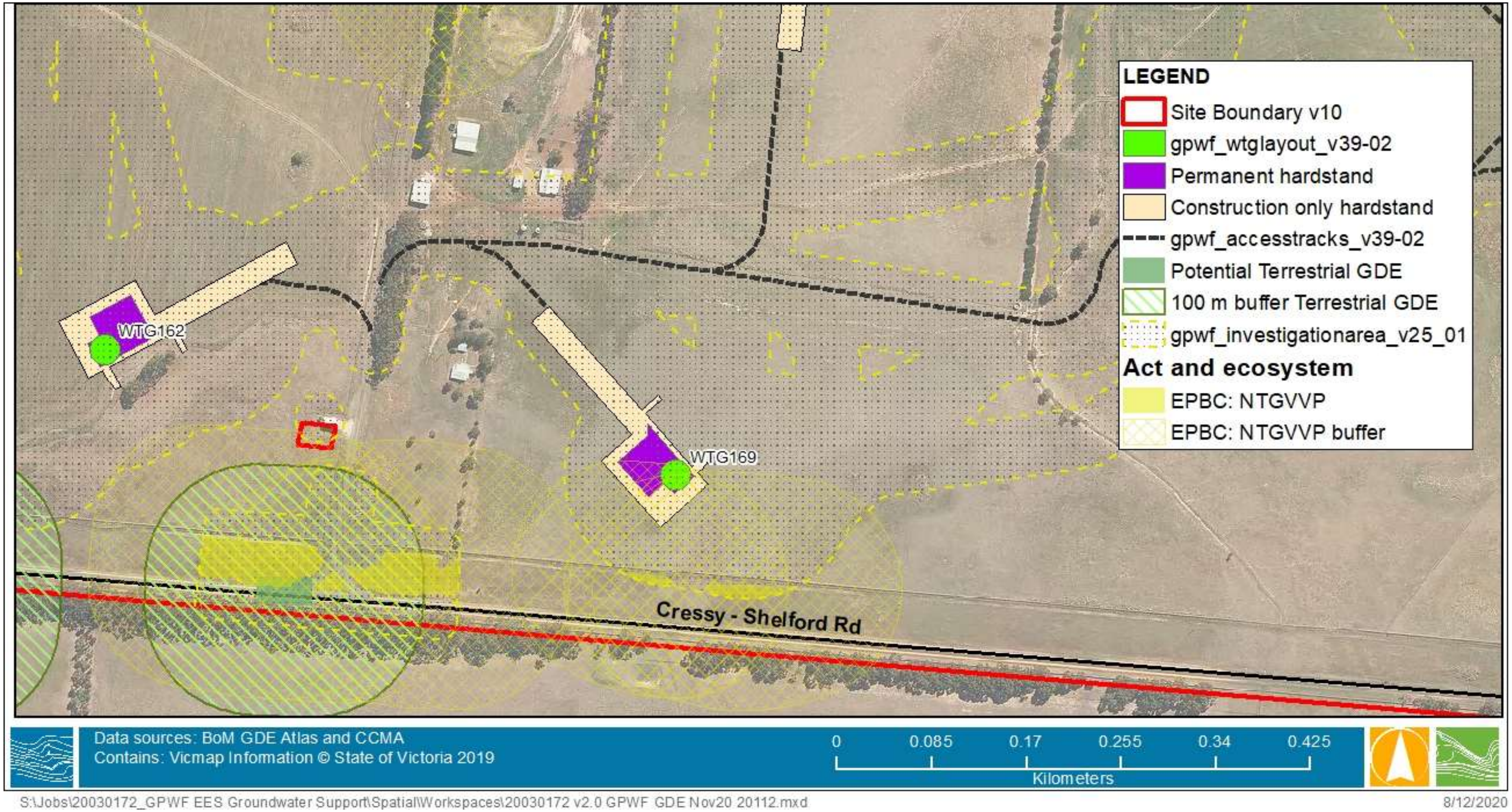


FIGURE D-22 