December 14

LOCAL WATER MANAGEMENT STRATEGY

MEADOWBROOKE LIFESTYLE ESTATE

PREPARED FOR: PRESTON GREEN PTY LTD

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Executive Summary

This Local Water Management Strategy (LWMS) has been prepared by MPM Development Consultants (MPM) on behalf of Preston Green Pty Ltd in support of the Development Guide Plan (DGP) for the Meadowbrooke Estate. The DGP proposal is to guide the development and infrastructure servicing of the site for a lifestyle village. The LWMS provides the strategy for the implementation of best management practises and principles of water sensitive urban design to ensure that total water cycle management is achieved within the DGP and its development.

The LWMS has been completed in accordance with the Better Urban Water Management (Western Australian Planning Commission, 2008), the constraints and opportunities identified in referenced consultant reports, information from state and local government authorities.

The total development area of Meadowbrooke Estate is approximately 11.18ha. The development is located approximately 400 metres north east of Boyanup. The structure plan area is generally bounded by the Preston River and reserve with a creek to the north and east, private properties and Turner Street to the south, and South West Highway to the west.

The site currently contains two function centres and a range of short stay accommodation options including self contained cottages and villas.

The land is zoned, "Urban" by the Greater Bunbury Region Scheme (GBRS). The Shire of Capel District Planning Scheme No. 7 zones the subject land; Residential R10/15, Special Use (Various) In May 2010, Amendment No. 46 to the Shire of Capel Town Planning Scheme No 7 'District Planning Scheme' was granted final approval resulting in the land being included within the 'Special Use' zone of Council's Scheme with the predominant use for the subject land being an 'Aged Person's Village'

The present Meadowbrooke development sits on relatively level terrain in the eastern portion of the site. The undeveloped western portion of the site is also relatively level however the northern edge of both areas drops away 5 to 6m towards the Preston River.

The preliminary geotechnical assessment generally indicated the presence of dry clayey soil and surface level with silty and sandy clay of medium to high plasticity, grading to clayey/silty sands in parts. GHD described the western portion of the site as Class H in accordance with AS 2870-1996 due to highly reactive clay present on site. It was noted that the site is not suitable for onsite disposal of surface water, due to its low permeability and offsite disposal will be required. This was confirmed in a subsequent report in 2014 by Douglas Partners in 2014, in addition to confirming the lower, central, northern area of the site being Class S.

The current ASS mapping on the WA Atlas website indicates that the development area is within an area of moderate to low risk of ASS occurring within 3m of the natural soil surface.

The proposed development is to consist of approximately 180 units/homes to form a lifestyle village development. The units/homes will be of modular construction, being constructed offsite and trucked to site fully completed. The existing buildings across the estate will be maintained and upgraded into Village Community buildings.

The development will be connected to the existing adjoining reticulated sewer infrastructure and will be provided with reticulated water. These services will be extended to each component of the proposed development, ensuring the entire development is fully serviced.

The 1 in 1 year ARI storm event management will utilise multiple bioretention basins across the development. The use of soakwells for the disposal of roof generated runoff has been considered unsuitable for the site based on geotechnical advice. The 1 year/ 1 hour storm event will be retained on the site within bioretention areas, to be of a minimum size equivalent to 2.0% of the impervious area of each catchment.

A standard network of grated stormwater collection pits and pipe network will convey storm events upto and including 1 in 5 year event to each catchments bioretention basin for treatment and detention. Each of the

basin will be constructed with high flow overflow structures and outlet pipework restricted to only permit outflow at the predevelopment rate.

The 1 in 100 year storm event will be transferred by the road network and the Community areas to the northern drainage reserve and the Preston River. It is not proposed to detain the 1 in 100 year storm event on the site to predevelopment rates, instead allowing the small development catchment to enter and exit the Preston River system prior to the peak flood levels occurring.

Hyd20 completed a flood study of the Preston River in order to determine the 1 in 100 year flood height of the river adjoining the development. Discussions between HyD20 and the Department of Water resolved that development on the site should also consider anecdotal evidence on a flood event that occurred in 1964. Both storm events were modelled and the department of Water recommended a minimum habitable floor level for all development to be 1.2m above the calculated 100 year flood levels. The relevant levels are tabled below;

Location	100 Year Flood Level Estimate	1964 Flood Level Estimate	Minimum Habitable Floor Level
Preston River Downstream Property Boundary	29.72	30.64	30.92
Preston River Upstream Property Boundary	30.24	31.12	31.44

The entire development site will be serviced with a subsoil system that will generally maintain the MGL across most of the site. It is proposed that the subsoil network will act to control the maximum groundwater levels along the southern boundary of the property, where on site groundwater monitoring has indicated that the groundwater is within 0.44m of the natural surface.

The development proposes to promote a range of water sustainability measures from fixtures and fittings through to education policies, including the implementation of rainwater tanks for non potable water sources on each of the proposed units/homes.

This LWMS will be implemented through conditional approval requirements of this DGP and further detailed engineering design details to be submitted for approval by the Shire of Capel, prior to the commencement of civil or building construction on the site. It is not proposed to undertake a subsequent Urban Water Management Plan (UWMP).

Local Water Management Strategy Checklist

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1.0 Introduction

Preston Green Pty Ltd propose to undertake development of Lot 888 Turner Road, Boyanup from its current short term accommodation use to a lifestyle village. MPM Development Consultants (MPM) has been engaged to prepare this Local Water Management Strategy (LWMS) to support the Department Guide Plan (DGP) also being prepared by MPM. A copy of the DGP is included as Attachment A.

The development area is located approximately 300 metres north east of the Post Office in Boyanup. The development area is generally bounded by Preston River and a reserve with a creek to the north east, Private properties and Turner Street to the South, and South West Highway to the West. The location of the site is shown in Figure 1 below.

Figure 1 – Location Plan – Courtesy of Landgate

The latest aerial photograph of the site is provided as Figure 2 below to illustrate the site condition and proximity to prominent topographic features.

Figure 2 – Aerial Photography – Courtesy of Google Maps

The LWMS provides the approach to total water management required to be undertaken with development of the land in accordance with the DGP in order to be consistent with Better Urban Water Management (WAPC, 2008).

1.1 Planning Background

The Meadowbrooke Estate area is zoned 'Urban' under the terms of the GBRS, whilst the land surrounding the Preston River is reserved as 'Regional Open Space' under the GBRS. Land to the west of the subject site is zoned 'Urban' whilst land to the east (on the opposite side of the Preston River) is zoned 'Rural'. Land to the south (on the opposite side of Turner Street) is reserved by the GBRS for rail purposes.

The Shire of Capel District Planning Scheme No. 7 zones the subject land; Residential R10/15, Special Use (Various), Foreshore Protection and Regional Open Space.

The Greater Bunbury Region Scheme (GBRS) is the statutory land use planning scheme for the Bunbury region. The functions of the Region Scheme are to reserve and zone land and control development on reserved and zoned land. The GBRS reflects the agreed strategic direction for land within the region and is a catalyst for changes to planning controls at the local level and subsequent local area planning.

Figure 3 – Cadastral Boundaries

1.2 Policies, Guidelines and Strategies

The LWMS utilises and refers to the following State Government Policies, published guidelines and key requirements.

- Better Urban Water Management (WAPC, 2008)
- Decision Process for Stormwater Management WA (DoW, 2009)
- Stormwater Management Manual for WA (DoW, 2007)
- Australian Rainfall and Runoff (Engineers Australia, 1987)
- Australian Runoff Quality (Eng Aust, 2006)

In addition, the following previously completed studies were reviewed and incorporated into this strategy.

- Douglas Partners - Report on Geotechnical Investigation – October 2014
- MPM Development Consultants – Groundwater Level Monitoring Report – December 2014
- GHD – Geotechnical Investigation – May 2008
- Hyd2O – Preston River Flood Study – August 2011
- SWCS – Groundwater Quality Analysis - 2011

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2.0 Proposed Development

In May 2010, Amendment No. 46 to the Shire of Capel Town Planning Scheme No 7 'District Planning Scheme' was granted final approval resulting in the land being included within the 'Special Use' zone of Council's Scheme with the predominant use for the subject land being an 'Aged Person's Village'

The development of Meadowbrooke Lifestyle Estate will address the strategic planning initiatives and objectives promoted by the Shire of Capel and the Western Australian Planning Commission (WAPC) for the Boyanup Townsite while also achieving two key WAPC policy objectives being:

1. greater housing choice and lifestyle opportunities for the ageing population; and,
2. affordability.

The proposal is supported by the Department of Planning's 'Greater Bunbury Strategy' which incorporates as one of its 'key outcomes' "*A range of housing types and lifestyle options will be provided across Greater Bunbury*."

In addition, the proposal is entirely consistent with the stated objectives contained within the Boyanup Townsite Strategy, in particular, the 'Aspiration' to "*Improve the attraction of the town as a retirement destination.*"

Clause 3.4 of the Shire of Capel Town Planning Scheme states:
"*No person shall use land or any building or structure thereon in a Special Use Zone, except for the purpose set against that land in Appendix 4 and subject to compliance with any conditions specified in the Appendix with respect to the land*."

The land is listed within Appendix 4 of the Shire of Capel Town Planning Scheme No.7 under its previous description of Lot 888 Turner Street, Boyanup. The list of permitted uses includes the following:

"*The Uses permitted will be in accordance with the interpretation of Aged Persons Village under the Scheme and the adopted Development Guide Plan relating to the zone.*
The following uses are listed as permitted uses:

- *Residential R40 – Aged Persons Accommodation*
- *Guest house/short term accommodation*
- *Community Centre*
- *Caretakers dwelling*
- *Car parking*
- *Administration office.*

Council may at its discretion determine and approve other uses that are considered to be ancillary and incidental to the objective of the zone.

Ancillary and incidental uses, Recreation Public, Recreation Private and Public Amusement uses may at its discretion of Council be approved in the zone for use of patrons and visitors, not being residents of the zone, subject to compliance with any standards, conditions or requirements specified by Council in conducting the use.

In considering the discretionary uses, the Council may invite public comment in accordance with Clause 8.2.3 of the Scheme prior to determining the use."

Appendix 4 lists the 'Development Standards/Provisions that apply to the land. These are summarised as:

- Council to adopt a Development Guide Plan and Design Guidelines Prior to development commencing on the land;
- Council may consider and adopt modifications to the Development Guide Plan and Design Guidelines.
- The objective of the Special Use Zone being to promote the development of a high quality Aged Persons Village which is in keeping with the character of the Boyanup town site.
- Development and use of the land to be generally in accordance with the Development Guide Plan and Design Guidelines.
- Preparation of a Local Water Management Strategy for endorsement by Council and the Department of Water.
- Aged Persons Accommodation to be developed to a density no greater than and in accordance with the R40 density code.

- Council's Planning Consent shall be obtained for the permitted uses prior to the commencement of the uses.
- A contribution towards community facilities except that Council may, subject to a formal agreement, consider wavering of contributions in part or whole.
- Dual use path linkages and associated facilities to be provided from the zone to the Town Centre facilities and services.
- Provision and possible upgrading of pedestrian and cyclist links.
- A traffic and pedestrian impact and management study to be undertaken.
- A contribution towards the upgrade of Turner Street and it intersection with *South West* Highway may be required.
- Development on the land to have due regard to the following:
  a) endorsed Development Guide Plan.
  b) endorsed Design Guidelines.
  c) parking requirements as required.
  d) connection to reticulated water, waste water and gas services.
  e) implementation of the endorsed Local Water Management Strategy through the preparation and submission of an Urban Water Management Plan.
  f) requirements of the traffic and pedestrian impact and management study.
  g) provisions of the Residential Planning Codes restricting occupancy of residential units on the site to aged persons (that is person aged 55 years or over).
  h) integration of the development with the adjacent local/regional open space and Boyanup urban area.
  i) Such other matters than may arise from the consideration of the integration of the development into the urban area of the town of Boyanup.
- "*Council may at its discretion vary the requirements of the Scheme in relation to the aged person's village where it is satisfied that the development is in accordance with the overall Development Guide Plan*."
- Preparation of a Foreshore Management Plan.
- Preparation of a Noise Management Study.
- Preparation of a Sustainability Outcomes and Implementation Plan.

'Aged Persons Village' is defined in the Scheme as meaning "*a building or group of buildings designed for residential occupation by aged persons and includes buildings and parts of buildings used for communal facilities, food preparation, dining, recreation, laundry or medical care*."

A development application is currently being prepared and lodged with the Shire of Capel. The application relates to the proposed development of a residential lifestyle village on the subject land to be known as '**Meadowbrooke Lifestyle Estate**'. The application also seeks the Shire of Capel's adoption of an amended Development Guide Plan and Design Guidelines for the proposed development

2.1 Site Context

The development site consists of 3 distinct areas, all within the proposed development lot. The entry to the site from Turner Street is the eastern elevated portion of the site and is the location of the existing infrastructure and buildings of the Meadowbrooke Estate. Feature survey of this area indicates elevations of 36.0m AHD. This area is bounded to the south by the railway reserve and the railway buildings presently being utilised by the Boyanup Mens Shed.

Figure 4 – Current Boyanup Mens Shed Courtesy of Google Street Smart

West of the existing infrastructure is an open paddock/grassland that connects the land parcel to the South Western Highway. This open area is bounded to the south by existing residential properties and to the north by a Shire drainage reserve. The open grassland area has indicative elevations varying between 36.0m and 35m AHD. The area exhibits signs of surface water logging in the winter months and likely consists of a clay subsurface.

Figure 5 – Open paddock/grassland Courtesy of Google Street Smart

The Third distinct area of the development site is the lower area to the north east of the site. This area currently contains a feature/landscape lake adjoining a slightly elevated central area containing fruit and decorative trees. With elevations in this area varying between 31.0m and 29.0m AHD, the area appears to be low lying however it does not exhibit signs of subsurface water in the winter, with the exemption of areas near the lake.

Image 1 – Lake Area

2.2 Landscape Concept

Although the central community open space is a major feature of the development site and dominates the overall plan, it is not proposed to implement large scale landscape design across this area.

The dominant feature of the area will be the landscaped lake, which will be tidied, enlarged to suit the stormwater requirements of the site and have its design amended where possible in accordance with the requirements for mosquito control. The second largest feature will be the community garden which is centrally located below the proposed clubhouse. This area will likely consist of a path network, seating areas and barbeques.

The bioretention areas are the next largest areas, which will be landscaped as part of the drainage infrastructure and will likely only be metered for the first summer. The Preston River Foreshore is not proposed to be landscaped at this stage as it is owned by the WAPC.

The remaining areas consist of the sloping terrain or batters to the river and drainage reserve, these areas will remain or be revegetated to native bushland planting areas, again requiring minimum reticulation for the first winter only. A detailed landscape plan will be created upon approval of the DGP, including the total planting areas, species and water use.

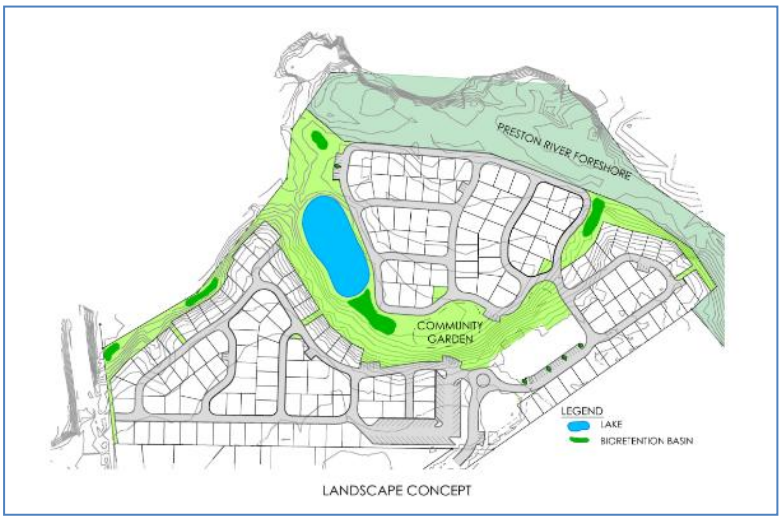

Figure 6 – Landscape Concept

3.0 Design Criteria

Table 2 – Design Criteria

Objective	Design criteria
Water conservation — potable and wastewater	
No potable water should be used outside of homes and buildings and achieve efficient use of scheme water, where alternative water sources are available.	• Consumption target for water of 100 kL/person/yr – as outlined in the *State Water Plan* (2007) – with an aspirational target of not more than 40–60 kL/person/yr scheme water, as provided in *Better urban water management* (2008).
Efficient Water Use	• Encouragement and advice to unit purchasers on water wise practices, such as water wise gardens and rain water re-use. • Implementation of water wise gardens to unit and road frontages. • Water wise, native planting to rehabilitation areas, minimization of grass/lawn/turf seeded areas.
Water supply	• Reticulated water supply to Authority and Australian Standard requirements with education to unit purchasers on water usage.
Wastewater	• Reticulated sewer network to Authority and Australian Standard requirements with education to unit purchasers on water usage and re-use.
Stormwater Management	
Extreme Storm Events	• Ensure overland conveyance to pre-development outlet location • Provision of earthworks to maintain minimum habitable floor levels 0.5m above the 100 year ARI flood event level.
Major Storm Events	• Provision of pit and pipe network designed to convey up to the 5 year ARI storm event. • Ensure site storage capable of maintaining pre-developed outflow rate for storm events up to 5 year ARI.
Environmental Flow	• Implementation of WSUD to all garden areas. • Encourage low nitrogen and phosphorous use by the Village management. • Retain and treat the 1 in 1 year 1 hour storm event on site. • Implementation of WSUD treatment areas at 2.0% of imperious catchment.
Groundwater Management	
Subsoil	• Subsoil drains to be provided with a free drainage outlet. • Subsoil located below the predevelopment GWL in the upper cress of site. • Implementation of subsoil network across the development to control potential post development groundwater rise. • Subsoil to be located at pre-development GWL within the lower areas of the site.

Objective	Design criteria
Development Levels	• Earthwork operations to establish development areas with adequate clearance above groundwater levels.
Infiltration	• All infiltration components to be located a minimum of 300mm above groundwater level.
Disease vector and nuisance insect management	
Mosquito Risk	• Undertake a review of the existing feature lake to bring it in line with the issues outlined in the *Interim position statement: Constructed Lakes (2007)*

4.0 Pre-Development Environment

4.1 Current Land Use

The listed present land use of the site is the Meadowbrooke Estate, consisting of short stay accommodation and restaurant facilities. The existing facilities occupy approximately 20% of the land area and have not been utilised for several years. The current owners of the property have kept up with maintenance and care of the facility inclusive of gardening, reticulation and mowing.

The property contains a small olive grove and an area of fruit trees that were utilised by the restaurant.

Image 2 – From the landscaped garden looking north to the Preston River

Image 3 – From the northern corner of the site looking south to facilities

4.2 Topography

A copy of the Feature Survey Plan is included as Figure 7 and within Attachment C.

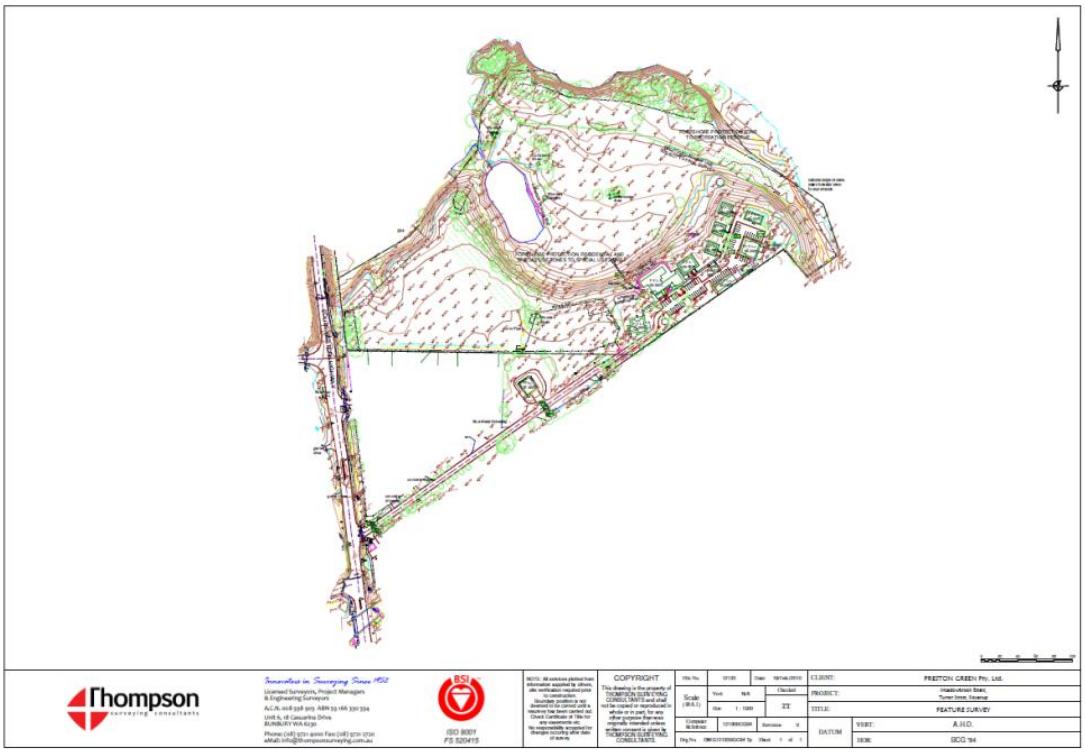

Figure 7 – Feature Survey Plan

The southern extent of the property is relatively flat with elevations of approximately 36.0m AHD to 35m AHD, with this land area 'wrapping' around a central but northerly located feature lake that includes elevations of 29.0m AHD.

The property falls to the north and east via the banks of a drainage reserve to the north and the Preston River to the east.

4.3 Climate

The area experiences a Mediterranean climate with warm dry summers and cool wet winters.

Rainfall monitoring (since 1898) at the Boyanup Bureau of Meteorology site 9503 indicates a mean average annual rainfall of 957.3mm with the highest average monthly rainfalls occurring in June and July.

4.4 Geotechnical

4.4.1 Geology

The site has had two preliminary geotechnical investigations undertaken within it. In May 2008 GHD undertook an investigation into the western portion of the site and in October 2014 Douglas Partners undertook an investigation into the lower eastern portion of the site inclusive of a review into the results from the earlier GHD investigation report. Copies of both reports are included as Attachment B.

The Douglas Partners report described the regional geology as;

"The Bunbury-Burekup 1:50 000 Urban Geology sheet indicates that shallow sub surface conditions beneath the site comprises alluvium and clayey materials of the Guildford Formation. The Guildford Formation is described as mainly alluvial sandy clay but it can be locally variable, comprising a variety of interbedded soils from sand to highly plastic, reactive clay".

The 2008 GHD geotechnical investigation involved 6 test pits excavated to depths between 1.7m and 2.2m and the 2014 Douglas Partners investigation involved 12 test pits excavated to a minimum depth of 3.0m.

The 2008 GHD report described the subsurface conditions in the western portion of the site as;

"In general, most of the test pits encountered clayey soils to depths between 1.7 and 2.2m. The soils variably comprised clay, clay with sand and sandy clay, with colour varying from brown, orange grey and red mottled grey. The strength varied from stiff at shallow depth, becoming very stiff to hard with depth. Laterite was encountered in three test pits below the clay layer. This varying composition of the clay is typical of Guildford formation."

The 2014 Douglas Partners report described the subsurface conditions in the eastern, lower portion of the site as;

"The investigation encountered interbedded soils with varying proportions of sand, silt and clay, which is typical of the Guildford Formation and consistent with the findings of the previous investigation. A summary of the general ground conditions encountered or inferred at the test locations is given below:

- *Topsoil – dark grey-brown, fine to medium grained silty sand topsoil with some rootlets to depths of between 0.1 m and 0.2 m below existing surface level at all test locations.*
- *Clayey Sand/Clayey Silty Sand/Clayey Gravelly Sand/Silty Sand – generally medium dense, dark grey-brown, orange-brown and red-brown, fine to medium grained clayey sand with varying amounts of silt and gravel, to depths of between 1.0 m and 3.0 m in the eastern site, except at TP01 where it was absent, and at TP10 to a depth of 0.8 m.*
- *Sandy Clay/Sandy Silty Clay – generally firm to stiff, medium to high plasticity, orange-brown mottled blue-grey sandy clay with varying silt and gravel content. This material was encountered underlying the predominantly sand layer described above in the eastern site and at TP10 from depths of between 0.8 m to 2.5 m to the termination depth of those test pits. It was encountered directly underlying the topsoil in the western site and at TP01 to depths of between 0.6 m and 2.2 m.*
- *Sandy Clay/Sandy Silty Clay – generally firm to stiff, medium to high plasticity, orange-brown mottled blue-grey sandy clay with varying silt and gravel content. This material was encountered underlying the predominantly sand layer described above in the eastern site and at TP10 from depths of between 0.8 m to 2.5 m to the termination depth of those test pits. It was encountered directly underlying the topsoil in the western site and at TP01 to depths of between 0.6 m and 2.2 m."*

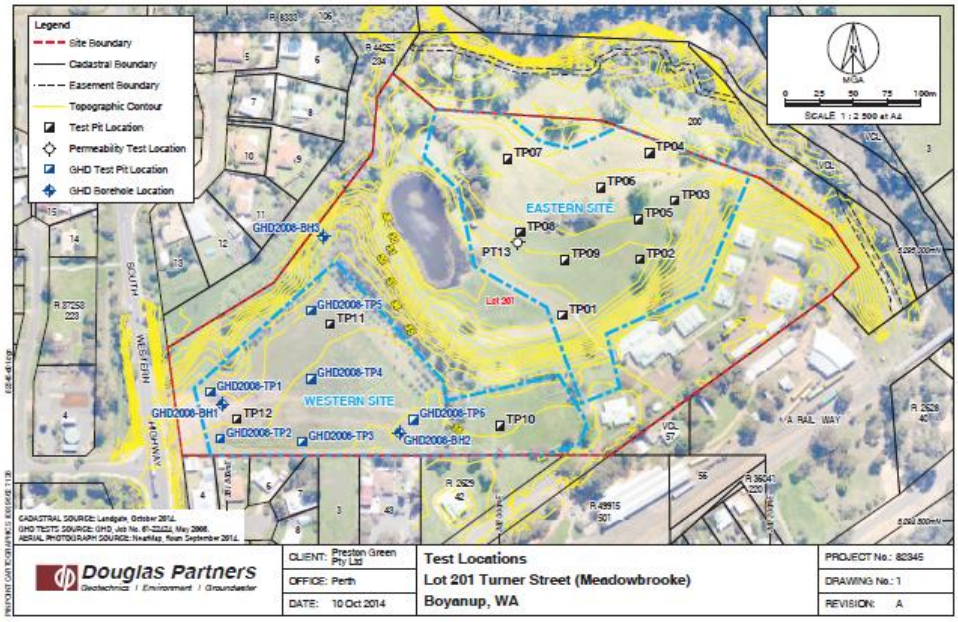

Figure 8 – Douglas Partners Test Pit Location Sketch

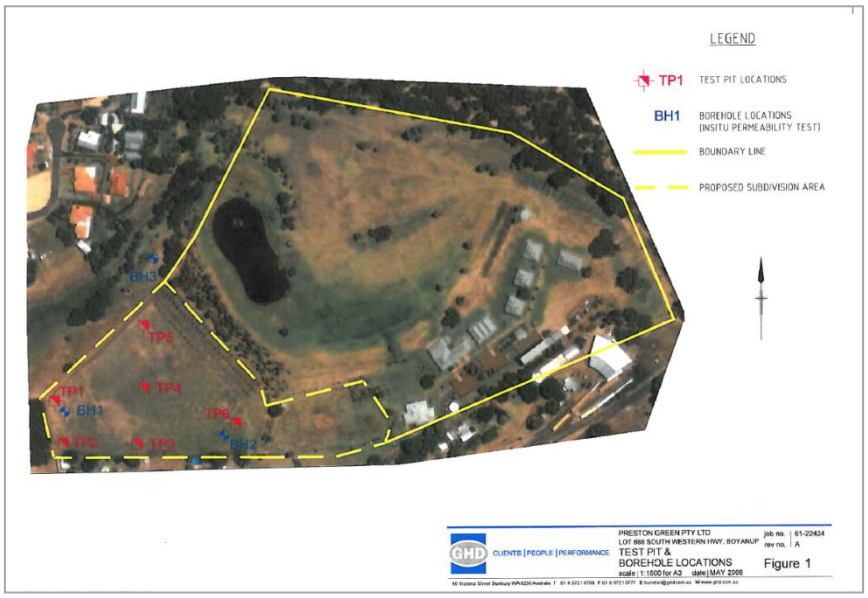

Figure 9 – GHD Test Results

Figures 8 and 9 above note the location of the GHD and Douglas Partners test locations relative to existing infrastructure within the site.

The 2008 GHD report provided the following conclusions and recommendations in relation to the western portion of the site:

"Based on the findings of the investigation, the in-situ material encountered in the proposed subdivision site is not suitable for onsite disposal of surface water, due to its low permeability. Offsite disposal will therefore be required.

In its current conditions, the general site classification of this site is conserved to be Class H in accordance with AS 2870-1996. This is due to the highly reactive clay present on site.

However, the site classification could be upgraded by placing an imported sand fill layer over the entire site. The site drainage will also be improved by raising the site with sand fill material.

In order to achieve Class S, a minimum depth of 1.0m well-compacted sand fill would be required. Prior to placing the sand fill, the site preparation for residential development should be carried out as follows:

- *Removal of the topsoil;*
- *The exposed clay will be susceptible to softening the disturbance, particularly during the wetter months of the year. Care should be taken during construction to ensure that the exposed clay is not disturbed further by keeping construction traffic off stripped areas and trafficking the sand fill;*
- *Place and compact sand fill in maximum 300mm thick layers and extending at least 2.0m beyond the building footprint; and*
- *The density of each layer should be checked by Perth Sand Penetrometer (PSP) testing with accepted criteria of a minimum 8 blows per 300mm penetration.*
- *Both edge beam and stiffening ribs could be founded within the sand fill, as this would be classified as Controlled Fill under AS 2870-1996.*

The earthworks for site should comply with AS 3798-1996 'Guidelines on earthworks for commercial and residential developments'. Upon completion of the site preparation, it is anticipated that the general site can be re-classified as Class S in accordance with AS2870-1996.(GHD 2008)

The 2014 Douglas Partners report provided the following site classification and comments in relation to the eastern and western portions of the site:

"As described in Section 4, the shallow ground conditions encountered at the test locations generally comprise medium dense clayey sand or firm to stiff sandy clay, with varying proportions of silt and gravel. The clay fraction was generally medium to high plasticity.

The predominantly clayey soils are present underlying the topsoil in the western site and at TP01, just below the embankment separating the two areas of the lot. In its current condition, based on the shrink-swell test result, this part of the site should be classified as Class 'H' in accordance with AS 2870-2011. The area of the site considered Class 'H' is indicated on Drawing 1, Appendix A. The site classification of the western portion of the site could be modified to an equivalent Class 'S' if a minimum depth of 0.7 m of well compacted non-reactive filling (clean sand) was placed above the current ground elevation. The site classification of this part of the site could be generally modified to an equivalent Class 'A' by increasing the thickness of the filling to 1.7 m.

Predominantly sandy soils underlie the topsoil in the eastern part of the site. In its current condition, based on the shrink-swell test result from the clayey sand, this part of the site should be classified as Class 'S' in accordance with AS 2870-2011. The site classification of this portion of the site could be generally modified to an equivalent of Class 'A' by placing a minimum depth of 1.7 m of clean sand above the existing surface elevation." (Douglas Partners, 2014)

In addition further discussion with Douglas Partners resolved that the western portion of the site could be improved to a site classification M if a minimum of 0.6m of clear sand fill was placed above the existing ground level.

Reference should be made to both the GHD and Douglas Partners geotechnical reports for site preparation, foundation design and Scope and Limits of the relevant geotechnical investigations.

4.4.2 Acid Sulphate Soils (ASS)

The current ASS mapping on the WA Atlas website, as per Figure 10 below, indicates that the development area is within a single distinct area of ASS mapping, being moderate to low risk of ASS occurring with 3m of the natural soil surface (yellow).

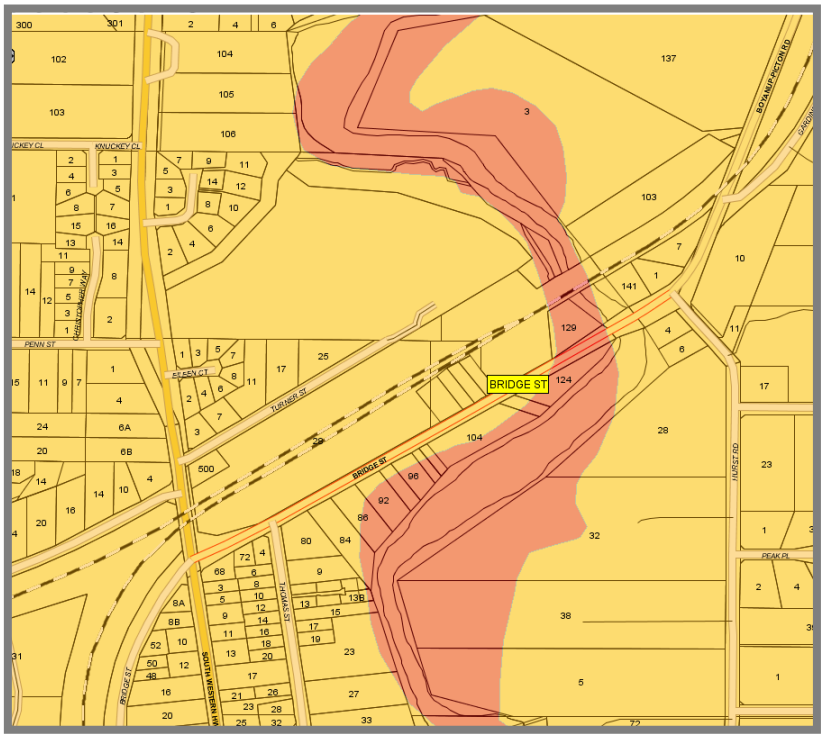

Figure 10, ASS Mapping, WA Atlas

The presence of the high risk area of ASS occurring within 3m of the natural surface as noted over the Preston River needs to be noted and may necessitate further investigation and management throughout design and construction process should major excavation and/or deep servicing be proposed.

Based upon the general ASS mapping and the likely extent of servicing at depth required, a preliminary acid sulphate soil investigation will be required to confirm the current regional scale mapping. Subsequent preliminary investigations may resolve that further detailed Acid Sulphate Soil investigations are required which are specifically based upon the depth and extent of anticipated ASS disturbance during servicing infrastructure installation.

4.4.3 Contamination

A review of the WA Atlas into potential contamination of land noted in December 2014 that the development site is not recorded as contaminated land.

No visual evidence exists on the property as at December 2014, of illegal dumping or potential areas of contamination.

4.5 Surface Water

Image 4 – Preston River in Flood

Image 5– Onsite Lake

4.5.1 Wetlands

The WA Atlas contains the DEC record of Geomorphic Wetlands of the Swan Coastal Plan. A review of this website indicates that a portion of the site is classified as a Multiple Use Wetland and therefore no restriction to development is applicable. The development site adjoins the Preston River, which under geomorphic wetlands classification is Conservation Category. No works are proposed adjacent to the Preston River and the Western Australian Planning Commission has purchased and reserved the Foreshore area between the development site and the river. A copy of the geomorphic wetland information is shown below as Figure 11.

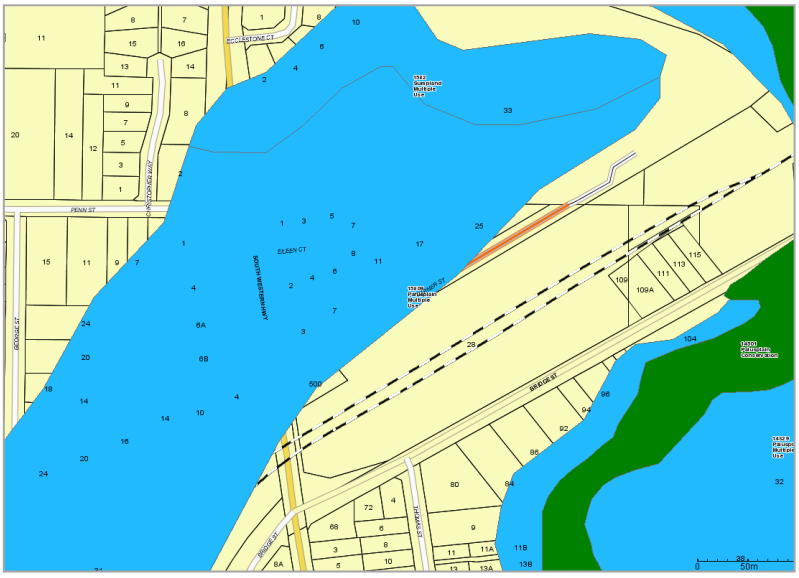

Figure 11 – Geomorphic Wetlands courtesy of WA Atlas

WA Atlas also contains the EPA's Environmental Protection Policy, Swan Coastal Lakes (EPP) record. The record indicates that the site or its near surrounds are not recorded as being part of the EPP.

4.5.2 Surface Water Bodies

The development site contains a manmade, landscaped lake that was previously utilised as a landscape feature by the short stay accommodation and restaurant.

The lake is approximately 3300m^2 in area and over the previous few years has appeared to have a steady top water level, based on observation during the groundwater bore monitoring across the site.

The construction methodology of the lake is unknown and further investigation has not been undertaken however anecdotal evidence from locals indicates that the lake is unlined but may have been created by shaping the subsurface clay.

4.5.3 Surface Water Hydrology

The development site can be simply described as two elevated portions of land overlooking the Preston River and a feature lake.

Essentially, the existing surface water hydrology consists of the land contouring and subsequently draining in a northerly direction to the Shire drain reserve or the Preston River.

There is a small drainage flow path on the western side of the property that has a relatively small catchment. The major drainage flow path is through the centre of the site, through the feature lake and a depression that exists between the elevated southern area and the lower, but marginally elevated area prior to the Preston River.

Attachment E indicates the predevelopment environment plan, clearly defining the existing surface water hydrology.

The site is defined as 6 different surface water catchments however only 2 of these catchments have defined outlet points, being the two flow paths as described above.

4.5.4 Preston River

The development borders the Preston River, which defines the property's eastern and northern boundaries. In order to confirm that the development site would be protected from any flooding of the Preston, the developer engaged Hyd20 to undertake the Preston River Flood Study.

Hyd20 undertook field investigations, research and estimation of design flows to conclude and recommend:

- *"The site has two watercourses requiring consideration in terms of flood management, the Preston River which runs along the north and eastern boundaries of the site and a smaller tributary which drains a local catchment running along its western boundary. The catchment areas of these watercourses are 808 km2 and 0.76 km2 respectively.*
- *Design flow estimates for the Preston River were calculated based on a range of different hydrological techniques. Flood frequency analysis based on gauged local data is considered to provide the best estimate for use in design. This provides a 100 year ARI peak flow estimate of 241 m3/s at the site, which is similar to the Water Authority (1989) estimate.*
- *For the small tributary, a 100 year peak flow of 0.64 m3/s is estimated based on XP-Storm modelling.*
- *A HECRAS model of the Preston River and small tributary was developed based on DoW LiDAR data and successfully calibrated using field observations and anecdotal information.*
- *Based on this model, the 100 year flood level of the Preston River is estimated to range from 29.74 m AHD at the downstream boundary of the site to 30.24 m AHD at the upstream boundary.*
- *Floodplain mapping indicates the proposed development is located outside the 100 year floodplain of the Preston River and small tributary, with existing natural surface levels having a clearance of approximately 5 m – 6 m above the adjacent 100 year flood level.*

- *The area within the site (outside of the main Preston River channel) which floods to 29.74 mAHD occurs due to backflow from the flood level in the Preston River, and filling this area would prevent this from occurring without affecting the 100 year flood level of the Preston River.*
- *The results indicate that there is additional land within the site located outside of the Preston River floodplain which may be also considered for development. It is recommended that advice on a suitable clearance above the 100 year flood level be requested from DoW in review of this report to inform the potential development opportunity of this land. " (Hyd2O, 2011)*

Table 3: 100 Year Flood Level Estimates at Key Locations

Location	100 Year Flood Level Estimate (m AHD)
Preston River Downstream Property Boundary	29.72
Preston River Upstream Property Boundary	30.24
Tributary Watercourse at South Western Highway	30.33

Table 1 – Courtesy of Hyd20 report

Subsequent to this report the DoW requested that additional modelling be undertaken to determine the effect on flood levels utilising the estimated peak flow of a flood event that occurred in 1964 on the Preston River. Hyd20 subsequently produced, in late August 2011, a letter to the DoW indicating the relative flood height increase associated with an estimated 4000m³/s flow occurring at the Boyanup Bridge.

The Hyd20 comparison between calculated flood levels and the 1964 flood level estimate, is shown below:

Table 1: Comparison of 100 Year ARI and 1964 Flood Level Estimates

Location	100 Year Flood Level Estimate (flow ~241 m³/s) (m AHD)	1964 Flood Level Estimate (flow ~400 m³/s) (mAHD)	Relative Flood Height Increase (m)
Preston River Downstream Property Boundary	29.72	30.64	0.92
Preston River Upstream Property Boundary	30.24	31.12	0.88

Table 2 – Comparison of flood level estimated - Courtesy of Hyd20 report

Subsequent to this additional information on the 25th August 2011, the DoW recommended:

"A *minimum habitable floor level 1.20m above the 100 year ARI flood level to ensure adequate flood protection is provided.*" Department of Water, Simon Rodgers, Email 25/8/2011.

A copy of the Preston River Flood Study, subsequent 1964 assessment and all Hyd20 and DoW correspondence is included within Attachment J.

In summary the relevant habitable floor levels for the development shall be;

Location	100 Year Flood Level Estimate	1964 Flood Level Estimate	Minimum Habitable Floor Level
Preston River Downstream Property Boundary	29.72	30.64	30.92
Preston River Upstream Property Boundary	30.24	31.12	31.44

Table 3 – Relevant habitable floor levels

4.6 Groundwater Hydrology

4.6.1 Groundwater Levels

The development site groundwater levels were recorded by MPM Development Consultants and reported in the Groundwater Level Monitoring Report of December 2014. A copy of this report is included as Attachment D.

Groundwater level monitoring took place to record two winter peak maximum ground water (MGL) levels through the 2011 and 2012 winters. A summary of the MGL's is shown below with the bore location plan.

Figure 12 – Location Plan – Courtesy of Landgate

BORE NO.	LOWEST GWL	DEPTH OF BORE	HIGHEST GWL	HIGHEST GWL (m AHD)	MONTH HIGHEST GWL RECORDED
1	Dry	3.02	0.75	35.48	Sept 2012
2	Dry	3.06	1.39	33.80	Aug 2011
3	Dry	3.01	Dry	-	-
4	Dry	3.04	Dry	-	-
5	Dry	2.98	2.63	26.99	Oct 2011
6	Dry	3.03	1.19	30.92	Aug 2012
7	Dry	3.96	0.91	33.48	Aug 2011
8	Dry	4.05	2.46	32.34	Aug 2011
9	Dry	3.00	0.44	35.54	Aug 2012

Table 4

Notes:
1. Highest/Lowest GWL noted in metres below Natural Surface
2. Depth of bore noted in metres below Natural Surface
3. A dry notation indicates that no groundwater level was recorded.

The report concluded "*Based upon the comparison to yearly total rainfall for Boyanup and a comparison to regional Department of Water groundwater bore data, it could be expected that the maximum groundwater levels across the development site could be marginally higher than those recorded in 2011 and 2012.*"

The report recommended "*The shallow maximum groundwater levels across the development site, particularly in the elevated but clayey areas of the site will necessitate groundwater management during construction and for development to occur.*

The shallow maximum groundwater will necessitate that appropriate strategies and plans are created to manage the groundwater resource.

These may include:

- *Subsurface/Subsoil Drainage to control/maintain maximum groundwater levels.*
- *Importation of fill to create additional separation of proposed infrastructure to maximum groundwater levels.*
- *Management and/or restriction of stormwater infiltration.*
- *Appropriate management of sewer effluent disposal.*

The proximity of the development site to the Ferguson River, a protected water body, will necessitate that any alteration to the existing groundwater regime should be carefully managed and future development should ensure that all groundwater extracted from subsoil networks will be tested to ensure it will not affect the Ferguson River.

A review of the sites groundwater quality will be required should groundwater control mechanisms be put in place with future development.

Groundwater management should be addressed within a subsequent Local Water Management Strategy or Urban Water Management Plan prior to development proceeding to ensure appropriate management and detailed design considers the groundwater resource." (MPM, 2014)

4.6.2 Groundwater Quality

South West Chemical Services (SWCS) undertook a suite of monitoring bore and surface water samples across the development in August 2011.

The report from SWCS noted "The results show nothing outstanding, no Petroleum Hydrocarbons, no Polynuclear Aromatic Hydrocarbons and no Organochlorine or Organophosphate pesticide residences."

A copy of the report is included as Attachment K, for reference.

The report did note monitoring bores 2 and 8 contained elevated levels of total nitrogen. Monitoring bore 2 is located near the old fruit orchard, which is likely the cause of this elevated result.

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5.0 Water Sustainability Initiatives

5.1 Water Supply

A requirement for development will be the connection of the site to the Water Corporations existing reticulated water supply scheme of Boyanup.

The site is currently serviced by a small 58mm water supply main in Turner Street, which will not be of sufficient size to accommodate the proposed development.

A 150mm diameter water main is located to the western boundary (South West Highway). It is proposed that reticulated water will be provided to each of the proposed unit sites via a water plumbing main circulating the site.

The units/homes will be constructed with 5 star building standards inclusive of water wise practises of water efficient fixtures and fittings.

5.2 Rainwater Tanks

It is proposed to implement rainwater tanks to all proposed lifestyle units across the development. As the development is a lifestyle village rather than a green title subdivision the land remains under the ownership and management of Preston Green. This allows for greater direction and control over the unit purchasers and allows the developer to require rainwater tanks rather than the purchase decision being left to the lot purchaser. Rainwater tanks will be provided as part of unit/home purchase.

The tanks will be utilised as a non-potable water supply for the units/homes providing toilet flushing water and a reticulation supply.

5.3 Water Wise Gardens

Lot scale water efficiency can be enhanced through the implementation of Water wise Gardens. The Water Corporation and Department of Water both provide information on the establishment and maintenance of water wise gardens with this information to be actively promoted by the Developer and eventual village manager.

The lifestyle estate will undertake the installation of all garden areas, inclusive of community areas as well as front and rear gardens of the units/homes.

Image 6 – Water Wise Garden

The front and rear gardens will be installed and maintained in accordance with the best water wise garden principles. This not only provides the lifestyle estate with a water sustainable solution but an economic saving with reduced demand for potable supply from the Water Corporations network.

At present the site is reticulated across the central northern area, the garden areas around the existing infrastructure and the olive and fruit tree orchards. The lower area reticulation will be removed along with the olive and fruit tree orchards. These areas are presently reticulated via the onsite bore and with additional supply as required from the landscape lake. It is proposed that these sources of reticulation water will also be utilised by the proposed development. In addition with each home/unit be provided with a rainwater tank for additional localised reticulation water.

5.4 Wastewater

Wastewater will be collected and transferred offsite by a network of developer funded and maintained, sewerage plumbing reticulation, transferring the generated sewer effluent to the Water Corporation sewer network in South West Highway. Based upon the existing contours across the site, the development will be required to install a gravity network of pipes that drain to the central low area of the site which will then be pumped via a small pump station to a new connection to the Water Corporation network.

6.0 Stormwater Management Strategy

The stormwater management strategy for the development of the Meadowbrooke Lifestyle Estate is to be undertaken in accordance with the guidelines of the DoW through Water Sensitive Urban Design (WSUD) and the requirements of the Shire of Capel.

The key components of the stormwater management strategy are;

- Treatment for the 1 in 1 year 1 hour storm event within the biofiltration basin.
- Collection and transfer of storm events up to 1 in 5 year ARI within a standard pit and pipe system.
- Detention of the 5 year major storm event with the biofiltration basin with outflow rate set in accordance with a predevelopment rate.
- Ensure passage of the 100 year extreme storm event directly to the Preston River to ensure it passes through the Preston River system prior to the river going to flood.

6.1 Modelling

The stormwater modelling has been completed utilising the Rational Method, based on the relatively small scale of the development area. The development site exists as multiple catchments and is modelled post development as the same multiple catchments.

A critical design criterion for the rational method includes the runoff coefficients which are shown below in Table 4.

LAND USE	RUN OFF COEFFICIENT		
	1 YEAR ARI	5 YEAR ARI	100 YEAR ARI
Predevelopment	0.15	0.15	0.15
Residential	0.5	0.6	0.8
Road Reserve	0.8	0.8	0.9
Community Garden Areas	0	0.2	0.2
Community Infrastructure Area	0.5	0.7	0.8

Table 4 – Runoff Coefficients

Multiple storm events have been modelled utilising the Rational Method as described in Australian Rainfall and Runoff (AR & R).

6.2 Predevelopment Peak Storm Flows

1 in 5 year event predevelopment out flow rates for each of the catchments have been calculated based upon a general run off coefficient of 0.15 with the peak flows being shown in Table 5 below:

	Runoff Coefficient	Peak Flow (L/S)
Catchment A	0.15	4.49
Catchment B	0.15	14.83
Catchment C	0.15	25.04
Catchment D	0.15	82.31
Catchment E	0.2	27.66
Catchment F	0.15	40.14

Table 5 – Predevelopment outflow rates

Rainfall intensities for the various storm events and storm durations are calculated and provided by the Bureau of Meteorology (BoM) computerised design IFD Data System (www.bom.gov.au).

6.3 Unit/Home/Building Level Stormwater Management

All units, homes and community buildings proposed within the development will be connected to its own rainwater tank with overflow pipework that connects to the proposed stormwater pipework in the road network.

The use of soakwells for the infiltration of roof generated stormwater at source has been deemed unsuitable for this site based upon the Douglas Partners geotechnical investigation which stated:

"Given the high clay content of the soils underlying the site and shallow perched groundwater, on site disposal of stormwater is considered unsuitable on this site."

6.4 Environmental Flow (1 Year ARI)

In accordance with the guidelines as provided by the DoW the development will undertake the retention of the 1 year ARI 1 hour storm event within the development. It is proposed that this retention be undertaken within a series of Bioretention basins at the outlet of each post development catchment. The biggest bioretention basin will be located within central, lower land adjacent to the landscaped lake which will form part of the major and extreme event detention storage areas.

The environmental flow 1 year stormwater strategy is indicated in Attachment F.

Image 7 – Landscape lake, already containing wetland vegetation.

The bioretention basins will be provided with a low flow subsoil outlets, amended soil base and vegetated with suitable, locally sourced nutrient stripping vegetation in accordance with the Stormwater Biofiltration system, Adaption Guidelines by FAWB and the recently released *Vegetation guidelines for stormwater biofilters in the south-west of Western Australia* and its accompanying Practice Notes. The indicative cross section of the largest central bioretention basin and Detention area (Lake) is included as Figure 13 below.

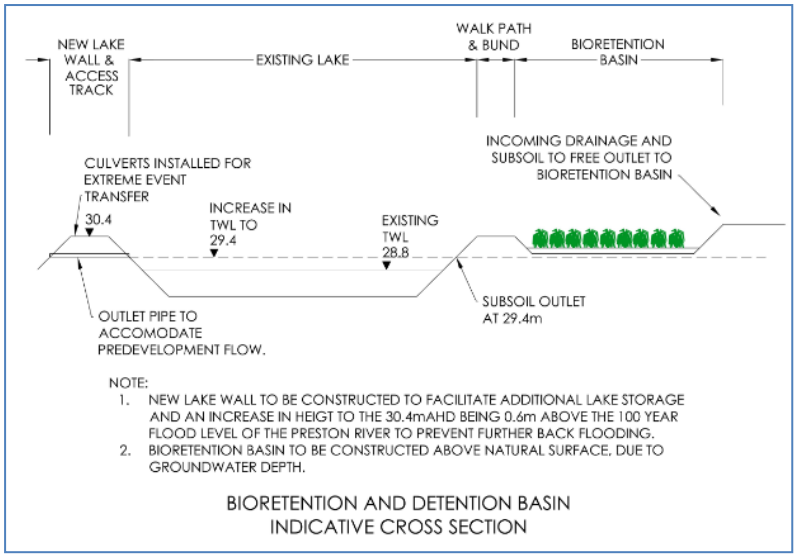

Figure 13 – Cross section of Bioretention Basin and Landscaped Lake Detention Area

The bioretention areas required have been calculated at 2.0% of the equivalent impervious area and are summarised as follows:

Post Development Catchment	Impervious Area (ha)	Retention Volume 1 year/1 hr (m^3)	Bioretention Area @ 2% (m^2)
1	0.238	42.5	48
2	0.427	76	85
3	2.727	485.5	545
4	0.327	58.3	65
5	0.591	105.25	118

Table 6 – Environmental Storm Event

Table 7 below provides a summary of the expected pollutant removal efficiencies for the proposed environmental flow WSUD options, as provided by the DoW's Stormwater Management Manual for WA.