WTG169 WITHIN 100 M OF NTGVVP

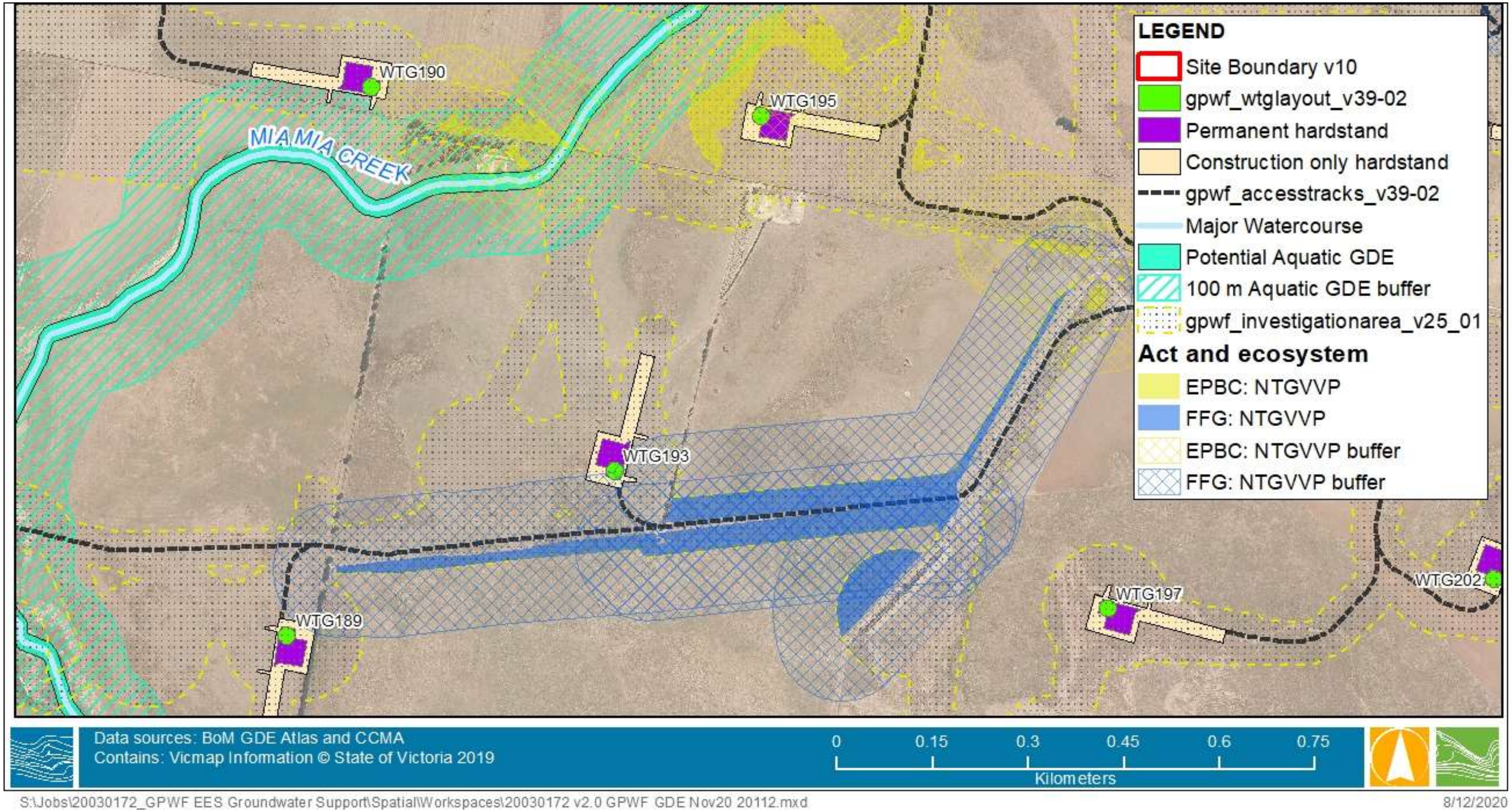