Parameter	Design Criteria via BUWM	Structural Controls Nutrient Output Reduction	
		Vegetated Swales/Bioretention Systems	Detention/Retention Storages
Total Suspended Solids	80%	60-80%	65-99%
Total Phosphorus	60%	30-50%	40-80%
Total Nitrogen	45%	25-40%	50-70%
Gross Pollutants	70%	-	>90%

Table 7 – BMP Water Quality Performance in Relation to Design Criteria

In order to facilitate a single, controlled outflow point for each post development catchment, given that 4 of the existing catchments discharge surface waters via sheet flow, it has been necessary to adjust the predevelopment catchment areas. The post development catchments generally discharge to the same surface water body externally of the site, however a single discharge point allows for treatment and detention of the post development generated stormwater to occur within the site.

The proposed predevelopment peak outflow rates to align with the post development catchments are as follows:

- Catchment 1 to consist of combined predevelopment catchments A and B.
- Catchment 2 to consist of predevelopment catchment C.
- Catchment 3 to consist of predevelopment catchment D.
- Catchment 4 to consist of predevelopment catchment E and 50% of predevelopment catchment F.
- Catchment 5 to consist of 50% of predevelopment catchment F.

6.5 Major Flows (5 Year ARI)

The development proposes a series of grated collection pits within a sealed and kerbed road network for the collection and transfer of major storm events.

Each of the homes/units will be connected to this stormwater network via a pipework connection located at each sites frontage. Stormwater from each home/units gutter will then connect directly to the road network after passing through or overflowing off the home/units rainwater tank.

Although not in accordance with the Best Management Practice of disposing of stormwater as close as possible to source, the existing geotechnical conditions do not allow infiltration adjacent any infrastructure. Therefore it is not proposed to utilise soakwells.

The detailed design of the pipe and pipe network will form part of the detailed engineering designs of the Building License submission. The concept design for the management of the major storm event is included in Attachment G.

The relevant detention volumes, peak discharges and outlet controls are summarised as follows with visual representation included on the stormwater management plan, for each catchment:

Catchment	Peak Flow (L/S)	Predevelopment outflow rate (m^3/s)	Detention required (m^3)	Outlet required (m)	Outlet grade 1 in ?
1	78.92	0.019	43	0.15	90
2	119.40	0.025	76	0.15	55
3	380.80	0.080	626	0.3	220
4	108.1	0.028	58	0.15	50
5	159.2	0.040	125.02	0.225	180

Table 8 – Detention Volumes Major Flows

Levels of outlets, basin base and top water levels have not been provided as part of the LWMS as detailed survey will be required of each basin location to confirm relevant heights and existing vegetation. An indicative cross section of the smaller bioretention areas and associated retention/detention basins is shown below as Figure 14.

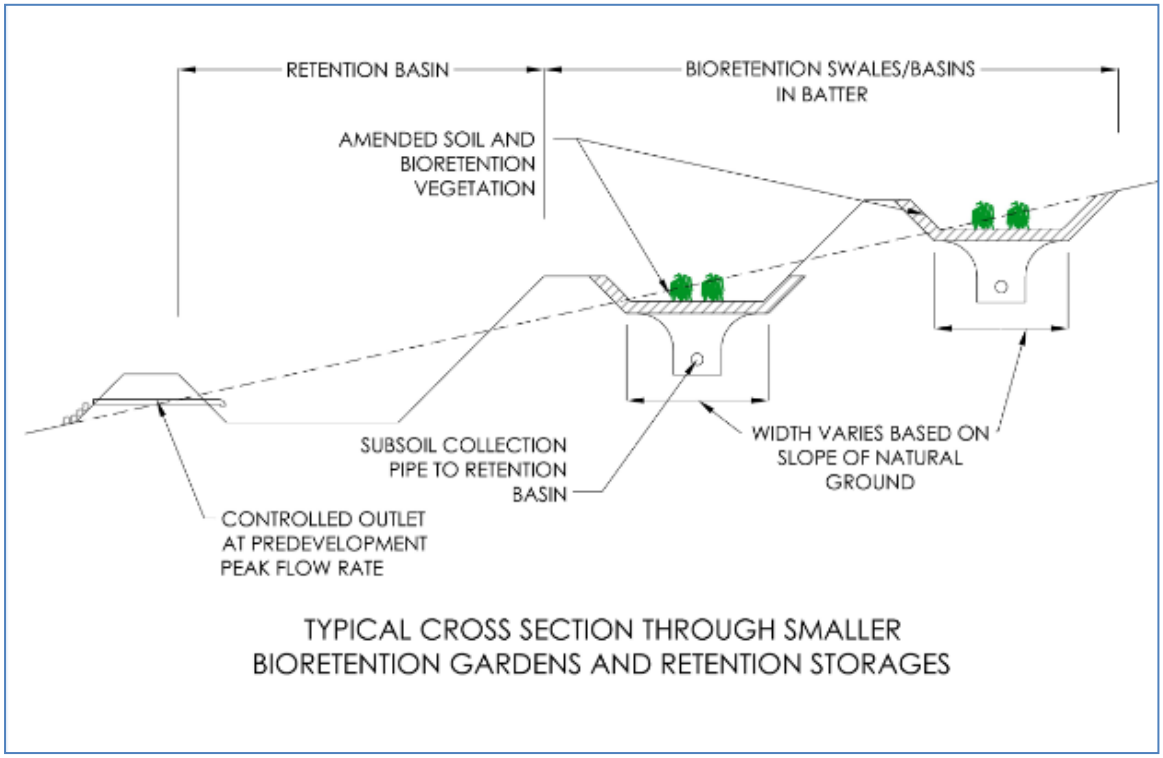

Figure 14 – Cross section of Bioretention Basin and Landscaped Lake Detention Area

6.6 Extreme Flows (100 Year ARI)

The development will include a network of road reserves that will generally grade in accordance with the current natural surface contours of the land. Amendments to these existing contours will occur to ensure that the proposed roads meet minimum grade criteria for drainage and Australian Standards. The detailed design of this road network will occur as part of each building license submission.

The road network in conjunction with the central community garden, bioretention basins and landscape lake will act to convey the extreme event storm from the developments catchment, through the development and directly to the northern drainage channel or the Preston River.

It is not intended to detain the extreme storm event to a predevelopment rate but rather, given the small scale of the development, allow the event to discharge from the site and enter the Preston River. The likely time of concentration for a 100 year event on the site is less than an hour whereas based on the extent of catchments as indicated in the Hyd20 Preston River Flood Study Report the time of concentration from the entire Preston River catchment is likely to be days.

The conveyance direction and flow paths of the extreme event are indicated on the 1 in 100 STORMWATER MANAGEMENT STRATEGY included within Attachment H. The relatively small size of each catchment prior to discharge to the northern drain, the Preston River Foreshore or the central low area containing the bioretention basin will ensure that the proposed road network will be capable of conveying events up to the 1 in 100 year extreme storm event.

The development must not only manage extreme storm events from within its own catchment but it shall undertake management and infrastructure in order for the development, and ultimately people's homes, to protect them from extreme events occurring on the Preston River catchment.

Based upon the advice of the Department of Water, as stated within section 4.5.4 of this strategy, the calculated 1 in 100 year flood levels for the development vary from 30.24m AHD at the upstream property boundary to 29.72m AHD at the downstream property boundary. In addition, the development should take into consideration back flooding in the drainage channel to the north of the property which will have a 1 in 100 year flood level of 30.33m AHD at South Western Highway.

In accordance with DoW recommendations all development will be earthworks and/or filled to ensure that the minimum habitable floor level will be 1.2m above the calculated 1 in 200 year flood levels. These minimum fill levels are shown below in table 9.

Location	**Minimum Fill Level to Habitable Floor Level**
Preston River Downstream Property Boundary	30.92m AHD
Preston River Upstream Property Boundary	31.44m AHD
Tributary Watercourse at South West Highway	31.53m AHD

Table 9 – Minimum fill levels

7.0 Ground Water Management Strategy

The development proposes to install a network of subsoil pipework to manage the groundwater levels and any potential groundwater rise due to development depending on the various maximum groundwater levels recorded across the site. The strategy's core principle is to maintain the existing maximum groundwater levels across the lower, northern portion of the site but control the maximum groundwater levels within the eastern portion, around the existing infrastructure and within the western portion that adjoins existing Turner Street residents.

The groundwater levels through the central northern portion are likely linked to the Preston River, which could be termed a groundwater dependant ecosystem. This area exhibited groundwater levels approximately 3.0m below the surface, well below the 1.2m to 1.5m minimums for separation to infrastructure. The flood management requirements for the development will also require additional fill in this area varying between 1.5m and 0.5m.

Within the eastern portion of the site, below the existing buildings on the site, the groundwater was not recorded. Monitoring Bore 1 recorded a MGL of 0.75 below natural surface to the west and monitoring bore 2 recorded a MGL of 1.39 below natural to the east of the site. It is proposed that the finished earthwork levels within this eastern portion will remain as they currently are, in order that the new modular homes and road network blend with the existing community infrastructure. It is therefore proposed to install a subsoil drain network to the southern boundary of the site and within the road network approximately 1.2m below the natural surface. The control of the maximum groundwater level in this portion of the site will not affect the Preston River, as subsoil inverts will be approximately 34.0 to 35.0m AHD and the standing water level of the Preston River is 25.65m AHD.

This subsoil network will interconnect with the stormwater drainage pipework and outflow to the proposed bioretention basins, ensuring all collected groundwater is treated through biofiltration prior to exiting the site.

Within the western portion of the site, 4 of the onsite groundwater monitoring bores are relevant;

	Depth to MGL
Monitoring Bore No. 1	0.75m
Monitoring Bore No. 7	0.91m
Monitoring Bore No. 8	2.46m
Monitoring Bore No. 9	0.44m

Table 10 – Site Monitoring Bore MGL's

Monitoring Bore 7 and 8 are likely affected by the drawdown of adjoining northern Drainage Reserve and monitoring bores 1 and 9 indicate very shallow groundwater.

The geotechnical report produced by GHD and confirmed by Douglas Partners indicates that this portion of the site is classified as 'H' in accordance with AS2870. Information from the supplier of the modular homes has indicated that they will require an 'M' classification for the proposed building footing requirements. In order to transform the 'H' classification to an 'M' classification Douglas Partners have recommended that a minimum of 0.6m of clean sand be placed above the existing ground.

It is therefore proposed to undertake earthworks across this western area to remove 0.6m of existing clay material along the southern boundary of the site, graduating to 0.3m of fill in the vicinity of monitoring bore 7.

The clay will be replaced and additional fill imported to a minimum of 1.2m of clean sand fill. A sub soil network will be installed along the southern boundary of the property and within the road network. The

subsoil network would be interconnected with the stormwater system with all groundwater treated through the biofiltration areas prior to discharge.

Discussions are currently ongoing with the supplier of the modular homes to determine what is an appropriate level of separation between the base of the modular home footings and a maximum groundwater level. Should the builder allow a reduced separation between footing and maximum groundwater level based upon additional structural amendments to the units/homes, the depth of excavation and depth of fill above natural surface will be reduced.

Fill sand utilised for the development should meet the following specification:

Imported clean sand fill, shall be approved for use by the Superintendent prior to any of the fill being carted onto the site. Imported clean sand fill shall;

- not contain contaminated, organic or deleterious material,
- not contain dangerous or toxic material, metallic objects, rubbish, plastic or any other waste material,
- be free draining, with a hydraulic conductivity greater than 4.0m per day when compacted to the specification,
- have a minimum 4 day soaked CBR value of 15.% when compacted to 95.0% MDD,
- be clean, cohesionless material,
- have a linear shrinkage of 1.0% for the portion of a sample passing the 0.425mm sieve,
- be non-plastic, with a plasticity index of 0.0% for fractions finer than the 0.075mm sieve, and
- have a particle size distribution conforming to the following table.

AS Sieve (mm)	% passing (by mass)
9.5	100
4.75	80 to 100
2.36	40 to 100
1.18	20 to 100
0.425	10 to 60
0.075	0 to 4

Table 11 – Fill Sand PSD

7.1 Acid Sulphate Soil Management

As described in Section 4.4.2 the development site is recorded as having a low to moderate risk of ASS at depths greater than 3.0m. Although ASS is unlikely to be present, it is noted that the subsoil network will be placed below the AMGL but the site is to be filled. Therefore preliminary assessment of the sites subsurface materials to check for the presence of ASS/PASS will be required. Details of this investigation and its results will be included at the detailed engineering design stage.

All assessment and management of ASS will be undertaken in accordance with ASS guidelines of the DER.

7.2 Groundwater Quality Management

In order to maintain or improve the groundwater quality it is proposed that the network of subsoil pipe work, as per the stormwater pipe work will be discharged to bioretention area that forms part of the Detention Basin Area. This will enable all collected subsoil to be treated through a Water Sensitive Urban Design Best Management Practice prior to discharge to the external environment.

8.0 The Next Stage - Subdivision and Urban Water Management Plan

In accordance with the recommendations of the Department of Water, detailed engineering designs will be provided to the Shire for compliance with the LWMS at each stage of building development. Prior to the application for building permits of each of the units/homes the Developer will lodge for approval the designs providing detailed stormwater and groundwater management infrastructure.

This LWMS provides the strategy to address structure planning related water management considerations, the detailed engineering design will clarify and refine these considerations.

The detailed engineering designs will be required to include:

- Confirmation of compliance with the recommendations and criteria of this LWMS.
- A preliminary investigation and assessment of ASS across the development site.
- Detailed stormwater drainage design of the pit and pipe work.
- Detailed detention and bioretention basin design including; batters, inverts, dimensions, depth, access protection, inlet control and outlet control.
- Groundwater subsoil control pipe work
- Earthworks design based on the combined requirements of groundwater separation, flood level separation, geotechnical fill and footing requirements of the modular homes.
- Management of development works.
- POS design, including confirmation of extent of seeded turf/grass and native planting areas.

The preparation of the proposed detailed engineering designs will be the responsibility of the developer as a condition of the approved DGP and will be undertaken prior to construction commencing on the property.

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9.0 Monitoring

9.1 Post Development

Post development monitoring should be undertaken to both surface water flows and groundwater monitoring bores to determine any effects of development.

The location of these monitoring base locations will be determined at detailed design stage based upon the existing monitoring bore locations and should they exist within public or private landholdings. The single outlet of each bioretention basin will provide an obvious test point for post development water quality.

The post-development testing regime shall include 6 monthly (Oct and April) testing of groundwater levels and groundwater quality. The outlet of each bioretention basin should also be tested 6 monthly during or within 24 hours of a storm event.

The groundwater and outlet water should be quality checked for the following parameters:

- pH
- Electrical Conductivity
- Total Nitrogen
- Total Kjeldahl Nitrogen
- Ammonia
- Nitrate
- Nitrile
- Total Phosphorus
- Filterable Reactive Phosphorus
- Arsenic
- Cadmium
- Chromium
- Copper
- Lead
- Mercury
- Zinc
- Manganese

All sampling and testing shall be undertaken by a NATA certified at approved testing agency/laboratory.

Monitoring shall continue for 2 years post construction completion.

9.2 Trigger Values and Contingency Action Plan

The trigger values for action shall be those as defined by the Anzecc Guidelines but shall be exactly determined post groundwater quality monitoring. Consideration should be included to consider second trigger like criteria being a significant (20-25%) increase in recorded values between monitoring events.

Should trigger values be exceeded during a monitoring event, the first course of action shall be a simple re-test of the bore or outlet to confirm validity of test.

The second course of action shall be the isolation of exceedence source via testing of the inlet and outlet locations of both the stormwater and subsoil pipe networks to isolate the potential area of exceedence.

The third course of action should determine the location of the exceedence and potential reason which can then be rectified, through notification and education or removal.

Additional monitoring events should be undertaken upon notification and education or removal at monthly intervals to confirm a return to normal results.

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10.0 Implementation

This LWMS provides the water management framework for the proposed DGP. As such amendment of the DGP through its review and adoption by the Shire of Capel and the WAPC may require amendment to the LWMS.

The responsibilities of the LWMS are summarised below in Table 11.

Implementation	Preston Green	Shire of Capel	DoW	Home Purchaser
Geotechnical and ASS review	✓			
Detailed Engineering Water Management Design	✓			
Approval of Detailed Engineering Water Management Design		✓		
Implementation of Unit/House Rainwater Storage and Fe-use system	✓			✓
Construction of Stormwater and Groundwater Infrastructure	✓			
Post Construction Maintenance or Stormwater and Groundwater Infrastructure	✓			
Post Construction Quality monitoring for 2 years	✓			

Table 12 –Responsibilities of LWMS

References

Argue J.R., 2006, WSUD: Basic Procedures for 'Source Control' for Stormwater: a Handbook for Australian Practice.
Department of Water, 2008: Developing a Local Water Management Strategy.
Department of Water, 2007: Stormwater Management Manual for Western Australia.
Engineers Australia, 2006: Australian Rainfall Quality (ARQ).
Engineers Australia, 2001: Australian Rainfall Runoff (ARR) A Guide to Flood Estimation.
FAWB, Stormwater Biofiltration system, Adaption Guidelines
Queensland Urban Drainage Manual (QUDM).
Western Australian Planning Commission (WAPC), 2008: Better Urban Water Management.
Western Australian Planning Commission (WAPC), 2007: Acid Sulphate Soils Risk Mapping (Bulletin 64).

ATTACHMENT A
DEVELOPMENT GUIDE PLAN

N

EMERGENCY ESCAPE ROUTE

MAN-MADE WATER FEATURE (EXISTING)

PEDESTRIAN ACCESS

NOISE WALL

BIORETENTION BASIN

VILLAGE GREEN

GOLF / PUTTING AREA

SHORT STAY

BOWLING

CLUB HOUSE

EMERGENCY ESCAPE ROUTE AND PEDESTRIAN ACCESS

LANDSCAPING STRIP

ONE WAY TRAFFIC FLOWS

ONE WAY TRAFFIC FLOWS

FAMILY CENTRE

ACROD CAR PARKING BAYS

SHED

WORKSHOP

CARPORT

COMMUNITY GARDEN (TO BE SCREENED FROM VIEW)

EXISTING ACCESS TO BE RETAINED FOR INITIAL STAGE(S) AND SUBJECT TO STAGING REQUIREMENTS

TURNER STREET

LEGEND

- INDIGENOUS SITE
- WATER MAIN
- SEWER MAIN
- OVERHEAD POWER LINE
- GAS MAIN
- LANDSCAPING STRIP TO ACHIEVE SHADE TREE POLICY REQUIREMENT
- PROPOSED DISPLAY HOMES (Subject to Separate Application for Planning Consent)
- PROPOSED DRAINAGE BASINS

LAND USE NOTES

1. DEVELOPMENT AND LAND USES SHALL BE GENERALLY IN ACCORDANCE WITH THE ENDORSED DEVELOPMENT GUIDE PLAN. IN ACCORDANCE WITH CONDITION 3 OF APPENDIX 4 OF TPS No. 7 THE SHIRE OF CAPEL MAY CONSIDER AND ADOPT MODIFICATIONS TO THE DEVELOPMENT GUIDE PLAN.
2. PROPOSED LEASE AREAS ARE INDICATIVE ONLY AND ARE SUBJECT TO DETAILED DESIGN, SURVEY AND WAPC APPROVAL IN ACCORDANCE WITH SECTION 136 OF PLANNING AND DEVELOPMENT ACT 2005.
3. LANDSCAPING AND PEDESTRIAN PATHS TO BE SUBJECT TO LANDSCAPE MASTER PLAN.

SHIRE ADOPTION

THIS DEVELOPMENT GUIDE PLAN HAS BEEN ADOPTED BY THE SHIRE OF CAPEL ON _____

DEVELOPMENT GUIDE PLAN

1:750
0 5m 10 15 20 25 30

mpm development consultants
107 Beach Road
PO Box 2035
BUNBURY WA 6231
Website: www.mpmdc.com.au
Telephone: (08)97 214777
Facsimile: (08)97 214666
Email: reception@mpmdc.com.au

Project: MEADOWBROOKE LIFESTYLE ESTATE
Drawing Number: 14041-01 Revision A
Original Size: A1

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ATTACHMENT B
GEOTECHNICAL REPORTS

mpm development consultants

CLIENTS|PEOPLE|PERFORMANCE

23 May 2008

John Taylor
Preston Green Pty Ltd
C/o Thompson Consulting Surveyors
PO Box 1719
BUNBURY WA 6231

Our ref: 61/22424/11204
Your ref:

Dear John,

Lot 888 South Western Highway, Boyanup
Geotechnical Investigation

1 Introduction

Preston Green Pty Ltd has commissioned GHD to undertake a geotechnical investigation of Lot 888 South Western Highway, in Boyanup. We understand that the south west area of this lot is designated for residential zone and it is proposed to develop this area into an aged care facility.

The aims of the geotechnical investigation were to determine the suitability of the in-situ material for onsite disposal surface water drainage and a general site classification in accordance with AS 2870 – 1996.

2 Site Conditions

2.1 Site Description

Lot 888 South Western Highway is located in Boyanup township, which covers a total area of approximately 11.18 ha. The lot is bounded by Preston River and a reserve with a creek to the north and east, private properties and Turner Street to the south, and South Western Highway to the west. The proposed subdivision site is approximately one-third of the total size of Lot 888. The remaining of the lot comprises a resort and a recreational area. Access to the site was via Turner Street, behind the fire station building.

The proposed subdivision site is generally flat and covered with grasses. An olive orchard is located at the north east part of the site. Some mature trees were observed near the west boundary and near the orchard. A small valley, which is located near the north boundary, appears to be a run off waterway and discharging into the creek. At the time of the investigation, the valley was dry. Patches of un-vegetated spots with ground surface cracking were scattered across the site. This was due to the present of dry clayey soil at the surface level.

2.2 Regional Geology

The Bunbury – Burekup 1 : 50,000 geological map indicates that the lot is underlain by Guildford Formation, an alluvial deposit of Pleistocene age. The Guildford Formation is highly variable in composition, reflecting its alluvial origin, but generally consists silty to sandy clay of medium to high plasticity, grading to clayey/silty sand in parts.

3 Ground Investigation

3.1 Fieldwork and Laboratory Testing

The fieldwork was carried out on 24th April 2008 and comprised six test pit excavations and three in-situ permeability test. The works was supervised by a geotechnical engineer from GHD.

The test pits (numbered as TP1 to TP6) were excavated across the proposed subdivision site, using an 11 tonne tracked excavator, supplied and operated by JW Cross and Sons. The pits were excavated to depths between 1.7 and 2.2m.

Perth Sand Penetrometer (PSP) tests to 1.05m depth were carried out adjacent to the test pits to get an indicative consistency of the in-situ material.

Three in-situ permeability tests (BH1 to BH3) were conducted using the constant head method in 100mm diameter holes.

The test pit and borehole locations are presented in Figure 1.

Selected samples from the test pits were sent to Civi Test Sou West, a NATA accredited laboratory in Bunbury, for geotechnical laboratory testing. The tests comprised particle size distribution and Atterberg Limit.

3.2 Subsurface Conditions

In general, most of the test pits encountered clayey soils to depths between 1.7 and 2.2m. The soils variably comprised clay, clay with sand and sandy clay, with colour varying from brown, orange grey and red mottled grey. The strength varied from stiff at shallow depth, becoming very stiff to hard with depth. Laterite was encountered in three test pits below the clay layer. This varying composition of the clay is typical of Guildford Formation.

Groundwater was not encountered in any of the test pits.

Laboratory test results from three samples indicated that the clays have high plasticity. In-situ permeability test results indicated the clays have a very low permeability, in magnitude order of 10^{-7} to 10^{-8} m/sec.

The test pit results and laboratory test results are presented in Tables 1 and 2, respectively. The laboratory test certificates are presented in Appendix A.

4 Conclusions and Recommendations

Based on the findings of the investigation, the in-situ material encountered in the proposed subdivision site is not suitable for onsite disposal of surface water, due to its low permeability. Offsite disposal will therefore be required.

In its current conditions, the general site classification of this site is considered to be **Class H** in accordance with AS 2870–1996. This is due to the highly reactive clay present on site.

However, the site classification could be upgraded by placing an imported sand fill layer over the entire site. The site drainage will also be improved by raising the site with sand fill material.

In order to achieve **Class S**, a minimum depth of 1.0m well-compacted sand fill would be required. Prior to placing the sand fill, the site preparation for residential development should be carried out as follows:

- Removal of the topsoil;
- The exposed clay will be susceptible to softening and disturbance, particularly during the wetter months of the year. Care should be taken during construction to ensure that the exposed clay is not disturbed further by keeping construction traffic off stripped areas and trafficking the sand fill;
- Place and compact sand fill in maximum 300mm thick layers and extending at least 2.0m beyond the building footprint; and
- The density of each layer should be checked by Perth Sand Penetrometer (PSP) testing with accepted criteria of a minimum 8 blows per 300mm penetration.
- Both edge beam and stiffening ribs could be founded within the sand fill, as this would be classified as Controlled Fill under AS 2870–1996.

The earthworks for site should comply with AS 3798–1996 "Guidelines on earthworks for commercial and residential developments". Upon completion of the site preparation, it is anticipated that the general site can be re-classified as **Class S** in accordance with AS 2870–1996.

5 Scope and Limits of Geotechnical Investigation

This report presents the results of a geotechnical investigation prepared for the purpose of this commission. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Pty Ltd (GHD) accepts no responsibility for other use of the data.

Where drill hole or test pit logs, cone tests, laboratory tests, geophysical tests and similar work have been performed and recorded by others the data is included and used in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

The advice tendered in this report is based on information obtained from the investigation locations tests points and sample points and is not warranted in respect to the conditions that may be encountered across the site at other than these locations. It is emphasised that the actual characteristics of the subsurface materials may vary significantly between adjacent test points and sample intervals and at allocations other than where observations, explorations and investigations have been made. Subsurface conditions, including groundwater levels and contaminant concentrations can change in a limited time. This should be borne in mind when assessing the data.

It should be noted that because of the inherent uncertainties in subsurface evaluations, changed or unanticipated subsurface conditions may occur that could affect total project cost and/or execution. GHD does not accept responsibility for the consequences of significant variances in the conditions and the requirements for execution of the work.

The subsurface and surface earthworks, excavations and foundations should be examined by a suitably qualified and experienced Engineer who shall judge whether the revealed conditions accord with both the assumptions in this report and/or the design of the works. If they do not accord, the Engineer shall modify advice in this report and/or design of the works to accord with the circumstances that are revealed.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based.

Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances, which arise from the issue of the report, which has been modified in any way as outlined above.

Should you have any further queries, please do not hesitate to contact the undersigned.

Yours faithfully
GHD Pty Ltd

Waldo Dressel
Principal Geotechnical Engineer
61 8 9721 0734

Attachment:
Figure 1 Test Pit and Borehole Locations
Table 1 and Table 2
Appendix A Laboratory Test Certificates

LEGEND

TP1 TEST PIT LOCATIONS

BH1 BOREHOLE LOCATIONS (INSITU PERMEABILITY TEST)

BOUNDARY LINE

PROPOSED SUBDIVISION AREA

GHD CLIENTS | PEOPLE | PERFORMANCE

PRESTON GREEN PTY LTD
LOT 888 SOUTH WESTERN HWY, BOYANUP
TEST PIT & BOREHOLE LOCATIONS
scale | 1:1500 for A3 date | MAY 2008

job no. | 61-22424
rev no. | A

Figure 1

10 Victoria Street Bunbury WA 6230 Australia T 61 8 9721 0700 F 61 8 9721 0777 E bunmail@ghd.com.au W www.ghd.com.au

Date 29 May 2008 - 11:02 AM Cad File No 61-22424 - Figure 1.dwg

Table 1 Test Pit Results – Lot 888 South Western Highway, Boyanup

Test Pit	Depth (m)	Soil Description	Groundwater (mbgl)	PSP
TP1	0.0 – 0.2	TOPSOIL, Silty sand, dark brown, loose, moist, with fine roots.	Not encountered	0.15 – 0.45m: 14 blows
	0.2 – 0.4	SILTY SAND, brown red, loose, moist, with some large roots and pockets of cemented silt.		0.45 – 0.75m: >30 blows
	0.4 – 0.9	CLAY with sand, brown, high plasticity, stiff to very stiff, dry.		
	0.9 – 2.0	CLAY, grey with red mottling, very stiff to hard, dry		
		Terminate at 2m due to near refusal.		
TP2	0.0 – 0.2	TOPSOIL, Silty sand, dark brown, loose, moist, with fine roots.	Not encountered	0.15 – 0.45m: 9 blows
	0.2 – 0.5	CLAY with sand, brown, stiff, slightly moist		0.45 – 0.75m: >30 blows
	0.5 – 2.0	CLAY, grey with orange mottling, stiff to very stiff becoming hard, slight moist.		
		Terminate at 2m due to near refusal.		
TP3	0.0 – 0.2	TOPSOIL, Silty sand, dark brown, loose, moist, with fine roots.	Not encountered	0.15 – 0.45m: 10 blows
	0.2 – 0.9	SANDY CLAY, brown, stiff to very stiff, moist.		0.45 – 0.75m: 16 blows
	0.9 – 1.7	CLAY, orange grey to 1.5m and becoming grey with orange mottling, very stiff to hard, slightly moist.		0.75 – 1.05m: 20 blows
	1.7 – 1.9	Laterite gravel, very dense, dry.		
		Terminate at 1.9m due to refusal on laterite caprock.		
TP4	0.0 – 0.2	TOPSOIL, Silty sand, dark brown, loose, moist, with fine roots.	Not encountered	0.15 – 0.45m: 11 blows
	0.2 – 1.4	CLAY with sand, brown grey, high plasticity, stiff to very stiff, slightly moist		0.45 – 0.75m: 22 blows
	1.4 – 2.2	CLAY, grey with red mottling, very stiff to hard, slightly moist.		0.75 – 1.05m: >30 blows
		Terminate at 2.2m due to near refusal.		

Test Pit	Depth (m)	Soil Description	Groundwater (mbgl)	PSP
TP5	0.0 – 0.2	TOPSOIL, Silty sand, dark brown, loose, moist, with fine roots.	Not encountered	0.15 – 0.45m: 14 blows
	0.2 – 1.7	CLAY, brown becoming orange grey, stiff to very stiff, slightly moist.		0.45 – 0.75m: 20 blows
	1.7 – 1.8	Laterite gravel, very dense, dry.		0.75 – 1.05m: >30 blows
		Terminate at 1.8m due to refusal on laterite caprock.		
TP6	0.0 – 0.2	TOPSOIL, Silty sand, dark brown, loose, moist, with fine roots.	Not encountered	0.15 – 0.45m: 4 blows
	0.2 – 1.8	Sandy CLAY, brown becoming brown grey, high plasticity, firm to stiff becoming very stiff to hard, slightly moist.		0.45 – 0.75m: 9 blows
				0.75 – 1.05m: >30 blows
	1.8 – 2.1	Laterite gravel, very dense, dry.		
		Terminate at 2.1m due to refusal on laterite caprock .		

Table 2 Summary of Laboratory Test Results

Test Pit	Depth (m)	Material & Unified Classification	Particle Size Distribution			Atterberg Limit			
			% Fines (< 75µm)	% Sand	% Gravel (> 2mm)	LL	PL	PI	LS
TP1	0.8	High plasticity CLAY with Sand (CH)	76	24	0	70	20	50	14.2
TP4	0.5	High plasticity CLAY with Sand (CH)	80	20	0	84	23	61	12.6
TP6	0.8	Sandy high plasticity CLAY (CH)	62	37	1	55	21	34	13.8

Appendix A

Laboratory Test Certificates

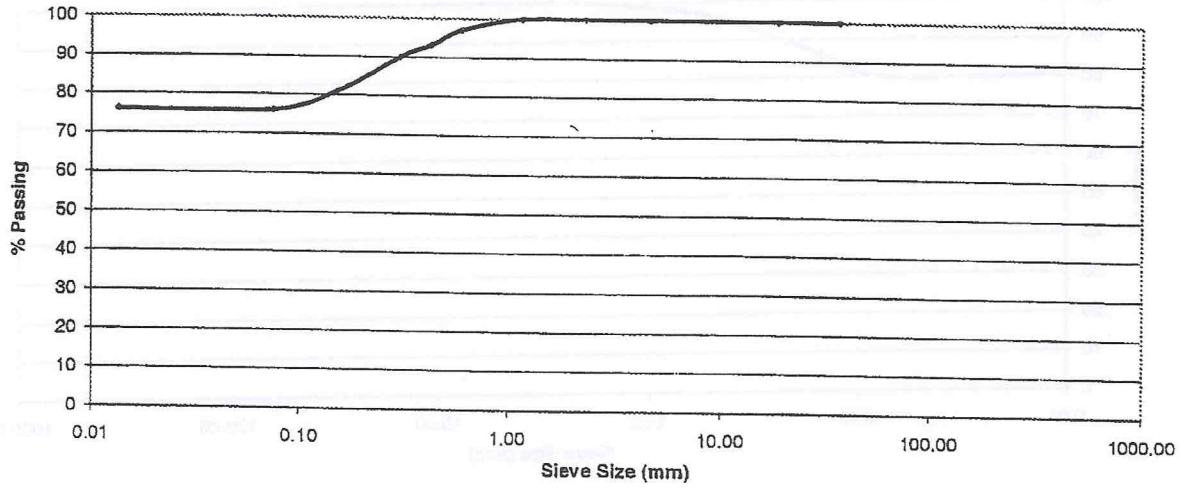
CIVI TEST SOU-WEST
ENGINEERING MATERIALS TESTING LABORATORY
UNIT 4 / 4 MUMMERY CRES. BUNBURY W.A 6230
PH: 08 9721 7022 FAX 08 9721 7033

TEST REPORT

CLIENT:	DEWI BEALING	SAMPLE No.:	CT 21288
PROJECT:	LOT 888 SOUTH WESTERN HIGHWAY	JOB No.:	55-1-1
LOCATION:	BOYANUP- TP 1	FIELD DESCRIPTION:	CLAY
		DATE TESTED:	05-May-08
		DEPTH:	800mm

PARTICLE SIZE DISTRIBUTION

AS 1289 3.6.1/2.1.1



Sieve Size	% Passing
37.50	100
19.00	100
9.50	100
4.75	100
2.36	100
1.18	100
0.600	97
0.425	93
0.300	90
0.150	81
0.075	76

Liquid Limit AS 1289 3.1.2	70
Plastic Limit AS 1289 3.2.1	20
Plasticity Index AS 12859 3.3.1	50
Linear Shrinkage AS 1289 3.4.1	14.2

Sampled in accordance with AS 1289 1.2.1
Sample history: AIR DRIED
Wet/dry sieve: DRY SIEVE

Approved Signatory : S. ARNOLD
Date: 15-May-08
Report Number : CT 21288 / 1

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory 14165
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Accredited for compliance with ISO/IEC 17025
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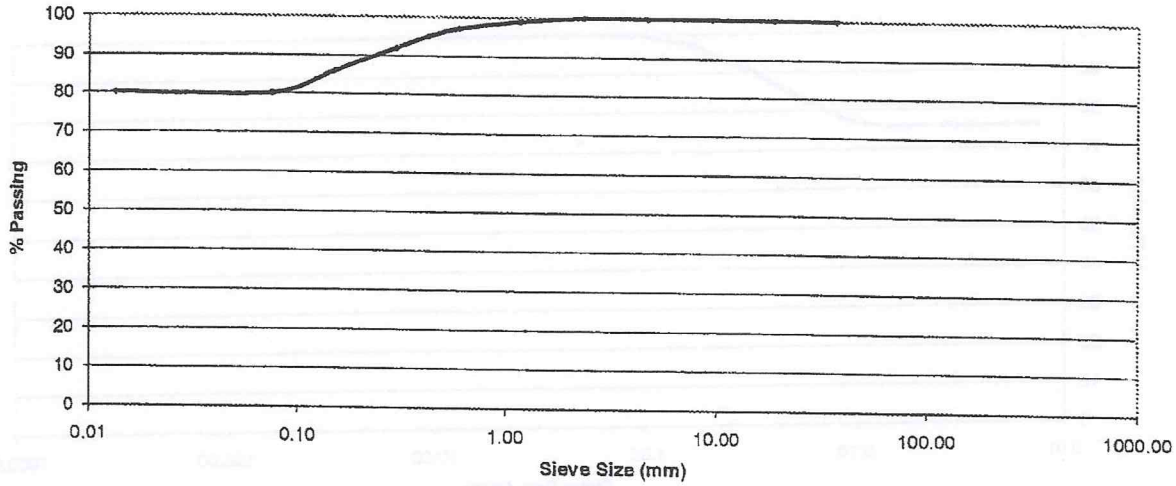
CIVI TEST SOU-WEST
ENGINEERING MATERIALS TESTING LABORATORY
UNIT 4 / 4 MUMMERY CRES. BUNBURY W.A 6230
PH: 08 9721 7022 FAX 08 9721 7033

TEST REPORT

CLIENT:	DEWI BEALING	SAMPLE No.:	CT 21289
PROJECT:	LOT 888 SOUTH WESTERN HIGHWAY	JOB No.:	55-1-1
LOCATION:	BOYANUP- TP 4	FIELD DESCRIPTION:	CLAY
		DATE TESTED:	05-May-08
		DEPTH:	500mm

PARTICLE SIZE DISTRIBUTION

AS 1289 3.6.1/2.1.1



Sieve Size	% Passing
37.50	100
19.00	100
9.50	100
4.75	100
2.36	100
1.18	99
0.600	97
0.425	95
0.300	92
0.150	86
0.075	80

Liquid Limit AS 1289 3.1.2	84
Plastic Limit AS 1289 3.2.1	23
Plasticity Index AS 12859 3.3.1	61
Linear Shrinkage AS 1289 3.4.1	12.6

Sampled in accordance with AS 1289 1.2.1
Sample history: AIR DRIED
Wet/dry sieve: DRY SIEVE

Approved Signatory : S. ARNOLD
Date: 15-May-08
Report Number : CT 21289 / 1

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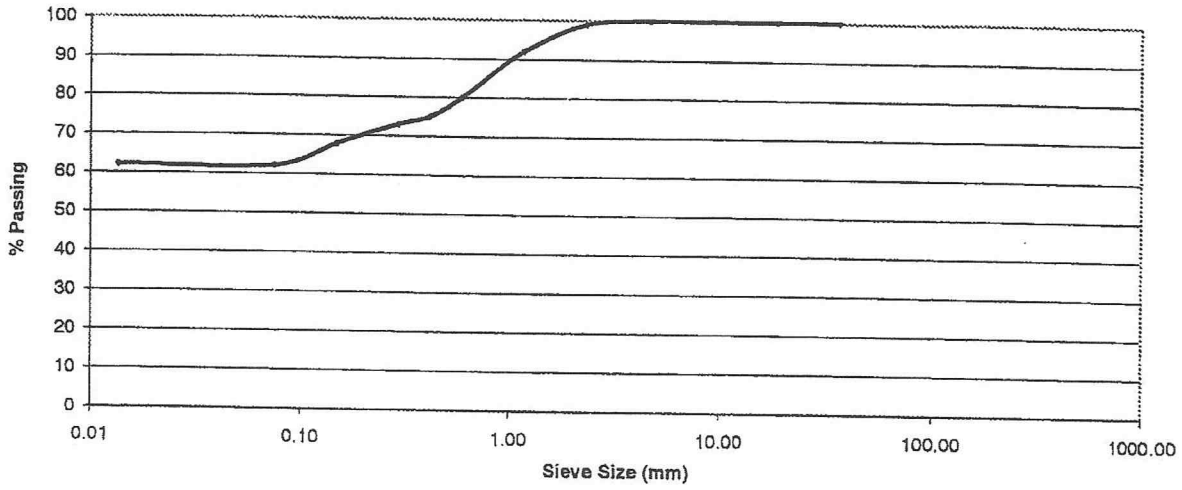
ENGINEERING MATERIALS TESTING LABORATORY
UNIT 4 / 4 MUMMERY CRES. BUNBURY W.A 6230
PH: 08 9721 7022 FAX 08 9721 7033

TEST REPORT

CLIENT:	DEWI BEALING	SAMPLE No.:	CT 21290
PROJECT:	LOT 888 SOUTH WESTERN HIGHWAY	JOB No.:	55-1-1
LOCATION:	BOYANUP- TP 6	FIELD DESCRIPTION:	CLAY
		DATE TESTED:	05-May-08
		DEPTH:	800mm

PARTICLE SIZE DISTRIBUTION

AS 1289 3.6.1/2.1.1



Sieve Size	% Passing
37.50	100
19.00	100
9.50	100
4.75	100
2.36	99
1.18	92
0.600	80
0.425	75
0.300	73
0.150	68
0.075	62

Liquid Limit AS 1289 3.1.2	55
Plastic Limit AS 1289 3.2.1	21
Plasticity Index AS 12859 3.3.1	34
Linear Shrinkage AS 1289 3.4.1	13.8

Sampled in accordance with AS 1289 1.2.1
Sample history: AIR DRIED
Wet/dry sieve: DRY SIEVE

Approved Signatory : S. ARNOLD
Date: 15-May-08
Report Number : CT 21290 / 1

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ACCREDITED FOR TECHNICAL COMPETENCE

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Appendix E

Geotechnical Report

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Residential Development
Lot 201 Turner Street
Boyanup, WA

Prepared for
Preston Green Pty Ltd

Project 82345
October 2014

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	82345	Document No.	1
Document title	Report on Geotechnical Investigation Proposed Residential Development		
Site address	Lot 201 Turner Street, Boyanup, WA		
Report prepared for	Preston Green Pty Ltd		
File name	P:\82345 Boyanup Lot 201 Turner Street\Docs\82345 Report on Geotechnical Investigation, Lot 201 Turner Street, Boyanup.doc		

Document status and review

Revision	Prepared by	Reviewed by	Date issued
1	Paul Hutchinson	Michael Thom	22 October 2014

Distribution of copies

Revision	Electronic	Paper	Issued to
1	1	1	Shelley Coutts (MDM Development Consultants)

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		22.10.2014
Reviewer	P.P.	22.10.2014

NCS INTERNATIONAL
CERTIFIED
QUALITY
MANAGEMENT SYSTEM

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Osborne Park WA 6017
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Fax (08) 9204 3522

Ta

Pa

a a
P a
201 T S a

1.

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for a proposed residential development located at Lot 201 Turner Street in Boyanup, Western Australia. The investigation was commissioned on 8 September 2014, by Ms Shelley Coutts of MPM Development Consultants Pty Ltd on behalf of Preston Green Pty Ltd, and was undertaken in accordance with DP's proposal dated 3 September 2014.

The purpose of this investigation was to determine the sub-surface conditions beneath the site and thus provide comments on:

- the geotechnical suitability of the site for the proposed development;
- site classification in accordance with the requirements of AS 2870-2011 and earthworks requirements to achieve a Class "A" or Class "S" classification, if required;
- site preparation, compaction, and earthworks so as to allow the proposed development;
- appropriate foundation system(s) for the proposed structures;
- foundation design parameters including allowable bearing pressures for pad and strip footings;
- parameters for pavement design, including a design California bearing ratio value based on field observations and laboratory test results;
- the depth to groundwater, if encountered; and
- the permeability of the soils and suitability for on-site stormwater disposal.

The investigation included the excavation of 12 test pits, the performance of Perth sand penetrometer (PSP) tests adjacent to each test pit, the performance of one in situ permeability test, and laboratory testing of selected soil samples.

Details of the field work and the results of the investigation are presented in this report together with comments and recommendations on the issues listed above.

2. S

The overall sites comprises an irregular shaped area and is identified as Lot 201 Turner Street (Meadowbrooke) in Boyanup, Western Australia (Drawing 1, Appendix A). It is bounded by residential properties and holiday chalets to the south and south-east, by vacant land to the east and north and by South Western Highway to the West. The site is divided into two distinct areas known as the western site and the eastern site, with a steep slope between them falling approximately 6 m from

west to east. The areas covered by the two parts of the site are shown on Figure 1, Appendix A. There is a central corridor of land between the two areas which does not form part of the sites.

Most of the total site is currently open grassland, with occasional trees. Two wooden gazebos and a metal shed were observed towards the central, western and northern parts of the eastern site. A stockpile of tree trunks and branches was observed on the western part of the western site.

The western site and eastern site are generally level, though they are separated by a 6 m slope with the western site at the crest elevation of the slope. A lake lies at the base of the slope in the central corridor, and therefore outside the study area. The eastern part of the site has an existing surface elevation varying between RL 29 m AHD to RL 30 m AHD, whilst the western site has an existing surface elevation of between approximately RL 35 m AHD and RL 36 m AHD.

The Bunbury-Burekup 1:50 000 Urban Geology sheet indicates that shallow sub surface conditions beneath the site comprises alluvium and clayey materials of the Guildford Formation. The Guildford Formation is described as mainly alluvial sandy clay but it can be locally variable, comprising a variety of interbedded soils from sand to highly plastic, reactive clay.

A previous geotechnical investigation was undertaken in the western part of the site in May 2008 on behalf of Preston Green Pty Ltd. The investigation comprised six test pits, excavated to depths between 1.7 m to 2.2 m. The test pits encountered variable soils generally comprising stiff to very stiff high plasticity clay, clay with sand and sandy clay.

3. k

Field work was carried out on 16 September 2014 and comprised the excavation of 12 test pits, Perth sand penetrometer (PSP) tests adjacent to the test locations and the performance of one permeability test using the constant head method.

The test pits were excavated using a 5 tonne excavator equipped with a 600 mm wide toothed bucket. Test pits TP01 to TP09 were excavated to a maximum depth of 3.0 m within the eastern portion of the site, and test pits TP10 to TP12 were excavated to a maximum depth of 1.6 m within the western portion of the site. The test pits were logged in general accordance with AS1726-1993 by a suitably experienced geotechnical engineer from DP. Soil samples were recovered from selected locations for subsequent laboratory testing.

The PSP tests were carried out adjacent to the test pit locations in accordance with AS 1289.6.3.2, to assess the in situ density of the shallow soils.

The permeability test PT13 was performed using the constant head method at a depth of 0.35 m.

Test locations were determined using a hand held GPS and are marked on Drawing 1 in Appendix A. Surface elevations at each test location were interpolated from a survey plan provided by the client.

4. k

4.1

Detailed logs of the ground conditions and results of the field testing are presented in Appendix A, together with notes defining descriptive terms and classification methods.

The investigation encountered interbedded soils with varying proportions of sand, silt and clay, which is typical of the Guildford Formation and consistent with the findings of the previous investigation. A summary of the general ground conditions encountered or inferred at the test locations is given below:

- **T** – dark grey-brown, fine to medium grained silty sand topsoil with some rootlets to depths of between 0.1 m and 0.2 m below existing surface level at all test locations.
- **a Sa a S Sa a a Sa S Sa** – generally medium dense, dark grey-brown, orange-brown and red-brown, fine to medium grained clayey sand with varying amounts of silt and gravel, to depths of between 1.0 m and 3.0 m in the eastern site, except at TP01 where it was absent, and at TP10 to a depth of 0.8 m.
- **Sa a Sa S a** – generally firm to stiff, medium to high plasticity, orange-brown mottled blue-grey sandy clay with varying silt and gravel content. This material was encountered underlying the predominantly sand layer described above in the eastern site and at TP10 from depths of between 0.8 m to 2.5 m to the termination depth of those test pits. It was encountered directly underlying the topsoil in the western site and at TP01 to depths of between 0.6 m and 2.2 m.
- **a** hard, orange-brown mottled blue-grey and red-brown mottled blue-grey, high plasticity clay, encountered underlying the sandy clay from depths of between 0.6 m and 1.1 m to test termination depths at test locations TP11 and TP12, which is the western part of the site.

The previous investigation in 2008 also encountered predominantly clayey soils in the western site.

4.2 a

Perched groundwater was observed at five of the test pits on 16 September 2014. The depth of groundwater is shown on the test pit logs in Appendix B. All test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels. A summary of groundwater levels observed during the field investigation is presented in Table 1.

Ta 1 S a a 16 S 2014

T a	a S a H [1]	a	a H [2]
TP01	29.5	0.7	28.8
TP02	30.0	0.8	29.2
TP05	30.4	2.4	28.0
TP08	30.3	1.7	28.6
TP09	29.9	0.7	29.2

Notes for Table 1: [1]: Surface level interpolated from contour plan provided by the client
[2]: Groundwater Level = Interpolated Surface Level – Groundwater Depth.

It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

4.3 S P a T

One in situ permeability test using the constant head method was carried out at test location PT13 at a depth of 0.35 m. A field permeability value was calculated in accordance with the procedure detailed in AS 1547:2012. Results of the permeability analysis are summarised in Table 2.

Ta 2 S a S P a T

T a		a P a	a a
PT13	0.35	4 x 10^{-6}	Clayey Silty Sand

5. a a T

A geotechnical laboratory testing programme was carried out on selected soil samples by a NATA accredited laboratory comprising of the particle size distribution test on three samples.

Results of the testing are summarised in Table 3 and test certificates are presented in Appendix B.

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of:

- samples collected from the eastern site:
  - the particle size distributions of three samples;
  - Atterberg limits and linear shrinkage of two samples;
  - shrink/swell index of one sample, if required; and

- California bearing ratio (CBR) and modified maximum dry density (MMDD) on one sample, if required.

o samples collected from the western site:

- the particle size distributions of one sample;
- Atterberg limits and linear shrinkage of one sample; and
- shrink/swell index of one sample, if required;

The detailed test report sheets are given in Appendix D, with the results summarised in Table 3.

Ta 3 a a T

T			Sa		P	P	S	3		S	S k S	a a
Eastern Site												
TP01	0.60	77	23	44	22	22	6.0	-	-	-	-	Sandy Silty Clay
TP03	0.5	54	46	23	19	4	0.5	1.855	18	0.0	-	Clayey Silty Sand
TP03	0.7 – 1.0	-	-	-	-	-	-	-	-	-	0.2	Silty Sand
PT13	0.3	42	58	-	-	-	-	-	-	-	-	Clayey Silty Sand
Western Site												
TP10	1.0	54	46	51	19	32	10.0	-	-	-	-	Clayey Sand
TP11	0.6 – 0.9	-	-	-	-	-	-	-	-	-	2.5	Sandy Clay

Notes on Table 3:
- The % fines is the amount of particles smaller than 75 µm;
- The % sand is the amount of particles larger than 75 µm and smaller than 2.36 mm;
- The % gravel is the amount of particles larger than 2.36 mm and smaller than 60 mm;
-LL: liquid limit -PL: plastic limit -PI: plasticity index -LS: linear shrinkage
-MMDD: Maximum Modified Dry Density -CBR: California Bearing Ratio

6. P

It is understood that the proposed development includes the construction of a residential subdivision development comprising 20 new lots, and associated pavement access ways.

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.1 S a S

The results of the investigation indicate that ground conditions across the site generally consist of clayey sand or sandy clay with varying proportions of silt and gravel. Perched groundwater level was encountered at between approximately 0.7 m to 2.4 m below the existing surface level of the site at the time of the investigation (groundwater levels can fluctuate seasonally).

From a geotechnical standpoint, it is considered the site is suitable for the proposed development described in Section 6, providing the site preparation recommendations described in Sections 7.2 and 7.3 are carried out.

.2 S a a

As described in Section 4, the shallow ground conditions encountered at the test locations generally comprise medium dense clayey sand or firm to stiff sandy clay, with varying proportions of silt and gravel. The clay fraction was generally medium to high plasticity.

The predominantly clayey soils are present underlying the topsoil in the western site and at TP01, just below the embankment separating the two areas of the lot. In its current condition, based on the shrink-swell test result, this part of the site should be classified as Class 'H' in accordance with AS 2870-2011. The area of the site considered Class 'H' is indicated on Drawing 1, Appendix A. The site classification of the western portion of the site could be modified to an equivalent Class 'S' if a minimum depth of 0.7 m of well compacted non-reactive filling (clean sand) was placed above the current ground elevation. The site classification of this part of the site could be generally modified to an equivalent Class 'A' by increasing the thickness of the filling to 1.7 m.

Predominantly sandy soils underlie the topsoil in the eastern part of the site. In its current condition, based on the shrink-swell test result from the clayey sand, this part of the site should be classified as Class 'S' in accordance with AS 2870-2011. The site classification of this portion of the site could be generally modified to an equivalent of Class 'A' by placing a minimum depth of 1.7 m of clean sand above the existing surface elevation.

It is estimated that placing the maximum thickness of filling to attain Class 'A' will result in approximately 10 mm to 15 mm of consolidation settlement, most of which will occur within two months of placement of the filling.

As the constituency of the soil is variable across the site, a more detailed investigation would be required to determine the classification on a lot by lot basis.

It should be noted that AS 2870 - 2011 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. It also applies to light industrial and commercial buildings if they are similar in size, loading and superstructure flexibility to those designs included in AS 2870 - 2011.

The site classification for individual building lots should be confirmed after earthworks is completed and the sites have been levelled for house construction.

.3 S P a a

All deleterious material including topsoil, tree roots, and any particles larger than 150 mm should be stripped from the proposed development areas of the site. Tree roots remaining from any clearing operations should be completely removed and the excavation backfilled with sand and suitably compacted. It is recommended that sand backfill be placed in loose lift thickness of not more than 300 mm and compacted to achieve a dry density ratio of not less than 95% relative to modified compaction.

Following removal of unsuitable material and prior to any filling, it is recommended that the exposed subgrade beneath the building envelopes and pavement areas be compacted using a medium to heavy (minimum of 10 tonne) vibrating smooth drum roller. Any areas that show signs of excessive deformation during compaction should be compacted until deformation ceases or, alternatively, the poor quality material should be excavated and replaced with suitable structural filling compacted to achieve a dry density ratio of not less than 95% relative to modified compaction. Care should be taken not to operate heavy plant immediately adjacent to existing buildings and services.