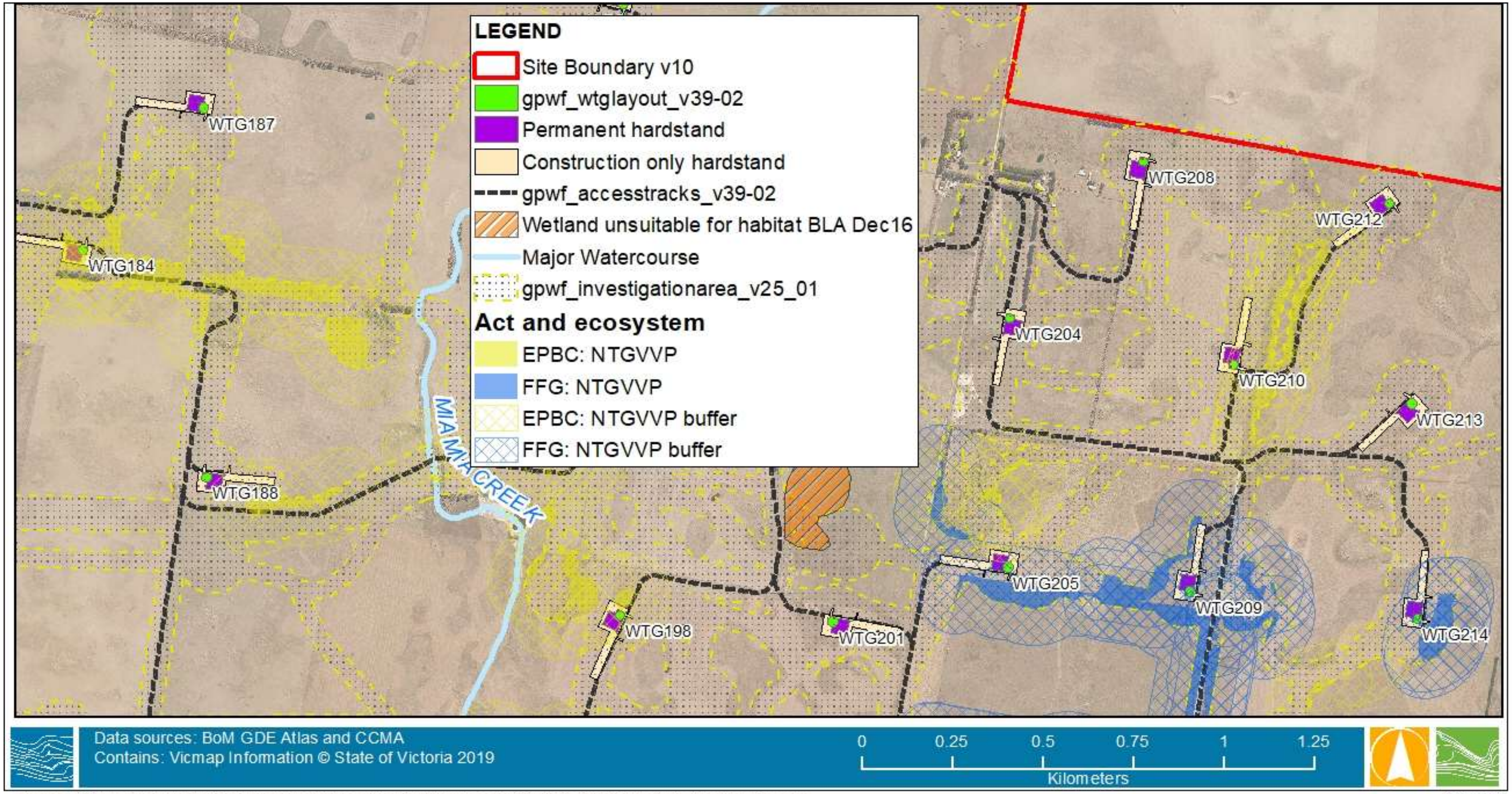