The in situ soils are considered unsuitable for reuse as filling. Imported filling, if required, should comprise free draining cohesionless sand with less than 5% by weight of particles passing a 0.075 mm sieve. The material should be free from organic matter and particles greater than 150 mm in size. It is recommended that naturally occurring sand at this site and imported sand filling be placed in loose lift thickness of not more than 300 mm, within 2% of its optimum moisture content with each layer compacted to achieve a dry density ratio of not less than 95% relative to modified compaction.

During construction, some loosening of the surface sand in foundation excavations is expected. Therefore the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings.

.4 a

Shallow foundation systems comprising slab, pad and strip footings should be suitable to support the proposed structures. Footings of buildings covered by AS 2870-2011 should be designed to satisfy the requirements of this standard for the suitable site classification discussed in Section 7.2, provided that site preparation is carried out as detailed in Section 7.3.

For structures not covered by AS 2870-2011, a presumptive maximum allowable bearing pressure of 150 kPa is suggested for pad footings up to1.5 m wide and 120 kPa for strip footings up to 1.0 m wide founded at a minimum depth of 0.5 m, provided that site preparation is carried out as discussed in Section 7.2.

In particular, it has been assumed that suitable compaction as described in Section 7.2 will be achieved to a depth of 1.0 m below final footing level and that the base of the footings are at least 0.5 m above the maximum groundwater level. The recommended minimum footing width for strip footings founded on sand is 0.5 m. This should result in the total and differential settlements being less than 15 mm (assuming consolidation from the filling is completed prior to construction of the house).

.5 Pa Pa a

Based on observation of the soils underlying the site, and assuming the recommendations in Section 7.3 are followed, a subgrade California bearing ratio (CBR) of 8% is suggested for pavement design in the eastern site and a CBR of 6% for the western portion, provided the subgrade is compacted to not less than 95% of modified maximum dry density.

In the event the subgrade comprises imported sand filling, the pavement could be designed using an appropriate CBR of that material. A presumptive design CBR value of 12% is suggested for clean sand filling, however, this value should be confirmed prior to pavement construction once the type of filling material is known and its CBR has been assessed.

.6 S P a

The investigation encountered clayey sand and sandy clay, with varying amounts of silt and gravel. Groundwater seepage was encountered at approximately RL 29.2 m AHD in the eastern site.

An in situ falling head permeability test was undertaken in the clayey silty sand at a depth of 0.35 m, as shown in Table 2 above. The estimated permeability arising from the test was 4×10^{-6} m (approximately 0.35 m/day).

A design permeability value of 4×10^{-6} m/s (0.35 m/day) is suggested for the eastern site. The clay content in the western site is higher and so a design permeability value of 1×10^{-6} m/s (0.1 m/day) is suggested for this area.

Given the high fines content of the soils underlying the site and shallow perched groundwater, on-site disposal of stormwater is considered to be unsuitable on this site.

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
3. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
4. Australian Standard AS 2870-2011, Residential Slabs and Footings
5. Australian Standard AS 3798-1996, Guidelines on Earthworks for Commercial and Residential Developments.
6. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004.

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Douglas Partners Pty Ltd (DP) has prepared this report for a proposed residential development at Lot 201 Turner Street, Boyanup, WA in accordance with DP's proposal dated 3 September 2014 and acceptance from Ms Shelley Coutts of MPM Development Consultants on behalf of Preston Green Pty Ltd dated 8 September 2014. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Preston Green Pty Ltd for this project only and for the purposes described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Subsurface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

The scope for work for this investigation did not include the assessment of surface or subsurface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

a Pa P

About this Report
Drawing 1
Results of Field Work

About this Report

Douglas Partners

T ese otes e ee ro e to Ps re ort re r to ss to et o s e ro e res t e o e ts se to . Not re e ess r ree t to re orts.

Ps re orts re se o or to e ro te s s r e e to s s e e te o e e o o eo o e ere e. or t s re so t e st e re r e s ter ret e r t er t t o e ts te to so e e te t t es o e o or to o t e re .

T s re ort s t e ro ert o o s P rt ers Pt Lt . T e re ort o e se or t e r ose or t s o sso e or e t t e Co to s o E e e t or t e o sso s e t t e t e o ro os . U t or se se o t s re ort or tsoe er s ro te .

a T P

T e ore o e test t o s rese te t s re ort re e eer or eo o ter ret to o t e s s r e o to s t er re t e e to so e e te t o re e o s t e et o o r or e to . l e o t o s st r e s or ore r ro e t e ost re e ssess e t t t s s ot s r t e or oss e to st o e o o ro s. I se t e ore o es test ts re rese t o er s s e o t e tot s s r e ro e.

I ter ret to o t e or to ts to to es o str to s o t ere ore t e to o t t e s o ore o es or ts t e re e o s t e oss t o ot er t str t e r to s et ee t e test o to s.

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W ere ro ter e e s re e s re ore o es t ere re se er ote t ro e s e

- I o er e t so s ro ter e ter t e o e er so or er s ot t r t et e t e o e s e to o e
- A o se er e ter t e e to erro eo s to o t e tr e ter t e
- W ter t e e e s r ro t e to t e t se so s or re e t e t er es. T e ot e t e s e t t e t e o o str to s re te t e re ort
- T e se o ter or s r s ro ter o . W ter s to e o o to t e o e r st rst e s e o t o t e o e ter e s re e e ts re to e e.

More re e e s re e ts e e st st es re re t ter s o er se er s or er s ee s or o er e t so s. P e o eters se e rt r str t e s e o er e t so s or ere t ere e ter ere e ro er e ter t e.

T e re ort s ee re re e erso e s se o t e or to o t e ro e or tor test s ee ert e to rre t e eer st r s o ter ret to ss. W ere t e re ort s ee re re or s e es ro os t e or to ter ret to ot e ree t t e es ro os s e . I t s e s P e e se to re e t e re ort t e s e o t e est to or .

E er re s t e t t e re ort s t re tes to ter ret to o s s r e o to s s sso o eote e ro e t s e ts re o e to s or s esto s or es o str to . Ho e er P ot s t te or ss e res o s t or

- U e e te r to s ro o to s. T e ote t or t s e e rt o ore o e or t s s re e
- C es o or ter ret to s o o st t tor t or tes or
- T e to s o o tr tors res o to o er ress res.

I t ese o r P e e se to ss st t est to s or e to reso e t e tter.

About this Report

S a

I t e e e t t t o to s e o tere o ste r o str to e r to r ro t ose ere e e te ro t e or to o t e t e re ort P re ests t t t e e te ot e . Most ro e s re ore re reso e e o to s re e ose r t er t t so e ter st e e ter t e e e t.

a a a P

W ere or to o t e ro t s re ort s ro e or te er r oses t s re o e e t t or to t e r tte re ort s ss o e e e. I r st es ere t e s ss o or o e ts se to s ot re e t tto t e o tr t st to t e ro r te to re re s e e te o e t. P o e e se to ss st t s re r or to e to re ort o es e or o tr t r oses t o r e.

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T e o s e e se to ro e e eer s e to ser es or eote e ro e t s e ts o or to t s re ort s re te . T s o r e ro ste st to o r t t o to s e ose re s e e te to t e e eer rese e o ste.

Sa

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U st r e s es re t e s t e s et e tot e so t r t to o t s e o t e so re t e st r e st te. S s es e or to o str t re stre t re e ess r or or tor eter to o s e r stre t o ress t . U st r e s s e er e e t e o o es e so s.

T P

Test ts re s e te t oe or e tor o ose e to o t e st so t s s e to e ter to t e t. T e e t o e to s te to o t 3 or oe to 6 or r e e tor. A ote t s t e o t s est to et o s t e r er re o str e to t e ste.

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ore o es e r e s rot t te or s ort s r er e er 300 or r er eter o o o te o st r r . T e tt s re ret r e to t e s r e t ter s e er ot ore t 0.5 re st r e t s e o st re o te t. I e t to o so str t s e er ore re e t t o t o s s r t ers s s s e e te o so st r e t e s es.

S a

T e ore o e s e s 90 115 eter o t o s s r t ers re t r t ter s to o s or st test . T s s re t e e o o e s o r s s s o e t e ter t e. S es re ret r e to t e s r e or e o e te ter t r o t e er ts t t e re st r e e e t so s ro t e s es o t e o e. I or to ro t e r s st t ro s e s SPTs or st r e s es s o re t e o re t e to t e re o oss e or so te o s es ro ter.

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T e ore o e s e s rot r t t ter or r e e o t e r ro s ret r e t e s rr t e r tt s. O or es str t to e eter e ro t e tt s to et er t so e or to ro t e r te o e etr to . W ere r s se t s s t e tt s re e e t to s o oss e ro se r te s s s SPTs.

A o t o s ore s e e o t e s o t e ore rre s t 50 ter eter. Pro e ore re o er s e e s ot s oss e e ro s r rso s t ste e ro es er re e et o o est to .

Sa a P a T

St r e etr to tests SPT re se s e so o est t e e st or stre t o so s so o o t re t e st r e s e. T e test ro e re s es r e A str St r 1289 Met o s o Test So s or E eer P r oses Test 6.3.1.

T e test s rre o t ore o e r 50 eter s ts e t e er t e to 63 er t ree o 760 . It s or or t e t e to e r e t ree s ess e 150 re e ts t e N e st e ste er o o s or t e st 300 . I ese s s er r s or e ro t e 450 e etr to ot e r t e t e test s s o t e .

T e test res ts re re orte t e o o or .

- I t e se ere e etr to s o t e t s ess e o o ts or e 150 o s 4 6 7 s
  4 6 7
  N 13
- I t e se ere t e test s s o t e e ore t e e etr to e t s ter 15 o s or t e rst 150 30 o s or t e e t 40 s
  15 30 40

Sampling Methods

T e res ts o t e SPT tests e re te e r to t e e eer ro ert es o t e so s.

a P T

P Sa P T

e etro eter tests CP or PSP re rr e o t r stee ro to t e ro s st r e t o er s e e st e. As t e ro e etr tes t e so t e er o o s re re to e etr te e s ess e 150 e t re re or e . Nor t ere s e t t to o 1.2 t t s e e te e ert o to s t e se o e te s o ro s. T o t es o e etro eter re o o se .

- Pert s e etro eter 16 eter t e e ro s r e s 9 er ro 600 AS 1289 Test 6.3.3 . T s test s e e o e or test t e e s t o s s s se r r so s .
- Co e e etro eter 16 eter ro t 20 eter o e e s r e s 9 er ro 510 AS 1289 Test 6.3.2 . T s test s e e o e t or e e t s r e est to s orre to s o t e test res ts t C or e r R to e ee s e ro s ro t or t es.

a a a

T e et o s o es r to ss to o so s ro s se t s re ort re se o A str St r AS 1726 eote Ste I est to s Co e. I e er t e es r to s e stre t or e st oo r str t re so or ro t e so s.

S T

So t es re es r e or to t e re o t rt e s e e t e r o ot er rt es rese t

T e	P rt e s e
o er	200
Co e	63 200
r e	2.36 63
S	0.075 2.36
S t	0.002 0.075
C	0.002

T e s r e s es e rt er s e s o o s

T e	P rt e s e
Co rse r e	20 63
Me r e	6 20
e r e	2.36 6
Co rse s	0.6 2.36
Me s	0.2 0.6
e s	0.075 0.2

T e ro orto s o se o r o stt e ts o so s re es r e s

Ter	Pro orto	E e
A	S e	C 60 S 40
A e t e	20 35	S C
S t	12 20	S t S C
Wt so e	5 12	C t so e s
Wt tr eo	0 5	C t tr e o s

e to so r ter s se re

- We r e oo re rese t to o rt es es
- Poor r e e ess or e e o rt rs es t t e s e r e
- U or r e e ess o rt r rt es e
- r e e e o rt r rt es e t t e r e

S

Co es eso s s s re ss e o t e ss o r e s e r stre t . T e stre t e e s re or tor test or est te e tests or e eer e to . T e stre t ter s re e e s o o s

es r to	A re to	U r e s e r stre t P
Ver so t	s	12
So t	s	12 25
r		25 50
St	st	50 100
Ver st	st	100 200
H r		200

S

Co es o ess so s s s e s s re ss e o t e sso re t e est e er ro t e res ts o st r e etr to tests SPT o e e etr to tests CPT or e etro eters PSP . T e re t e e st ter s re e e o

Re t e e st	A re to	SPT N e	CPT e MP
Ver oose		4	2
Loose		4 10	2 5
Me e se		10 30	5 15
e se		30 50	15 25
Ver e se		50	25

Soil Descriptions

s

It s o te t to r te eter e t e or
o so . So s e er e ss e s

- Res so er e ro s t e t er
  o t e er ro
- Tr s orte so s or e so e ere e se
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Tr s orte so s e rt er s e to

- A r er e os ts
- L str e e e os ts
- Aeo e os ts
- L ttor e e os ts
- Est r e t r er e os ts
- T s s ree or o rse o
- S o e s or Co tr s orte
  o s o e r t ss ste ter.
  O te es r ro r e ts
  o ers.

T ese otes s rse re to s o o se o ore oe o s test t re orts.

a a

C	Core r
R	Rot r r
S A	S r t ers
NMLC	o ore 52
N	o ore 47
H	o ore 63
P	o ore 81

a

▷	W ter see
▽	W ter e e

Sa a T

A	A ers e s e st r e s e
E	E ro e t s e
U_{50}	U st r e t es e 50
W	W ters e o et e etro eter P
PI	P oto o s to ete tor
PL	Po t o stre t ls 50 MP
S	St r Pe etr to Test
V	S e r e P

k

T e re te es r to s o t e e e ts s o e t e o o or er e t T e Ore t to Co t S e Ro ess Ot er. r re s re ot s e o t e o s.

T

Cs	C se
C	C e e
C	Cr s e o e s e o ose se t o t
L	to
Pt	P rt
S	S e re o e
V	Ve

a

T e to o e e ts s s e s re ro t e er e r to t e ore s.

	or o t ert
s	s or o t
s	s ert

a T

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st	s t

S a

	r e
r	rre r r
st	ste e t

o	o s e
ro	ro
s	s e s e
s	s oot
r	er ro

r e te

t rt

Symbols & Abbreviations

a S S a k

a


As t


Ro se


Co rete

S


To so


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C


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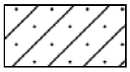
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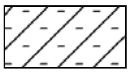
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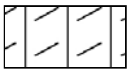
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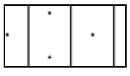
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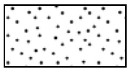
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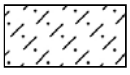
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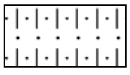
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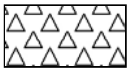
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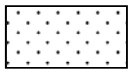
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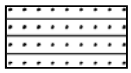
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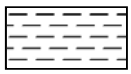
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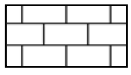
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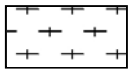
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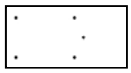
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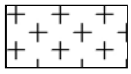
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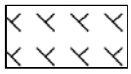
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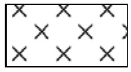
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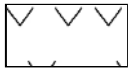
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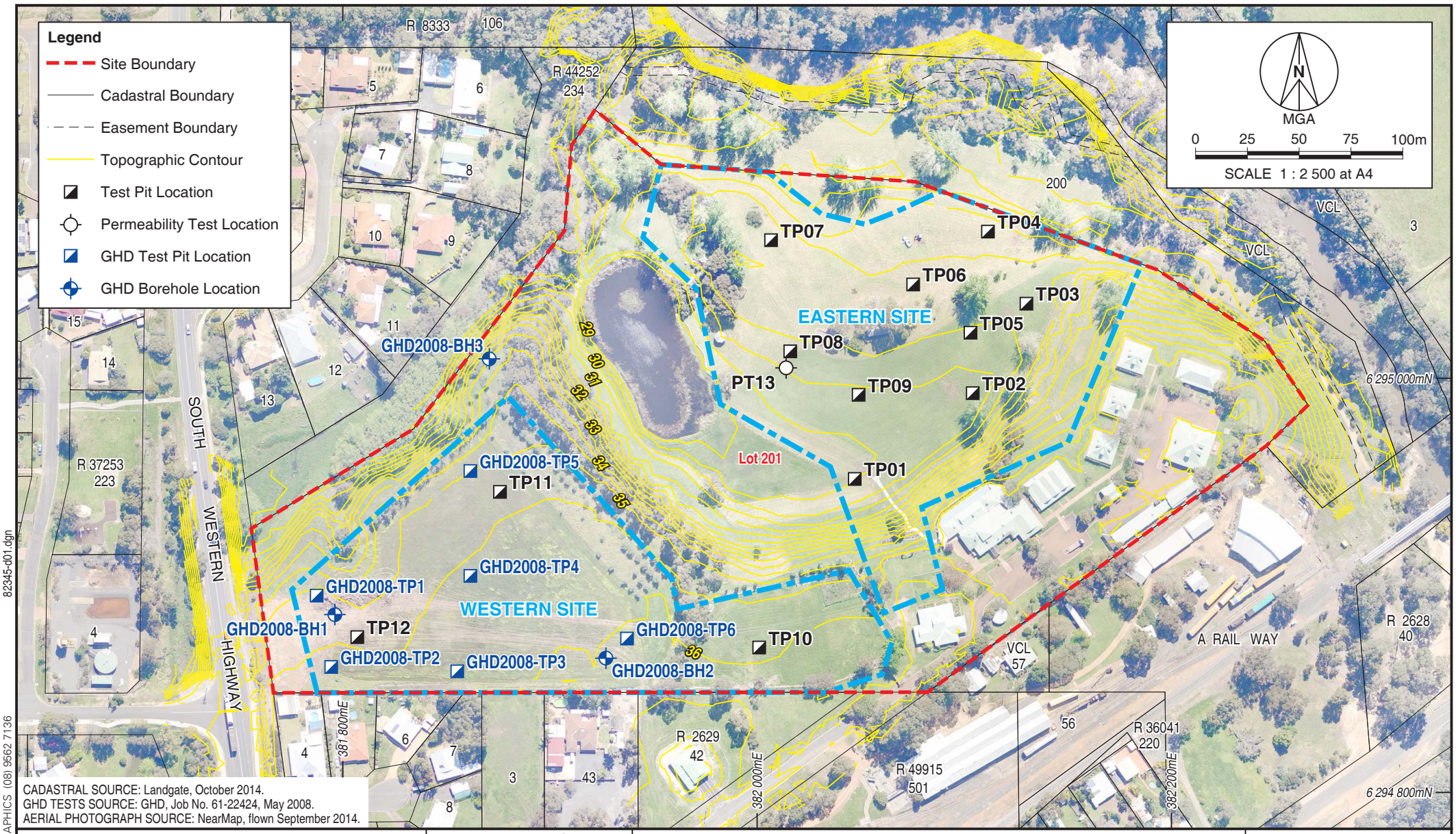

CADASTRAL SOURCE: Landgate, October 2014.
GHD TESTS SOURCE: GHD, Job No. 61-22424, May 2008.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown September 2014.

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT:	Preston Green Pty Ltd
OFFICE:	Perth
DATE:	10 Oct 2014

Test Locations
Lot 201 Turner Street (Meadowbrooke)
Boyanup, WA

PROJECT No.:	82345
DRAWING No.:	1
REVISION:	A

82345-d01.dgn

PINPOINT CARTOGRAPHICS (08) 9562 7136

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 29.5 m AHD*
EASTING:
NORTHING:

PIT No: TP01
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
29	0.2	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		SANDY SILTY CLAY - firm, orange brown mottled blue grey, medium plasticity sandy silty clay, moist.		D	0.6		pp = 80	▽	
	1	- clay content and stifness increasing with depth.							1
28				D	1.75		pp = 140		
					1.9		pp = 240		
	2								2
	2.2	Pit discontinued at 2.2m(hard digging)							
27									
	3								3
26									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater observed at 0.7 m depth.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.0 m AHD*
EASTING:
NORTHING:

PIT No: TP02
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.2	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY GRAVELLY SAND - medium dense, orange brown mottled blue grey, fine to medium grained clayey gravelly sand, wet. Gravel is fine sized.		D	0.4			▽	
29	1.0	SANDY SILTY CLAY - firm, orange brown mottled blue grey, medium plasticity sandy silty clay, moist.		D	1.3		pp = 70		
		- stiffness increasing with depth.			2.5		pp = 240		
28	2.6	Pit discontinued at 2.6m(due to collapsing conditions)							
27									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater observed at 0.8 m depth.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.7 m AHD*
EASTING:
NORTHING:

PIT No: TP03
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY SILTY SAND - dense, red brown, fine grained clayey silty sand, dry to moist.			0.3		pp = 240		
				B	0.5				
30		- becoming loose from 0.75 m depth.		U	0.7				
	1				1.0				1
		- becoming orange brown and moist from 1.5 m depth.							
29									
	2								2
		- becoming grey brown from 2.6 m depth.							
28									
	2.8	Pit discontinued at 2.8m(hard digging)							
	3								3
27									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.2 m AHD*
EASTING:
NORTHING:

PIT No: TP04
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.15	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY SILTY SAND - loose, red brown, fine grained clayey silty sand, dry to moist.			0.5		pp = 60		
29	1								1
				D	1.9				
28	2	- becoming orange brown and moist from 2.3 m depth.							2
	3								3
	3.0	Pit discontinued at 3.0m (target depth)							
27									

5 10 15 20

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.4 m AHD*
EASTING:
NORTHING:

PIT No: TP05
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.1	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		SILTY SAND - medium dense, red brown and dark grey brown, fine grained silty sand with some clay, dry to moist.							
	1								1
29	1.2	CLAYEY SAND - orange brown mottled blue grey fine grained slightly silty clayey sand, wet.						▽	
	2								2
28	2.5	SANDY SILTY CLAY - firm, orange brown mottled blue grey, medium plasticity sandy silty clay, moist.							
	2.8	Pit discontinued at 2.8m (hard digging)							
	3								3
27									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater observed at 2.4 m depth.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.5 m AHD*
EASTING:
NORTHING:

PIT No: TP06
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.15	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY SILTY SAND - medium dense, dark grey brown, fine grained clayey silty sand, dry to moist.		D	0.5				
		- becoming orange brown from 0.7 m depth.							
29		- with a trace of clay from 1.8 m depth.		D	2.2				
28	3.0	Pit discontinued at 3.0m (target depth)							
27									

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.7 m AHD* **PIT No:** TP07
EASTING: **PROJECT No:** 82345
NORTHING: **DATE:** 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.1	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY SILTY SAND - medium dense, dark grey brown, fine grained clayey silty sand, dry to moist.							
		- becoming loose from 0.75 m depth.							
		- becoming brown from 0.8 m depth.							
29		- with a trace of clay from 1.6 m depth.							
		- becoming dense from 1.8 m depth.							
				D	2.0				
	2.1	CLAYEY SILTY SAND - red brown mottled brown, fine grained clayey silty sand, dry to moist.							
28				D	2.4				
	3.0	Pit discontinued at 3.0m (target depth)							
27									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20; 1, 2, 3

RIG: 5.5 tonne excator equipped with 600 mm bucket. **LOGGED:** SJ **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.3 m AHD*
EASTING:
NORTHING:

PIT No: TP08
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.2	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY SILTY SAND - medium dense, red brown, fine grained clayey silty sand, dry to moist.							
	1								1
29	1.2	CLAYEY GRAVELLY SAND - orange brown mottled blue grey, fine to medium grained clayey gravelly sand, wet. Gravel is fine sized.		D	1.4			▽	
	2								2
28	2.0	SANDY SILTY CLAY - firm, orange brown mottled blue grey, medium plasticity sandy silty clay, moist.		D	2.4		pp = 160		
	2.8	Pit discontinued at 2.8m (hard digging)							
	3								3
27									

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: Perched groundwater observed at 1.7 m depth.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 29.9 m AHD* **PIT No:** TP09
EASTING: **PROJECT No:** 82345
NORTHING: **DATE:** 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
29	0.2	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY GRAVELLY SAND - medium dense, red brown, fine to medium grained clayey gravelly sand, wet. Gravel is fine sized.		B	0.5			▽	
		- gravel content decreasing with depth.		U	0.8				
28	1.4	SANDY CLAY - very stiff, red brown mottled dark grey brown, high plasticity sandy clay, moist. Sand is fine grained.			1.9		pp = 360		
27	2.7	Pit discontinued at 2.7m (hard digging)							
26									

RIG: 5.5 tonne excator equipped with 600 mm bucket. **LOGGED:** SJ **SURVEY DATUM:** MGA94

WATER OBSERVATIONS: Perched groundwater observed at 0.7 m depth.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▽	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 35.9 m AHD*
EASTING:
NORTHING:

PIT No: TP10
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
35	0.2	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		CLAYEY GRAVELLY SAND - medium dense to dense, orange brown mottled blue grey, fine to medium grained clayey gravelly sand, wet. Gravel is fine sized.							
	0.8	SANDY CLAY - stiff, orange brown mottled blue grey, high plasticity sandy clay, dry to moist. Sand is fine to course grained.		D	1.0		pp = 160	▽	
	1	- stiffness increasing with depth.			1.5		pp = 380		
	1.6	Pit discontinued at 1.6m (hard digging)							
34	2								
33	3								
32									

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 35.3 m AHD*
EASTING:
NORTHING:

PIT No: TP11
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
35	0.2	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
		SANDY CLAY - very stiff, orange brown mottled blue grey, high plasticity sandy clay, dry to moist. Sand is fine to course grained.		B	0.5		pp = 300		
	0.6	CLAY - hard, red brown mottled blue grey, high plasticity clay, dry to moist.		U	0.6				
34	1				0.9				1
				D	1.1		pp = 560		
	1.5	Pit discontinued at 1.5m (hard digging)							
33	2								2
32	3								3

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 35.4 m AHD*
EASTING:
NORTHING:

PIT No: TP12
PROJECT No: 82345
DATE: 16/9/2014
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
35	0.2	TOPSOIL - dark grey brown, fine to m,edium grained silty sand topsoil with some rootlets, moist.							
		SANDY CLAY - very stiff, orange brown mottled blue grey, high plasticity sandy clay, moist. Sand is fine to course grained.						▽	
		- stiffness increasing with depth.			0.7		pp = 320		
	1				1.0		pp = 400		1
34	1.1	CLAY - hard, orange brown mottled blue grey, high plasticity clay, dry to moist.			1.2		pp = 510		
	1.5	Pit discontinued at 1.5m (hard digging)							
	2								2
33									
	3								3
32									

RIG: 5.5 tonne excator equipped with 600 mm bucket.
LOGGED: SJ
SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from survey plan provided by the client.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Preston Green Pty Ltd
PROJECT: Lot 201 Turner Street
LOCATION: Boyanup, WA

SURFACE LEVEL: 30.0 m AHD* **BORE No:** PT13
EASTING: **PROJECT No:** 82345
NORTHING: **DATE:** 16/9/2014
DIP/AZIMUTH: 90°/-- **SHEET** 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.2	TOPSOIL - dark grey brown, fine to medium grained silty sand topsoil with some rootlets, moist.							
	0.35	CLAYEY SILTY SAND - medium dense, dark grey brown, fine grained clayey silty sand, moist.		D	0.3				
29	1	Bore discontinued at 0.35m(target depth)							
28	2								
27	3								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 110 mm hand auger. **DRILLER:** SJ **LOGGED:** SJ **CASING:**

TYPE OF BORING:

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Surface level interpolated from survey plan provided by the client.

☒ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Laboratory Test Certificates

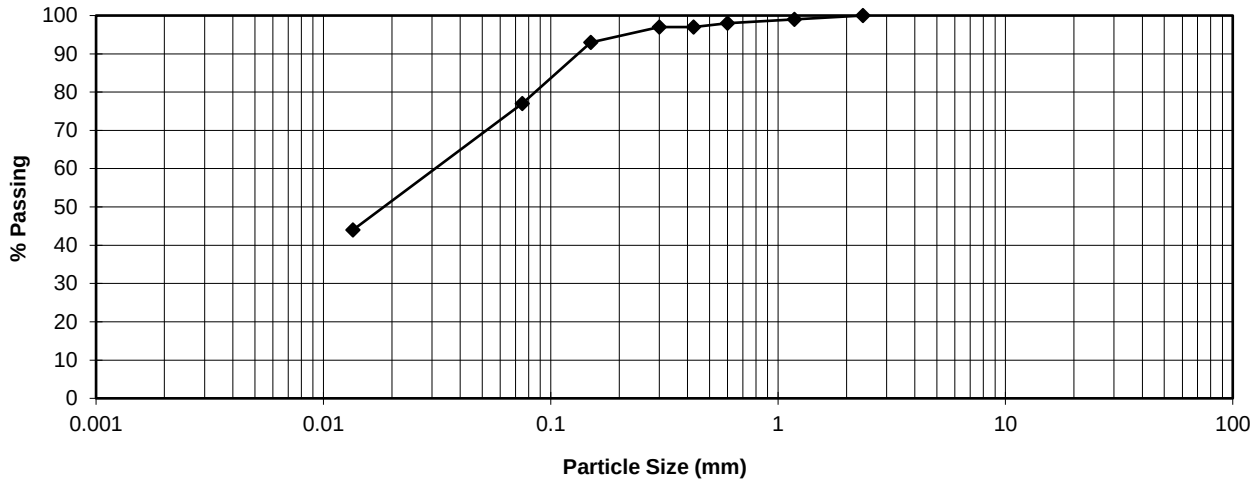
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60017
Report No:	60017-P14/3587
Sample No:	P14/3587
Issue Date:	2 October 2014

Client: Preston Green Pty Ltd
Project: Lot 201 Turner Street
Location: Boyanup, WA

Sample ID: TP01
Sample Depth(m): 0.60



SIEVE ANALYSIS WA115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	99
0.600	98
0.425	97
0.300	97
0.150	93
0.075	77
0.0135	44

Plasticity index tests
AS 1289

Liquid limit 3.9.1	44	%
Plastic limit 3.2.1	22	%
Plasticity index 3.3.1	22	%
Linear shrinkage 3.4.1	6.0	%

Cracked ☑
Curled ☐

Client Address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Accreditation for compliance with ISO/IEC 17025.
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Matthew van Herk

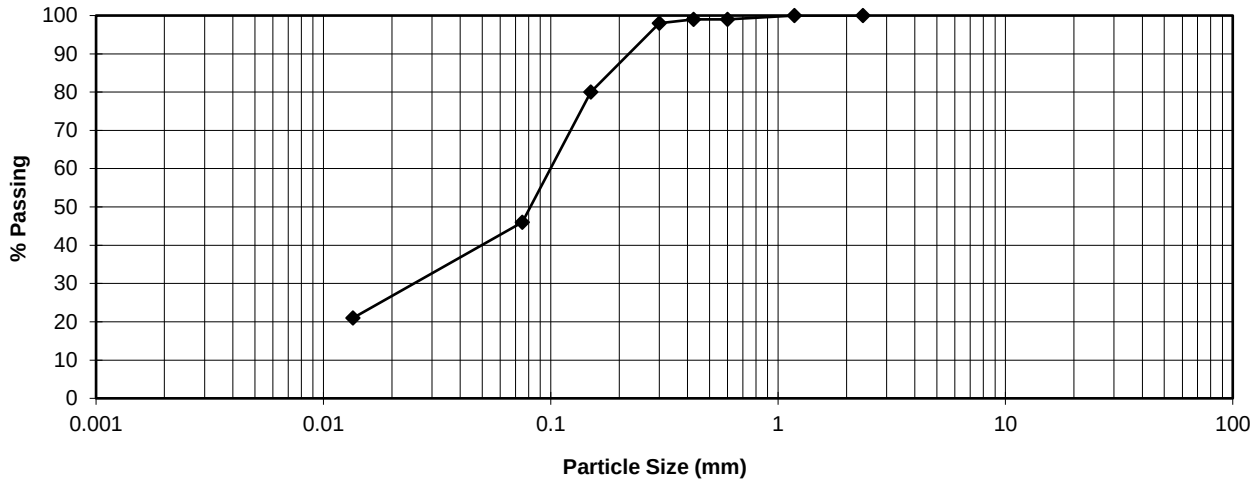
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60017
Report No:	60017-P14/3588
Sample No:	P14/3588
Issue Date:	2 October 2014

Client: Preston Green Pty Ltd
Project: Lot 201 Turner Street
Location: Boyanup, WA

Sample ID: TP03
Sample Depth(m): 0.50



SIEVE ANALYSIS WA115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	99
0.425	99
0.300	98
0.150	80
0.075	46
0.0135	21

Plasticity index tests
AS 1289

Liquid limit 3.9.1	23	%
Plastic limit 3.2.1	19	%
Plasticity index 3.3.1	4	%
Linear shrinkage 3.4.1	0.5	%

Cracked ☐

Curled ☐

Client Address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Mining &
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Geotest Pty Ltd
Unit 1/1 Pusey Road, JANDAKOT WA 6164
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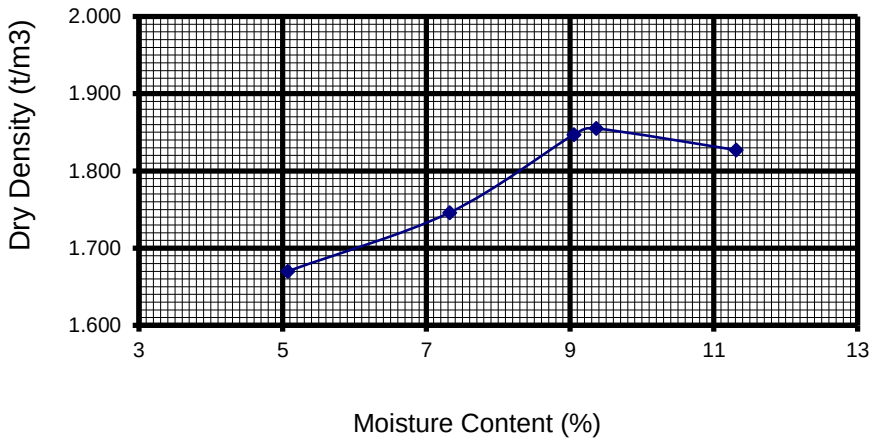
Email matt@mcgeotest.com.au

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

Certificate No:	60017-P14/3588	**Project:**	Lot 201 Turner Street
Sample No:	P14/3588	**Client:**	Preston Green Pty Ltd
Location:	Boyanup, WA	**Date of Issue:**	17 September 2014
	TP03 0.5	**Job No:**	60017

Maximum Dry Density t/m^3:	1.855	**Conditions at Test**	
Optimum Moisture Content %:	9.6	Soaking Period (Days)	4
Desired Conditions:	95/100	Surcharge (kg)	4.5
Compactive Effort		Entire Moisture Content %	17.7
Mass of hammer kg	4.9	Entire Moisture Ratio %	184.5
Number of layers	5	Top 30mm Moisture Content %	16.3
Number of blows/layer	16	Top 30mm Moisture Ratio %	169.5
Conditions after Compaction		Swell %	0.0
Dry Density t/m^3	1.761	C.B.R. at 5.0 mm Penetration %	18
Moisture Content %	9.8	**Conditions after Soaking**	
Density Ratio %	95.0	Dry Density t/m^3	1.761
Moisture Ratio %	101.5	Moisture Content %	17.1
Soaked / Unsoaked	Soaked	Dry Density Ratio %	95.0
		Moisture Ratio %	178.5

Comments:



Client Address: 36 O'Malley Street, Osborne Park

ASMDD-CBR June 2009

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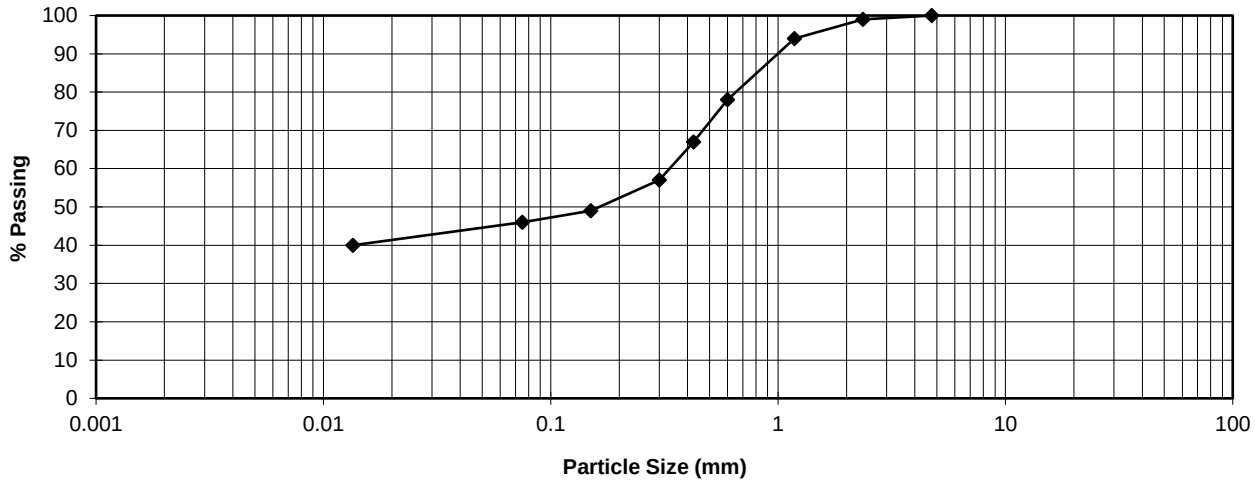
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60017
Report No:	60017-P14/3590
Sample No:	P14/3590
Issue Date:	2 October 2014

Client: Preston Green Pty Ltd
Project: Lot 201 Turner Street
Location: Boyanup, WA

Sample ID: TP10
Sample Depth(m): 1.00



SIEVE ANALYSIS WA115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	99
1.18	94
0.600	78
0.425	67
0.300	57
0.150	49
0.075	46
0.0135	40

Plasticity index tests
AS 1289

Liquid limit 3.9.1	51	%
Plastic limit 3.2.1	19	%
Plasticity index 3.3.1	32	%
Linear shrinkage 3.4.1	10.0	%

Cracked ☑

Curled ☐

Client Address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Matthew van Herk

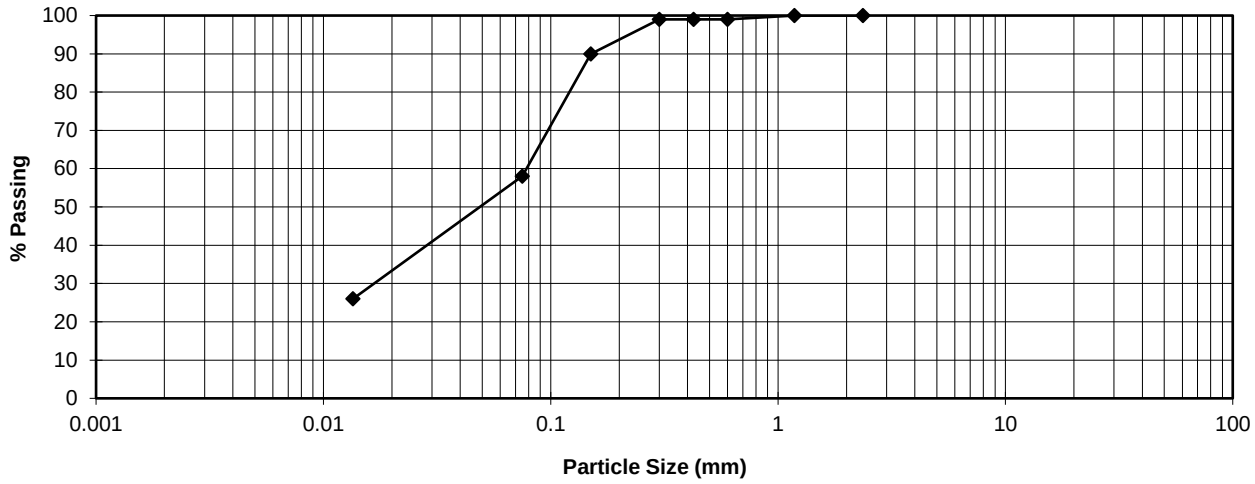
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60017
Report No:	60017-P14/3592
Sample No:	P14/3592
Issue Date:	2 October 2014

Client: Preston Green Pty Ltd
Project: Lot 201 Turner Street
Location: Boyanup, WA

Sample ID: PT13
Sample Depth(m): 0.30



SIEVE ANALYSIS WA115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	99
0.425	99
0.300	99
0.150	90
0.075	58
0.0135	26

Plasticity index tests
AS 1289

Liquid limit 3.9.1	NA	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client Address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

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Matthew van Herk
AS PSDPI May 2009

Mining & Civil Geotest Pty Ltd

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Email matt@mcgeotest.com.au
Unit 1/1 Pusey Road, JANDAKOT WA 6164

Determination of the Shrinkage Index of a Soil
Shrink Swell Index
AS 1289.7.1.1

		Job No:	60017
		Report No:	60017-P14/3589
		Date of issue:	2 October 2014
Client:	Preston Green Pty Ltd	Date tested:	25 September 2014
Project:	Lot 201 Turner Street	Tested by:	W Old
Location:	Boyanup, WA	Checked:	M van Herk
Sample:	TP03 0.7-1.0m	Sample No:	P14/3589

Sample details

Sample description : Brown Silty Sand

Sample Type : 63 mm Ø tube sample

Swell Specimen		Shrinkage Specimen	
Dry Density - Initial (t/m$^{3)}$	1.48	Moisture Content Initial (%)	14.7
Moisture Content - Initial (%)	13.6	Length/Diameter Ratio	2.1
Moisture Content - Final (%)	25.2	Extent of Crumbling	Nil
Overburden Pressure (kPa)	25	Extent of Cracking	Nil
Significant Inert Inclusions (%)	0		

Shrink-Swell Index

I_{ss} = **0.2** % Vertical strain per pF change in Total suction

Client address: 36 O'Malley Street, Osborne Park

Tested as received

Approved Signature

Matthew van Herk

Mining & Civil Geotest Pty Ltd

Ph (08) 9414 8022 Fax (08) 9414 8011
Email matt@mcgeotest.com.au
Unit 1/1 Pusey Road, JANDAKOT WA 6164

Determination of the Shrinkage Index of a Soil
Shrink Swell Index
AS 1289.7.1.1

		Job No:	60017
		Report No:	60017-P14/3591
		Date of issue:	2 October 2014
Client:	Preston Green Pty Ltd	Date tested:	25 September 2014
Project:	Lot 201 Turner Street	Tested by:	W Old
Location:	Boyanup, WA	Checked:	M van Herk
Sample:	TP11 0.6-0.9m	Sample No:	P14/3591

Sample details

Sample description : Brown Sandy Clay

Sample Type : 48 mm Ø tube sample

Swell Specimen		Shrinkage Specimen	
Dry Density - Initial (t/m$^{3)}$	1.64	Moisture Content Initial (%)	20.3
Moisture Content - Initial (%)	22.4	Length/Diameter Ratio	2.1
Moisture Content - Final (%)	27.4	Extent of Crumbling	Nil
Overburden Pressure (kPa)	25	Extent of Cracking	Nil
Significant Inert Inclusions (%)	2		

Shrink-Swell Index

I_{ss} = **2.5** % Vertical strain per pF change in Total suction

Client address: 36 O'Malley Street, Osborne Park

Tested as received

Approved Signature

Matthew van Herk

ATTACHMENT C
FEATURE SURVEY PLAN

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development consultants

Thompson surveying consultants

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Licensed Surveyors, Project Managers
& Engineering Surveyors

A.C.N. 008 938 903 ABN 59 166 330 334

Unit 6, 18 Casuarina Drive
BUNBURY WA 6230

Phone: (08) 9721 4000 Fax: (08) 9721 2720
eMail: info@thompsonsurveying.com.au

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FS 520415

NOTE: All services plotted from information supplied by others, site verification required prior to construction.
Boundary position is not deemed to be correct until a resurvey has been carried out.
Check Certificate of Title for any easements etc.
No responsibility accepted for changes occuring after date of survey.

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CLIENT:	PRESTON GREEN Pty. Ltd.	
PROJECT:	Meadowbrook Estate, Turner Street, Boyanup	
TITLE:	FEATURE SURVEY	
DATUM	VERT:	A.H.D.
	HOR:	BCG '94

ATTACHMENT D
GROUNDWATER LEVEL REPORT

development consultants

December 14

GROUNDWATER LEVEL MONITORING REPORT

MEADOWBROOK LIFESTYLE VILLAGE

PREPARED FOR: PRESTON GREEN

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DOCUMENT CONTROL

Title:	**GROUNDWATER LEVEL MONITORING REPORT MEADOWBROOKE LIFESTYLE VILLAGE**
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Client :	**PRESTON GREEN PTY LTD**

Revision

Revision	Summary	Revised by	Approved by	Date
A	Issued with LWMS			

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The document has been restricted to those issues that have been agreed between the Client and MPM. It shall be recognised that site conditions change and contain varying degrees of non-uniformity that cannot be fully defined by field investigation. Measurements and values obtained from sampling and testing in this document are indicative within a limited timeframe, and unless otherwise specified, should not be accepted as conditions on site beyond that timeframe.

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TABLE OF CONTENTS

Attachments

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1.0 Executive Summary

MPM Development Consultants (MPM) undertook the level monitoring of superficial groundwater within Lot 888 Turner Street, Boyanup, currently known as Meadowbrooke Estate in order to assist in the preparation of a Development Guide Plan (DGP) for the development of the site to a Lifestyle Village.

This report represents those groundwater monitoring levels and the impact on development.

The subject land is located within the Boyanup Townsite, directly north of the rail reserve and currently disused railway buildings. Access to the site is via Turner Street. The land is bounded to the east by the Ferguson River and to the north by a drainage reserve that contributes to the Ferguson River.

Figure 1 – Location Plan – Courtesy of Landgate

The information collected will be utilised for the preparation of groundwater management strategies and ultimately the detailed engineering design for the development infrastructure.

The site is characterised by high groundwater levels through the western portion of the site and groundwater levels of approximately 3.0m deep through the lower northern portion of the site.

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2.0 Introduction

MPM were engaged by Preston Green Pty Ltd to undertake measurement of the depth of groundwater across Lot 888 Turner Street, Boyanup to collect the 2011 and 2012 peak groundwater levels.

9 Groundwater monitoring bores were installed across the site by Australind Water Boring at the locations as shown below in Figure 1.

Figure 1 – Bore Locations

Measurements were taken on 15 occasions from 2nd June 2011 to the 21st November 2012. The measurement of all 9 bores was undertaken on the same day.

3.0 Results

The complete record of groundwater levels in included as Attachment A and a summary of the results is contained below in Table 1.

BORE NO.	LOWEST GWL	DEPTH OF BORE	HIGHEST GWL	HIGHEST GWL (m AHD)	MONTH HIGHEST GWL RECORDED
1	Dry	3.02	0.75	35.48	Sept 2012
2	Dry	3.06	1.39	33.80	Aug 2011
3	Dry	3.01	Dry	-	-
4	Dry	3.04	Dry	-	-
5	Dry	2.98	2.63	26.99	Oct 2011
6	Dry	3.03	1.19	30.92	Aug 2012
7	Dry	3.96	0.91	33.48	Aug 2011
8	Dry	4.05	2.46	32.34	Aug 2011
9	Dry	3.00	0.44	35.54	Aug 2012

Table 1

Notes:
1. Highest/Lowest GWL noted in metres below Natural Surface
2. Depth of bore noted in metres below Natural Surface
3. A dry notation indicates that no groundwater level was recorded.

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4.0 Rainfall

In order to determine if a correlation exists between rainfall and groundwater level, Figure 2 below provies the total monthly rainfall for 2011 and 2012, with Figure 3 providing the Groundwater level for each of the monitoring bores.

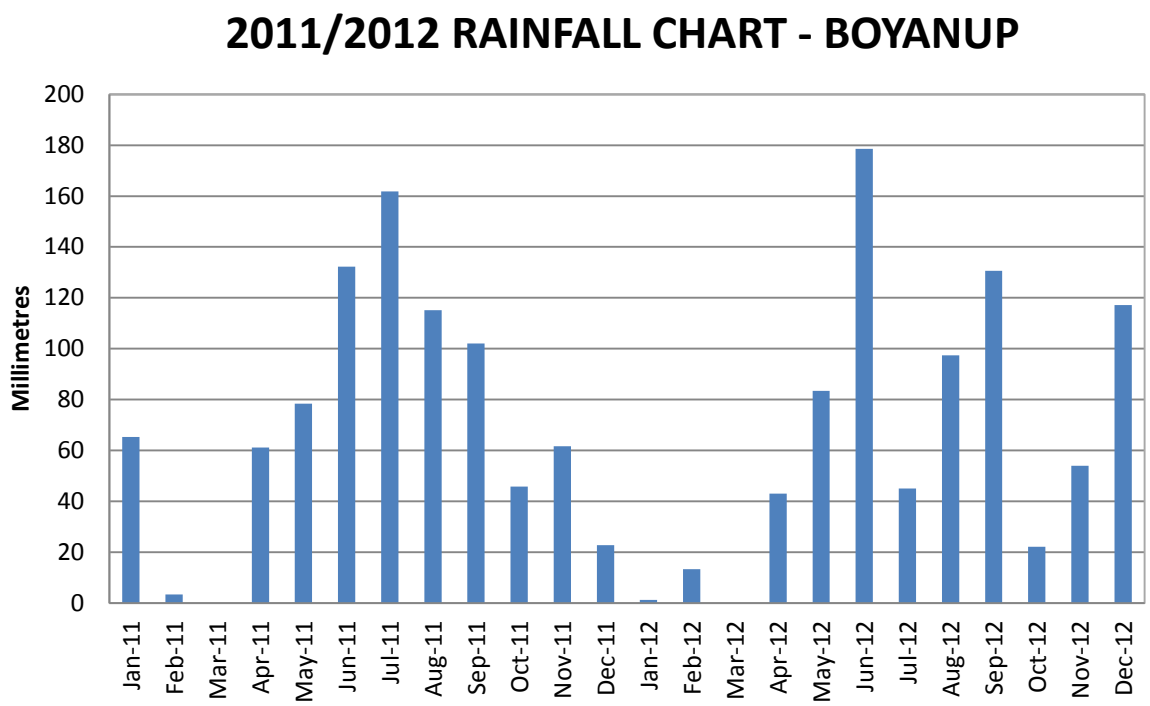


Figure 2 – Monthly Rainfall Chart

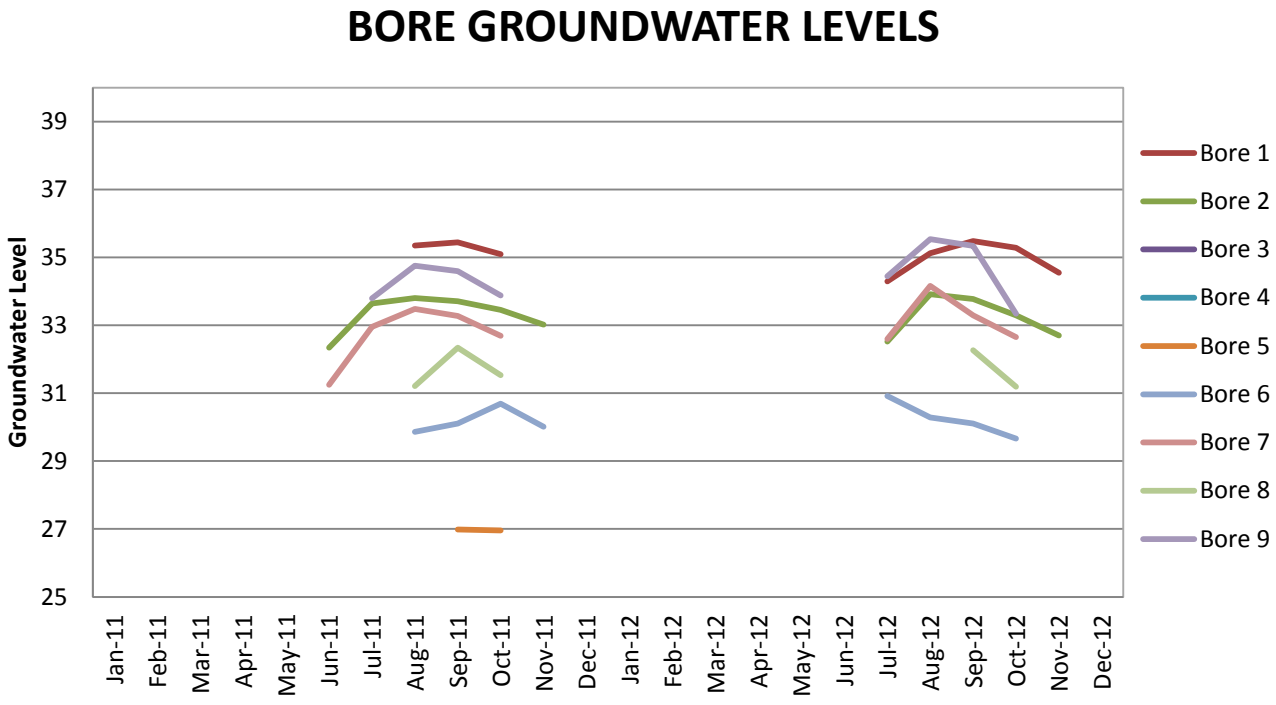
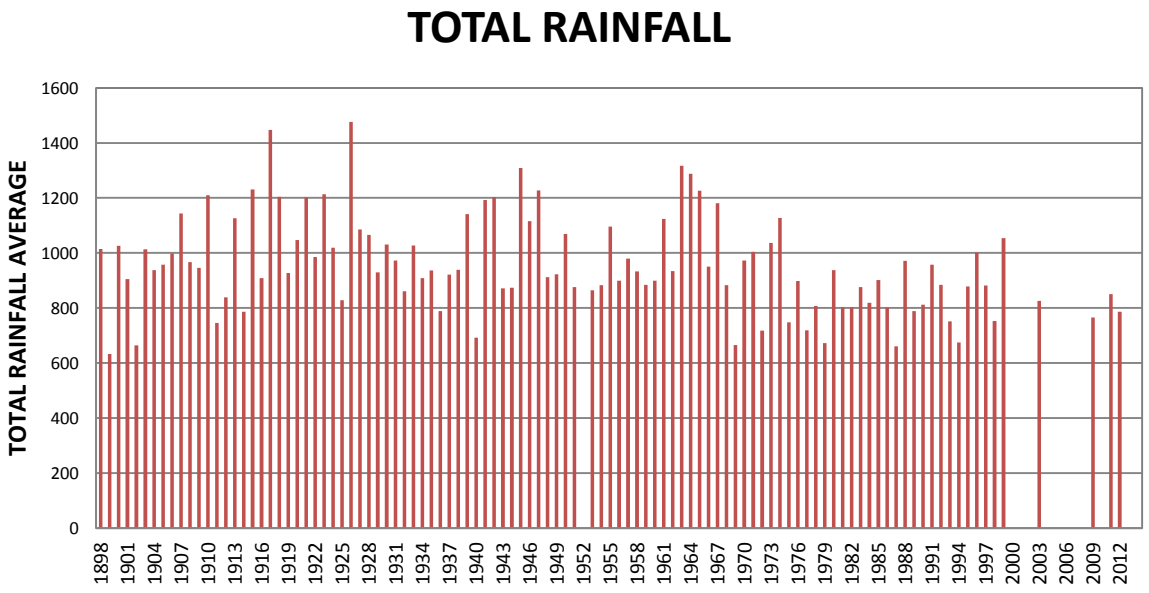


Figure 3 – Bore Groundwater Levels

It can be seen from Figure 2 and 3 above that there is a direct correlation between rainfall and groundwater level. The delay between the month of peak rainfall and peak of groundwater level is approximately 1 month.