FIGURE D-23 WTG189, WTG190, WTG193 & WTG195 WITHIN 100 M OF NTGVVP



S:\Jobs\20030172_GPWF EES Groundwater Support\Spatial\Workspaces\20030172 v2.0 GPWF GDE Nov20 20112.mxd 8/12/2020

FIGURE D-24 WTG184, WTG188, WTG198, WTG205, WTG209, WTG210, WTG212 & WTG214 WITHIN 100 M OF NTGVVP

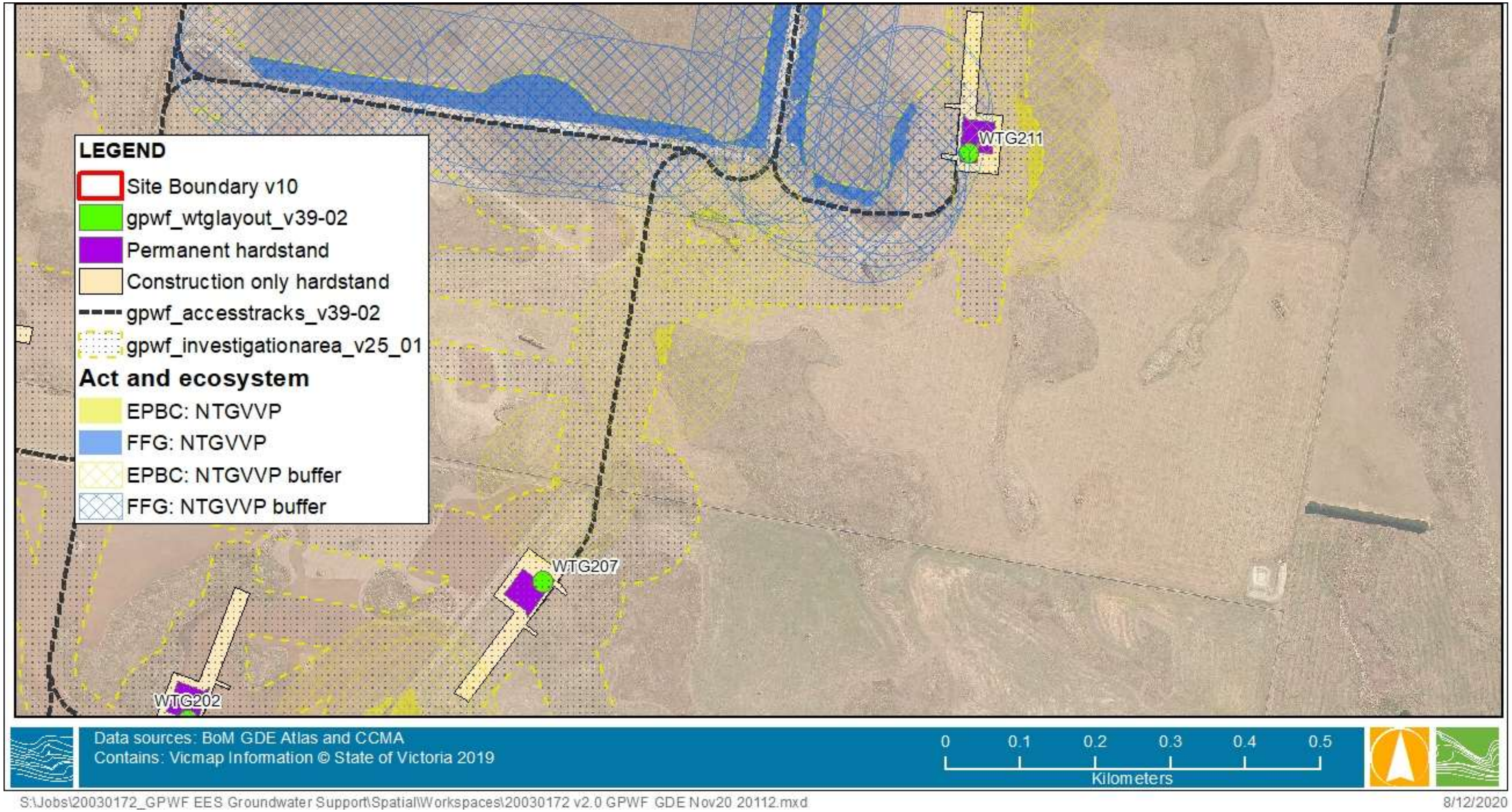


FIGURE D-25 WTG207 & WTG211 WITHIN 100 M OF NTGVVP

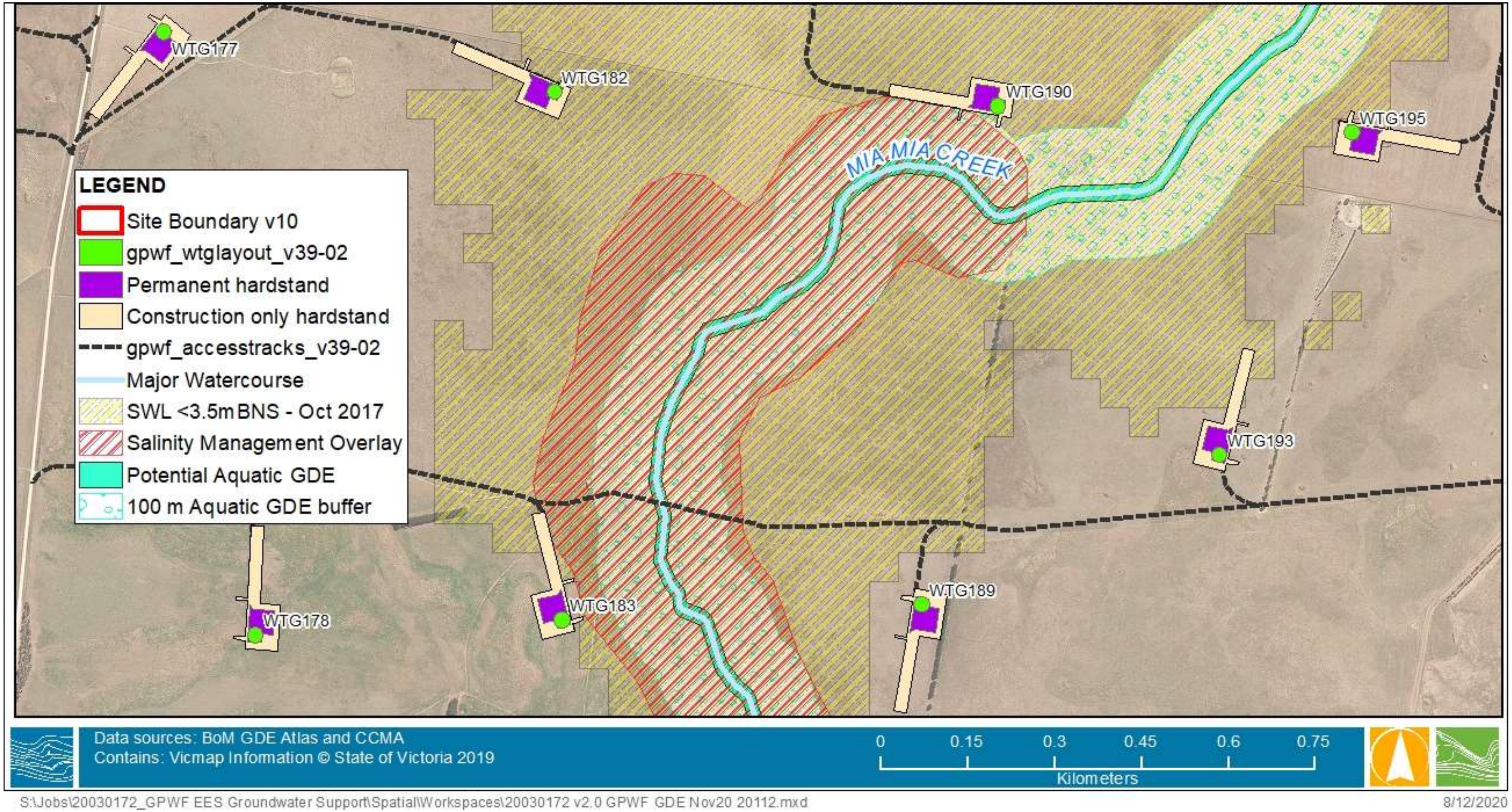


FIGURE D-26 WTG190 NEAR SMO, SWL<3.5 MBNS AND WITHIN 100 M FROM POTENTIAL AQUATIC ECOSYSTEMS. WTG183 ALSO IN SHALLOW SWL AND SMO AREA