A review of the entire rain fall records for the Boyanup area back to the first record in 1898 is shown below in Figure 4.



*Note: Space shows missing daily observations

Figure 4 – Total Rainfall

A review of the average yearly rainfall for the period of 1970 to current day indicates an average total yearly rainfall of 851mm. With the total yearly rainfall for 2011 and 2012 being 849.7 and 786mm respectively it can be determined that neither 2011or 2012 were considered a wet year, therefore marginal higher groundwater levels could be expected when an average yearly rainfall occurs.

5.0 Regional Groundwater

A search of the Department of Water (DoW) groundwater bore website Water Information Reporting indicates that 4 bores are located within relatively close proximity to the site.

- DoW Monitoring site 61118065 is located near Payne Street approximately 2.4km from the site
- DoW Monitoring site 61118066 is located near Payne Street approximately 2.4km from the site
- DoW Monitoring site 61118083 is located on Gray Road approximately 1.8km from the site
- DoW Monitoring site 61118084 is located on Gray Road approximately 1.8km from the site

Figure 5 below indicates the location of the bores relative to the site.

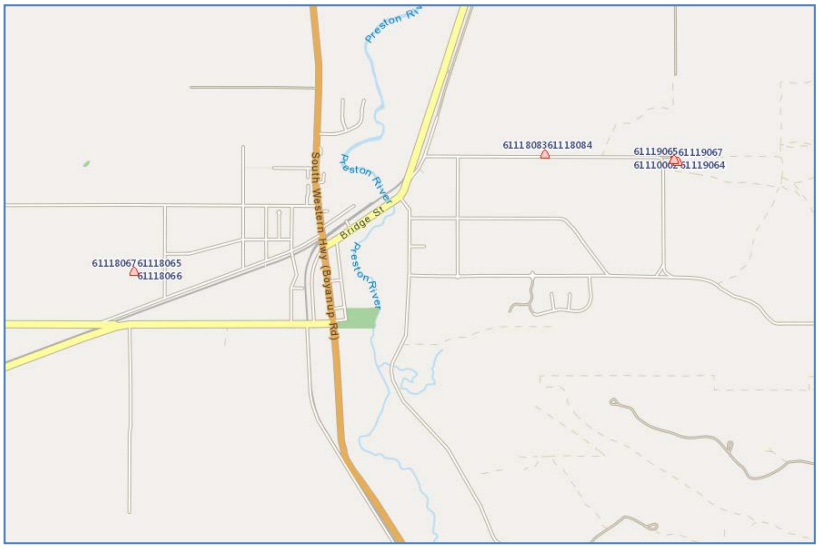


Figure 5 – Location of bores relative to site

The DoW monitoring sites collected a varied number of readings per year although a reading at each bore was generally recorded in September each year, it should be noted that this may not have been the maximum groundwater level for the site. The monitoring sites provided records from 1979 through to the present day, covering the 2011 and 2012 monitoring periods.

Each of the monitoring sites provided control data and an AAMGL was calculated for each site, as follows:

Monitoring	AAMGL	MGL 2011	MGL 2012
61118065	30.33	29.26	28.60
61118066	30.49	29.20	28.67
61118083	33.98	34.68	33.53
61118084	36.13	34.64	34.25

Table 2

A review of this analysis indicates that the 2011 and 2012 maximum groundwater levels for the DoW monitoring bores are an average 1.2m lower than the AAMGL with the exception of monitoring site 8083 which has recorded an MGL approximately 0.7m above the AAMGL.

The regional groundwater bore data therefore agrees with the rainfall data in that in wetter years or years of average rainfall higher groundwater levels can be expected across the development site.

6.0 Discussion

Figure 6 as included below and in larger scale with Attachment C provides an interpretation of the maximum groundwater contours for the development site based upon the recorded maximum groundwater levels for 2011 and 2012.

Based upon the comparison to yearly total rainfall for Boyanup and a comparison to regional Department of Water groundwater bore data, it could be expected that the maximum groundwater levels across the development site could be marginally higher than those recorded in 2011 and 2012.

The southern, elevated sections are evidenced by areas of high groundwater at the winter peak. The northern, lower sections of the site have a significantly deeper groundwater depth due to the effect of the adjoining drainage channel and Preston River. Both the drainage channel and Preston would act to draw down the groundwater to their permanent water levels.

7.0 Recommendations

The shallow maximum groundwater levels across the development site, particularly in the elevated but clayey areas of the site will necessitate groundwater management during construction and for development to occur.

The shallow maximum groundwater will necessitate that appropriate strategies and plans are created to manage the groundwater resource.

These may include:

- Subsurface/Subsoil Drainage to control/maintain maximum groundwater levels.
- Importation of fill to create additional separation of proposed infrastructure to maximum groundwater levels.
- Management and/or restriction of stormwater infiltration.
- Appropriate management of sewer effluent disposal.

The proximity of the development site to the Ferguson River, a protected water body, will necessitate that any alteration to the existing groundwater regime should be carefully managed and future development should ensure that all groundwater extracted from subsoil networks will be tested to ensure it will not affect the Ferguson River.

A review of the sites groundwater quality will be required should groundwater control mechanisms be put in place with future development.

Groundwater management should be addressed within a subsequent Local Water Management Strategy or Urban Water Management Plan prior to development proceeding to ensure appropriate management and detailed design considers the groundwater resource.

ATTACHMENT A
RECORDED GROUNDWATER LEVELS

Groundwater Monitoring Bores
Meadowbrooke

Table 1

BORE ID	EASTING (m)	NORTHING (m)	BORE RL (m)	GROUND RL (m)	DEPTH OF BORE RL (m)	DEPTH OF BORE (m)	DATE :		02/06/2011	DATE :		7/07/11	DATE :		08/08/2011	DATE :		31/08/2011	DATE :		04/10/2011	DATE :	
							RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE
MB1			37.198	36.228	33.208	3.020	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	1.85	0.88	35.35	1.76	0.79	35.44	2.11	1.14
MB2			36.141	35.193	32.131	3.062	3.8	2.85	32.34	2.5	1.55	33.64	2.34	1.39	33.80	2.43	1.48	33.71	2.69	1.74	33.45	3.12	2.17
MB3			32.491	31.541	28.531	3.010	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!
MB4			30.993	30.064	27.023	3.041	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!
MB5			30.644	29.621	26.634	2.987	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	3.65	2.63	26.99	3.68	2.66
MB6			33.081	32.113	29.081	3.032	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	3.22	2.25	29.86	2.97	2.00	30.11	2.39	1.42	30.69	3.07	2.10
MB7			35.423	34.390	30.423	3.967	4.17	3.14	31.25	2.47	1.44	32.95	1.94	0.91	33.48	2.15	1.12	33.27	2.73	1.70	32.69	NE	#VALUE!
MB8			35.760	34.803	30.750	4.053	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	4.55	3.59	31.21	3.42	2.46	32.34	4.23	3.27	31.53	NE	#VALUE!
MB9			36.967	35.978	32.977	3.001	NE	#VALUE!	#VALUE!	3.18	2.19	33.79	2.22	1.23	34.75	2.38	1.39	34.59	3.09	2.10	33.88	NE	#VALUE!

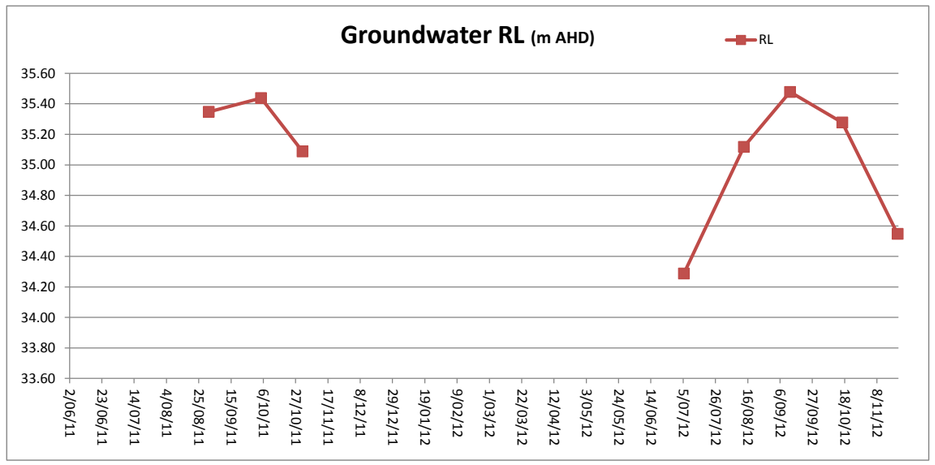
Note : NE = Not Encountered
NR = Not Recorded
SIP = Star Iron Picket
MB = Monitoring Bore

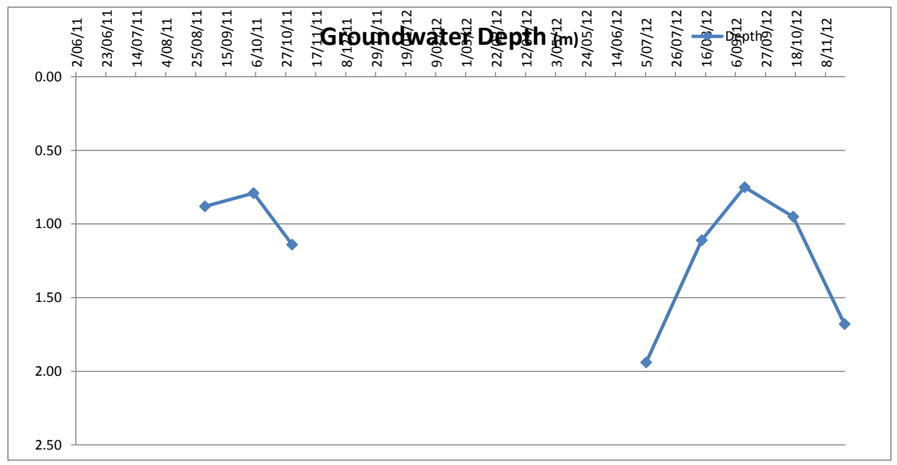
31/10/2011	DATE :		15/02/2012	DATE :		15/05/2012	DATE :		05/07/2012	DATE :		13/08/2012	DATE :		12/09/2012	DATE :		16/10/2012	DATE :		21/11/2012
RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	BORE ID	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE	RECORDED DEPTH TO WATER TABLE	ACTUAL DEPTH TO WATER TABLE	RL OF WATER TABLE
35.09	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	2.91	1.94	34.29	2.08	1.11	35.12	MB1	1.72	0.75	35.48	1.92	0.95	35.28	2.65	1.68	34.55
33.02	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	3.62	2.67	32.52	2.22	1.27	33.92	MB2	2.37	1.42	33.77	2.85	1.90	33.29	3.44	2.49	32.70
#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	MB3	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!
#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	MB4	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!
26.96	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	MB5	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!
30.01	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	2.16	1.19	30.92	MB6	2.79	1.82	30.29	2.97	2.00	30.11	3.42	2.45	29.66
#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	2.82	1.79	32.60	1.26	0.23	34.16	MB7	2.13	1.10	33.29	2.77	1.74	32.65	NE	#VALUE!	#VALUE!
#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	MB8	3.49	2.53	32.27	4.57	3.61	31.19	NE	#VALUE!	#VALUE!
#VALUE!	NE	#VALUE!	#VALUE!	NE	#VALUE!	#VALUE!	2.53	1.54	34.44	1.43	0.44	35.54	MB9	1.53	0.54	35.44	3.63	2.64	33.34	NE	#VALUE!	#VALUE!

ATTACHMENT B
MONITORING BORE GRAPHICAL SUMMARIES

Graph of Monitoring Bore Number **1**

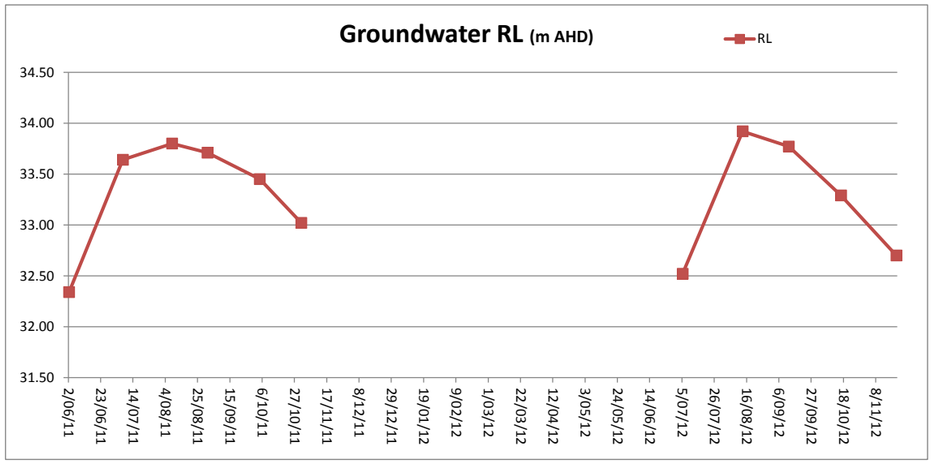
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11		
7/07/11		
8/08/11		
31/08/11	35.35	0.88
4/10/11	35.44	0.79
31/10/11	35.09	1.14
15/02/12		
15/05/12		
5/07/12	34.29	1.94
13/08/12	35.12	1.11
12/09/12	35.48	0.75
16/10/12	35.28	0.95
21/11/12	34.55	1.68

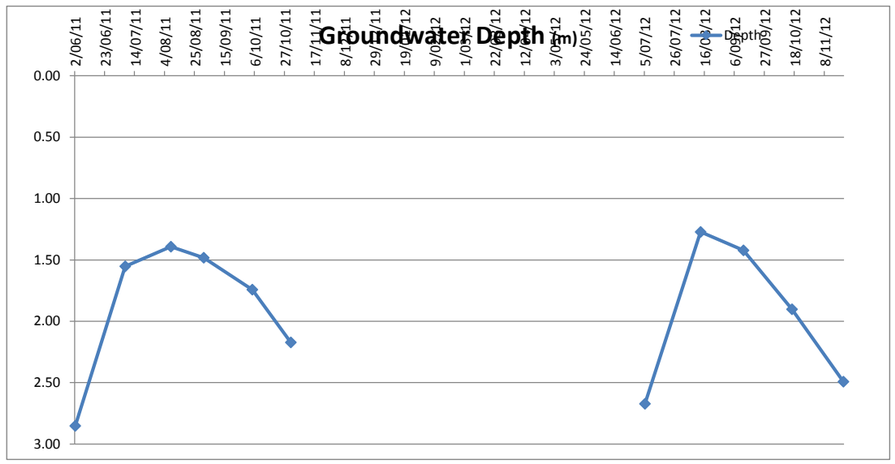




Graph of Monitoring Bore Number **2**

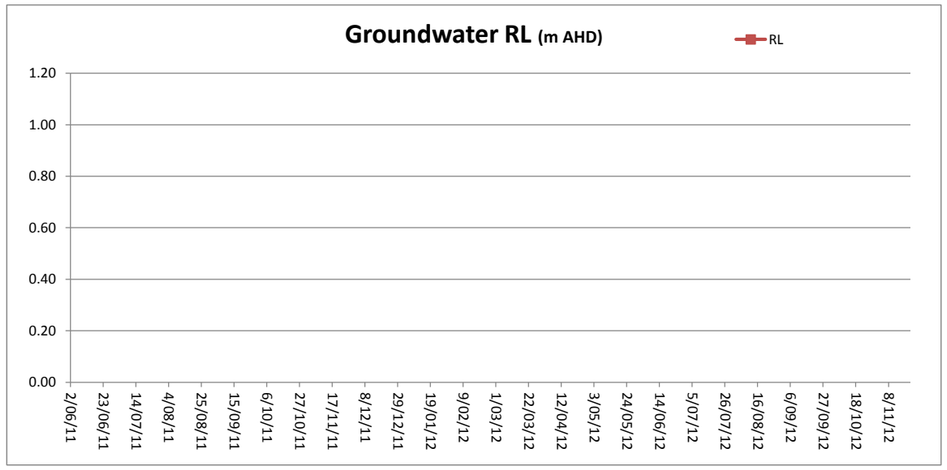
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11	32.34	2.85
7/07/11	33.64	1.55
8/08/11	33.80	1.39
31/08/11	33.71	1.48
4/10/11	33.45	1.74
31/10/11	33.02	2.17
15/02/12		
15/05/12		
5/07/12	32.52	2.67
13/08/12	33.92	1.27
12/09/12	33.77	1.42
16/10/12	33.29	1.90
21/11/12	32.70	2.49

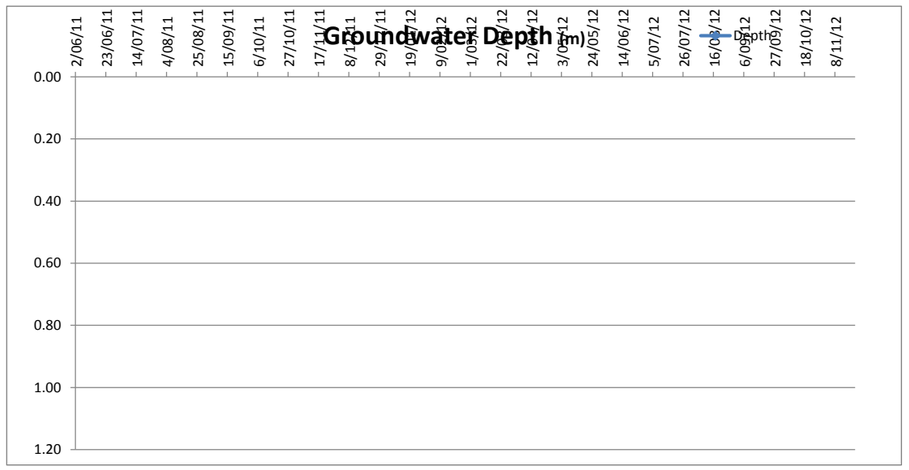




Graph of Monitoring Bore Number **3**

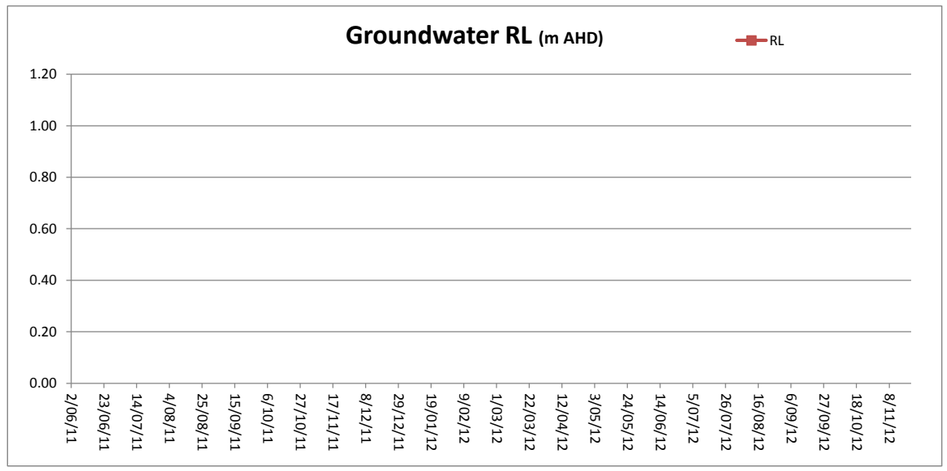
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11		
7/07/11		
8/08/11		
31/08/11		
4/10/11		
31/10/11		
15/02/12		
15/05/12		
5/07/12		
13/08/12		
12/09/12		
16/10/12		
21/11/12		

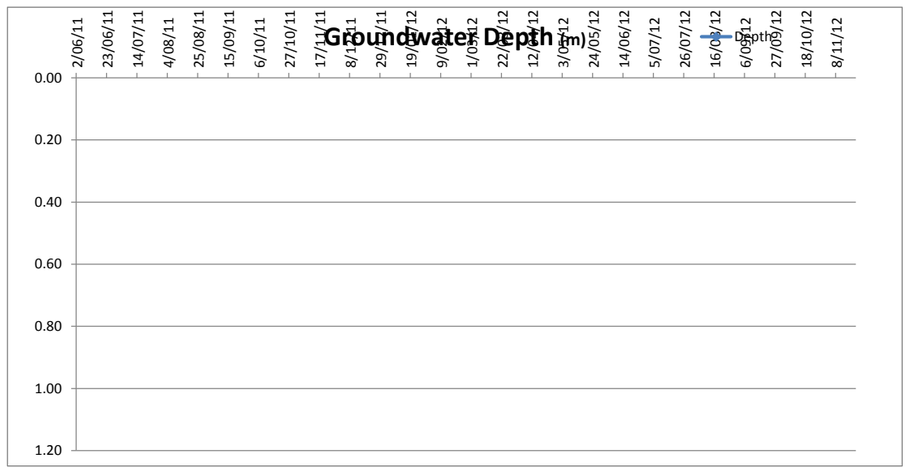




Graph of Monitoring Bore Number **4**

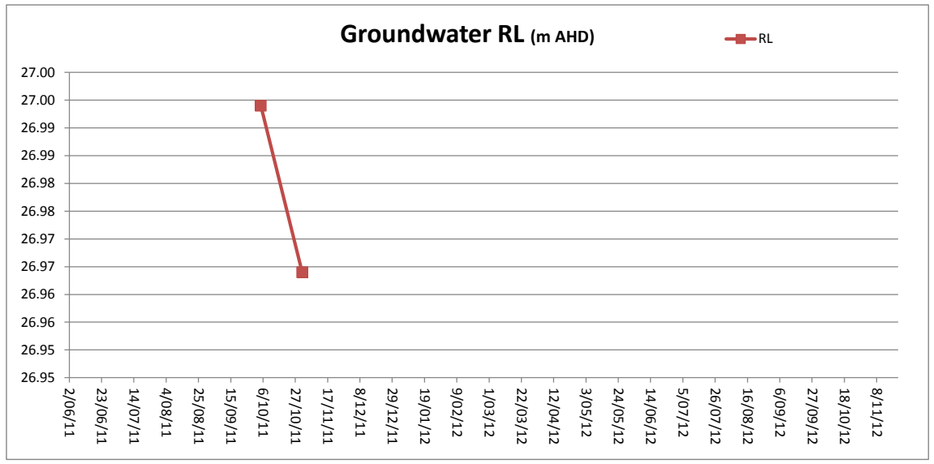
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11		
7/07/11		
8/08/11		
31/08/11		
4/10/11		
31/10/11		
15/02/12		
15/05/12		
5/07/12		
13/08/12		
12/09/12		
16/10/12		
21/11/12		

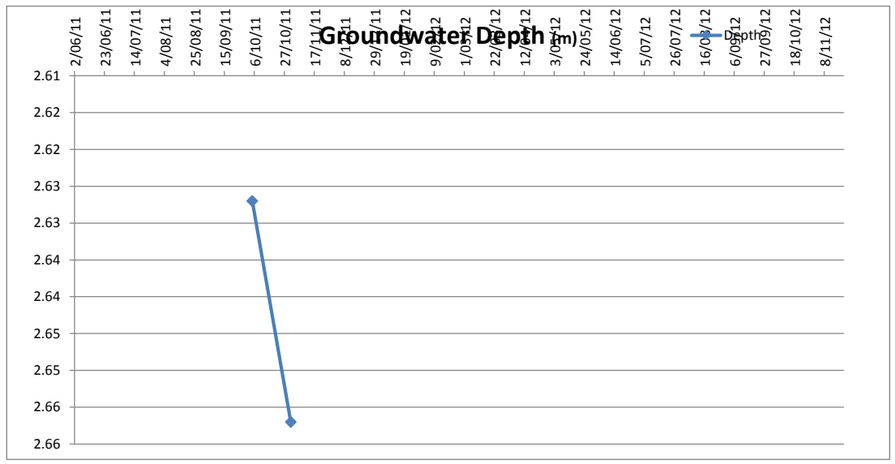




Graph of Monitoring Bore Number **5**

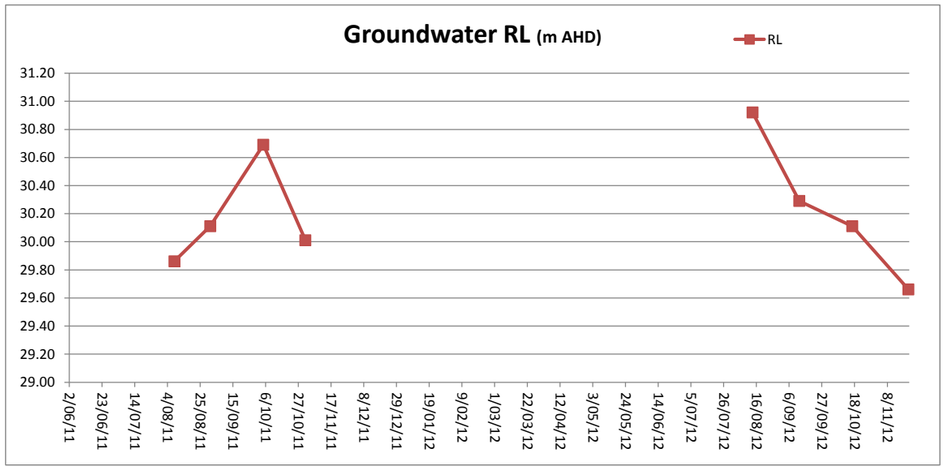
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11		
7/07/11		
8/08/11		
31/08/11		
4/10/11	26.99	2.63
31/10/11	26.96	2.66
15/02/12		
15/05/12		
5/07/12		
13/08/12		
12/09/12		
16/10/12		
21/11/12		