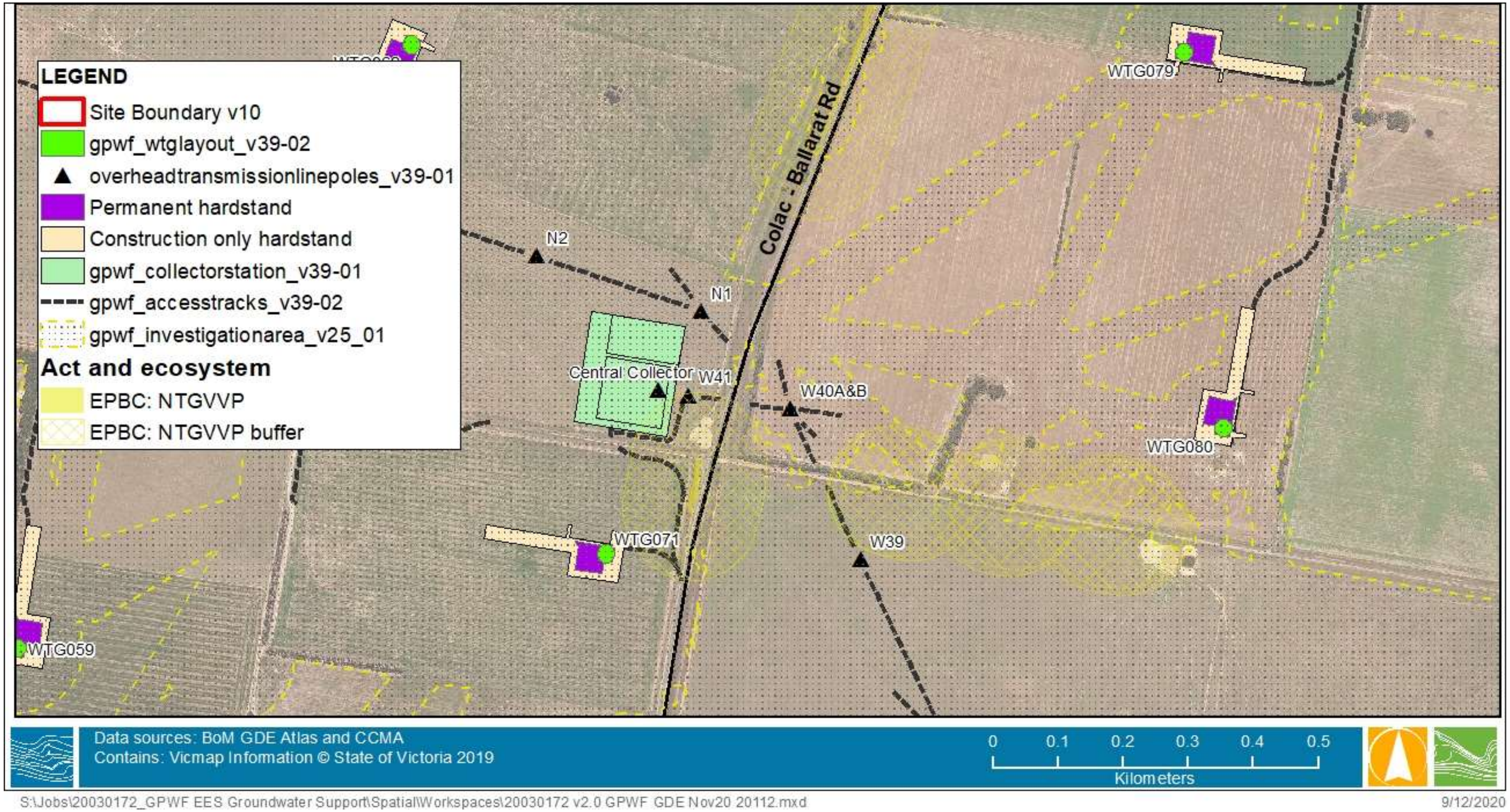


FIGURE D-27 CENTRAL COLLECTOR WITHIN 100 M OF MAPPED NTGVVP

Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800
Fax (03) 9558 9365

Adelaide

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Eastwood SA 5063
Telephone (08) 8378 8000
Fax (08) 8357 8988

Geelong

) Box 436
elong VIC 3220
lephone 0458 015 664

angaratta

st Floor, 40 Rowan Street
angaratta VIC 3677
lephone (03) 5721 2650

Brisbane

Level 3, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460
Fax (07) 3846 5144

Perth

Ground Floor
430 Roberts Road
Subiaco WA 6008
Telephone 08 6555 0105

Gippsland

154 Macleod Street
Bairnsdale VIC 3875
Telephone (03) 5152 5833

Wimmera

PO Box 584
Stawell VIC 3380
Telephone 0438 510 240

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