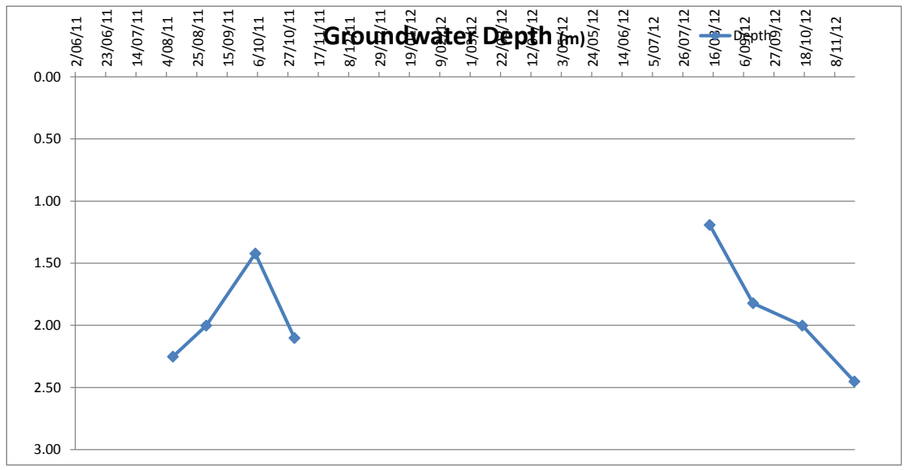




Graph of Monitoring Bore Number 6

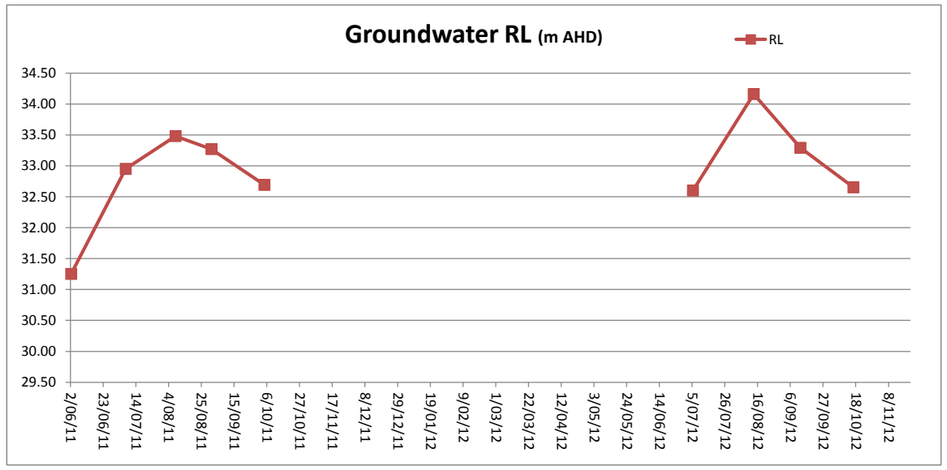
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11		
7/07/11		
8/08/11	29.86	2.25
31/08/11	30.11	2.00
4/10/11	30.69	1.42
31/10/11	30.01	2.10
15/02/12		
15/05/12		
5/07/12		
13/08/12	30.92	1.19
12/09/12	30.29	1.82
16/10/12	30.11	2.00
21/11/12	29.66	2.45

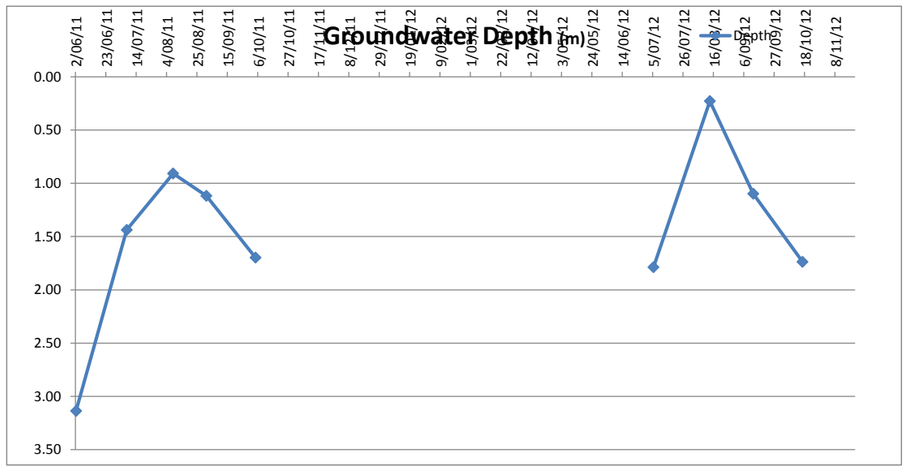




Graph of Monitoring Bore Number **7**

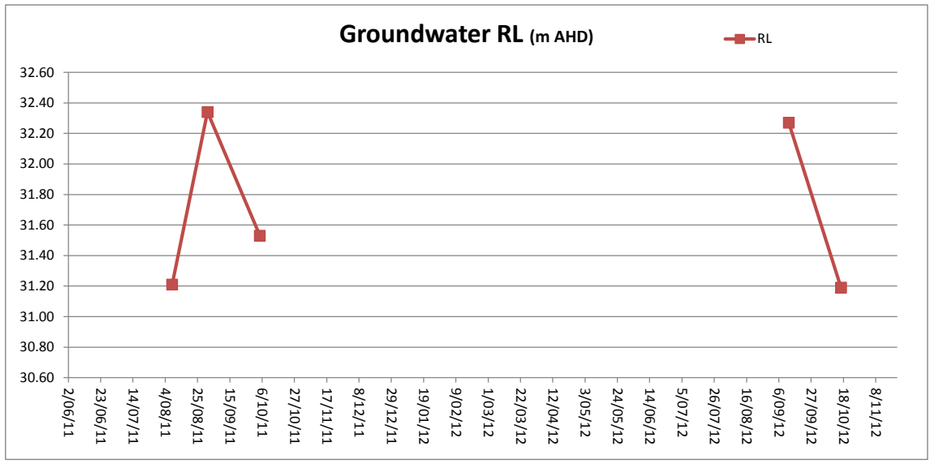
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11	31.25	3.14
7/07/11	32.95	1.44
8/08/11	33.48	0.91
31/08/11	33.27	1.12
4/10/11	32.69	1.70
31/10/11		
15/02/12		
15/05/12		
5/07/12	32.60	1.79
13/08/12	34.16	0.23
12/09/12	33.29	1.10
16/10/12	32.65	1.74
21/11/12		

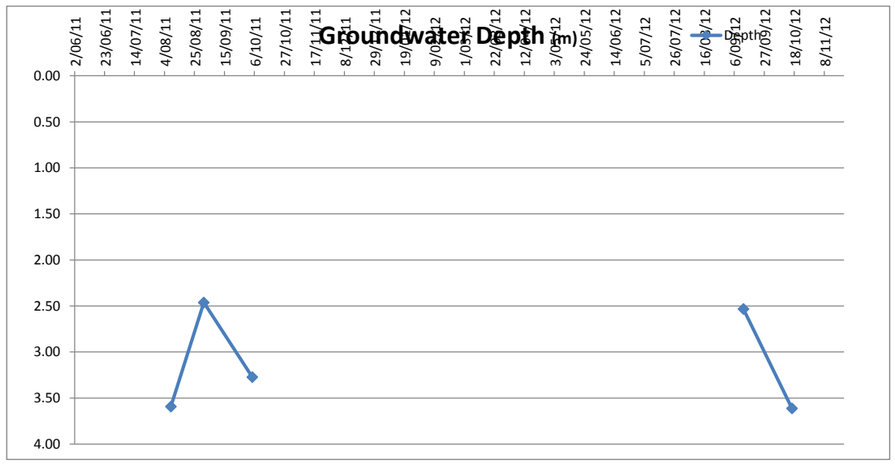




Graph of Monitoring Bore Number **8**

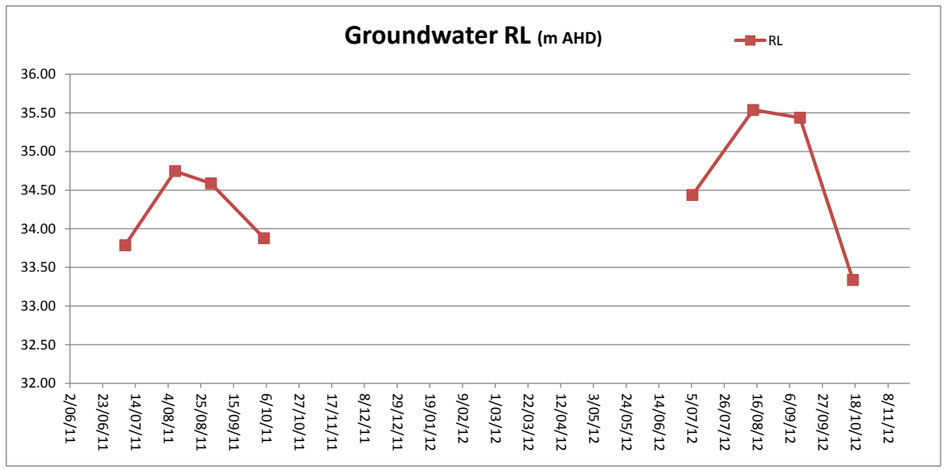
Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11		
7/07/11		
8/08/11	31.21	3.59
31/08/11	32.34	2.46
4/10/11	31.53	3.27
31/10/11		
15/02/12		
15/05/12		
5/07/12		
13/08/12		
12/09/12	32.27	2.53
16/10/12	31.19	3.61
21/11/12		

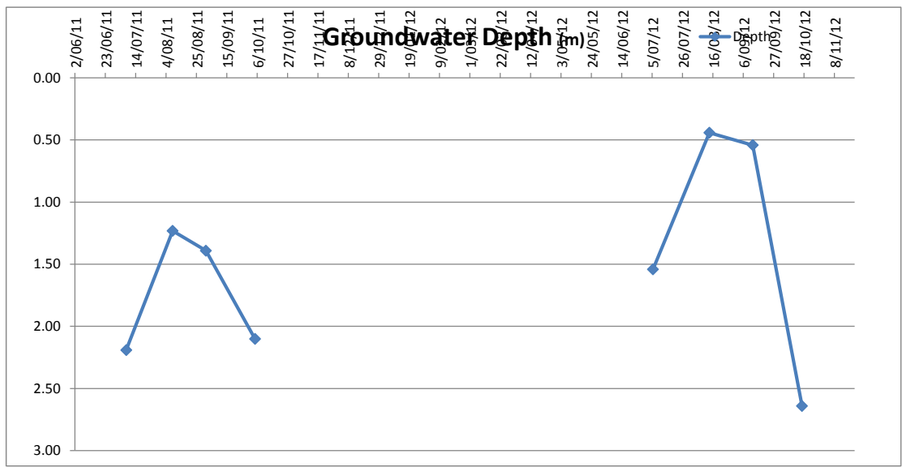


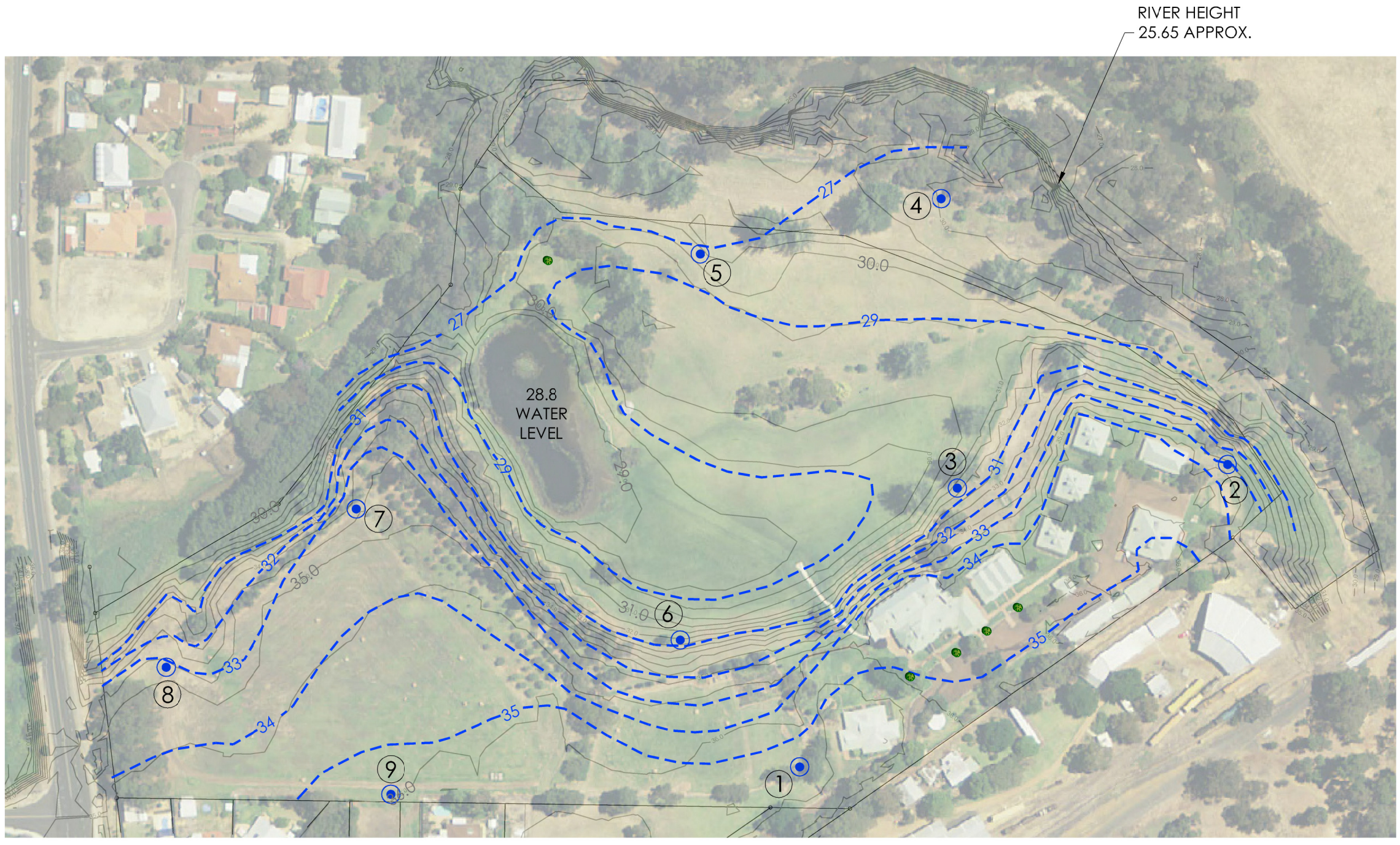


Graph of Monitoring Bore Number **9**

Date	Groundwater RL (m AHD)	Actual Depth to Groundwater (m)
2/06/11		
7/07/11	33.79	2.19
8/08/11	34.75	1.23
31/08/11	34.59	1.39
4/10/11	33.88	2.10
31/10/11		
15/02/12		
15/05/12		
5/07/12	34.44	1.54
13/08/12	35.54	0.44
12/09/12	35.44	0.54
16/10/12	33.34	2.64
21/11/12		







LEGEND

APPROXIMATE, RECORDED MAXIMUM GROUNDWATER WATER LEVEL

31.0 EXISTING SURFACE CONTOUR

N

mpm
development consultants
Telephone: (08)97 214777
Email: reception@mpmdc.com.au

Project: MEADOWBROOKE
Title: INTERPOLATED MAXIMUM GROUNDWATER LEVEL
Plan: 14041 14
Do Not Scale

ATTACHMENT E
PREDEVELOPMENT ENVIRONMENTAL PLAN

mpm development consultants

LEGEND

STORMWATER CATCHMENT

0.68 PREDEVELOPMENT FLOW (L/s)

A PREDEVELOPMENT CATCHMENT

N

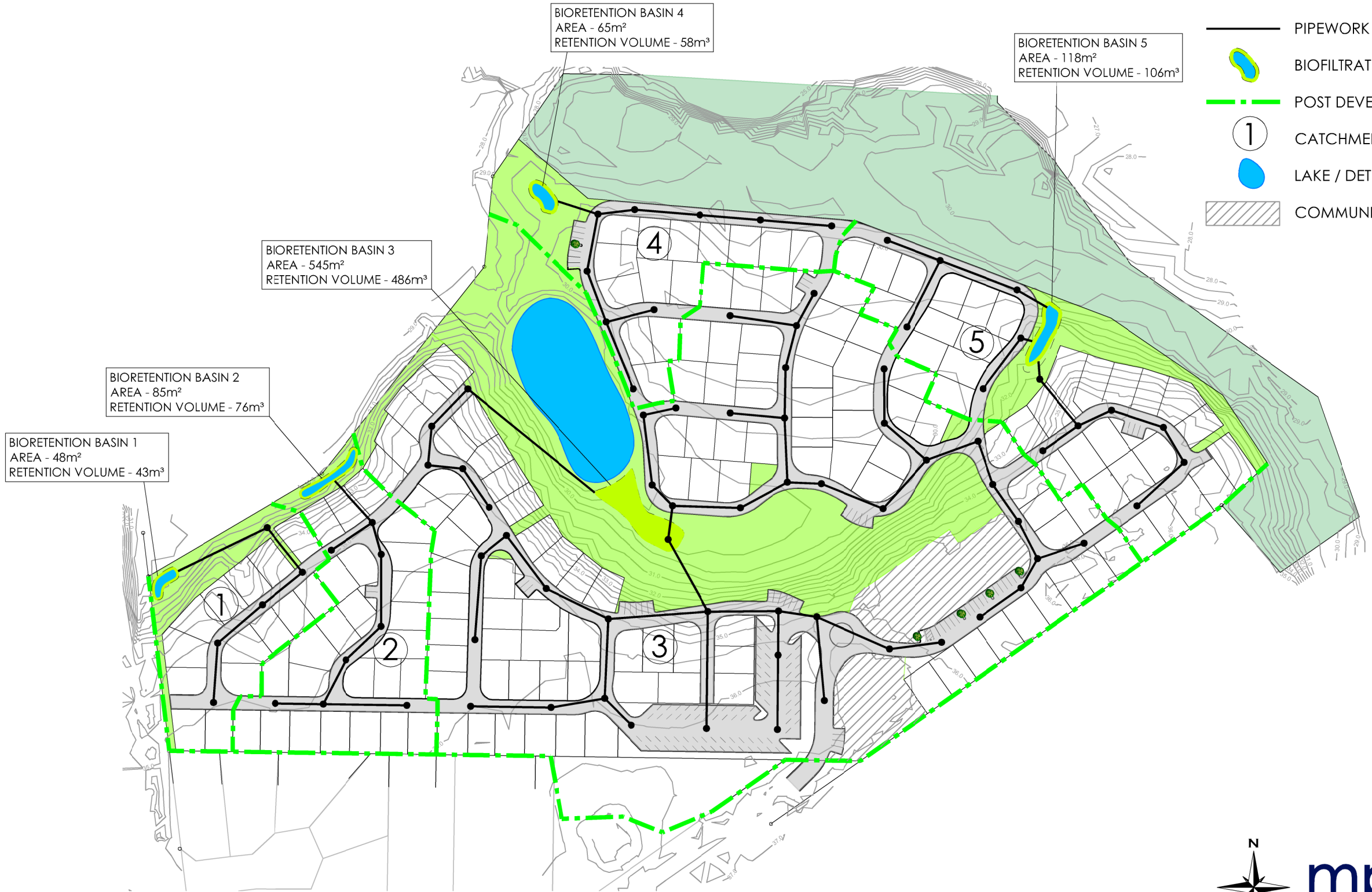
mpm
development consultants

Telephone: (08)97 214777
Email: reception@mpmdc.com.au

Project: MEADOWBROOKE LIFESTYLE ESTATE
Title: PREDEVELOPMENT ENVIRONMENT PLAN
Plan: 14041 10
Do Not Scale

ATTACHMENT F
1 IN 1 YEAR ENVIRONMENTAL FLOW STRATEGY

mpm development consultants



LEGEND

- GRATED INLET PIT
- PIPEWORK
- BIOFILTRATION BASIN
- POST DEVELOPMENT CATCHMENT
- 1 CATCHMENT No.
- LAKE / DETENTION
- COMMUNITY INFRASTRUCTURE AREA

N

mpm
development consultants
Telephone: (08)97 214777
Email: reception@mpmdc.com.au

Project: MEADOWBROOKE LIFESTYLE ESTATE
Title: STORMWATER MANAGEMENT STRATEGY 1 IN 1
Plan: 14041 11
Do Not Scale

ATTACHMENT G
1 IN 5 YEAR MAJOR STORM EVENT STRATEGY

mpm development consultants

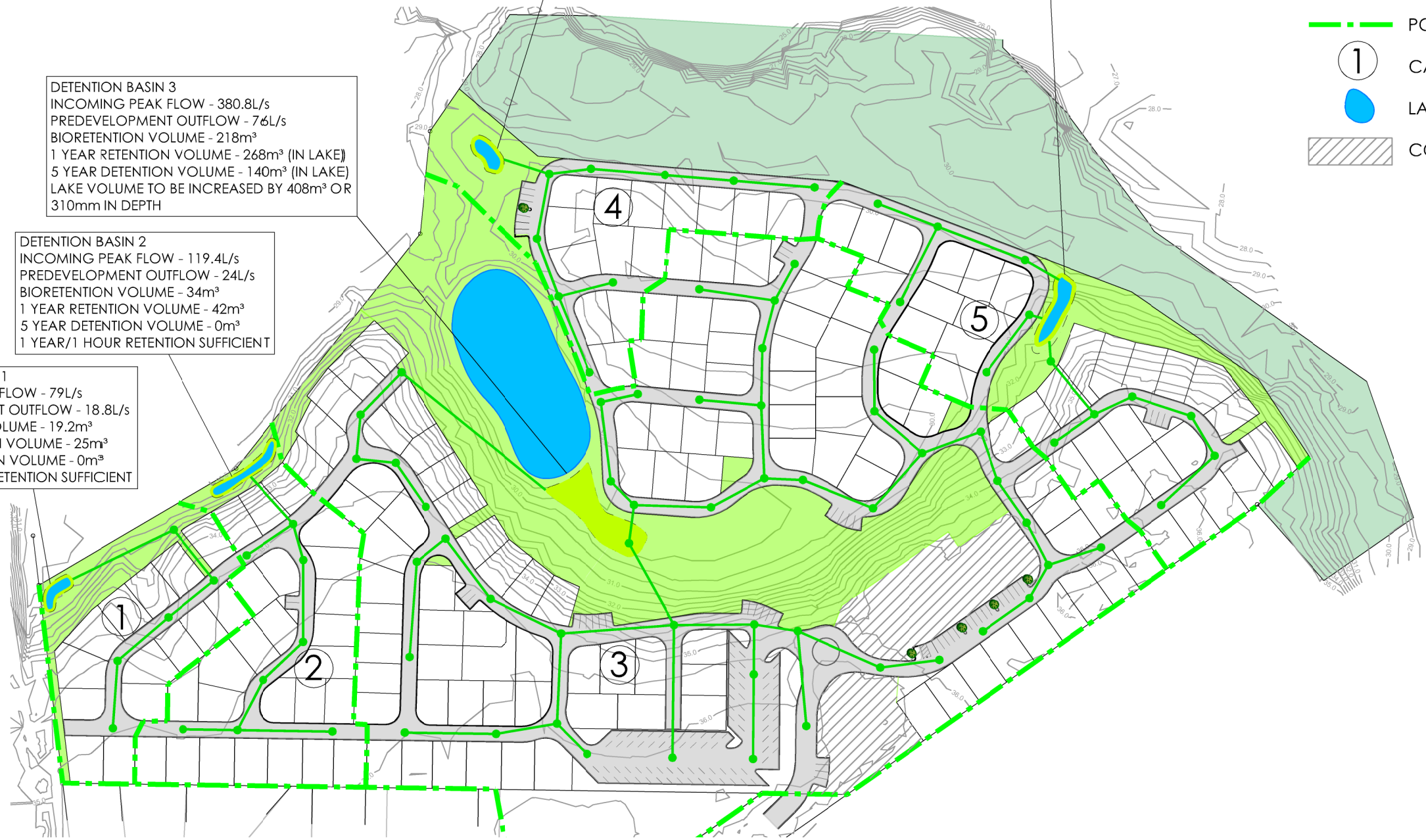
DETENTION BASIN 4
INCOMING PEAK FLOW - 108.1L/s
PREDEVELOPMENT OUTFLOW - 44.8L/s
BIORETENTION VOLUME - 26m³
1 YEAR RETENTION VOLUME - 32m³
5 YEAR DETENTION VOLUME - 0m³
1 YEAR/1 HOUR RETENTION SUFFICIENT

DETENTION BASIN 5
INCOMING PEAK FLOW - 159.2L/s
PREDEVELOPMENT OUTFLOW - 19.6L/s
BIORETENTION VOLUME - 47.2m³
1 YEAR RETENTION VOLUME - 58m³
5 YEAR DETENTION VOLUME - 20m³
ADDITIONAAL 20m³ OF DETENTION TO BE ADDED FOR 5 YEAR EVENT

DETENTION BASIN 3
INCOMING PEAK FLOW - 380.8L/s
PREDEVELOPMENT OUTFLOW - 76L/s
BIORETENTION VOLUME - 218m³
1 YEAR RETENTION VOLUME - 268m³ (IN LAKE)
5 YEAR DETENTION VOLUME - 140m³ (IN LAKE)
LAKE VOLUME TO BE INCREASED BY 408m³ OR 310mm IN DEPTH

DETENTION BASIN 2
INCOMING PEAK FLOW - 119.4L/s
PREDEVELOPMENT OUTFLOW - 24L/s
BIORETENTION VOLUME - 34m³
1 YEAR RETENTION VOLUME - 42m³
5 YEAR DETENTION VOLUME - 0m³
1 YEAR/1 HOUR RETENTION SUFFICIENT

DETENTION BASIN 1
INCOMING PEAK FLOW - 79L/s
PREDEVELOPMENT OUTFLOW - 18.8L/s
BIORETENTION VOLUME - 19.2m³
1 YEAR RETENTION VOLUME - 25m³
5 YEAR DETENTION VOLUME - 0m³
1 YEAR/1 HOUR RETENTION SUFFICIENT



LEGEND

- GRATED INLET PIT
- PIPEWORK
- BIOFILTRATION BASIN
- POST DEVELOPMENT CATCHMENT
- 1 CATCHMENT No.
- LAKE / DETENTION
- COMMUNITY INFRASTRUCTURE AREA

N

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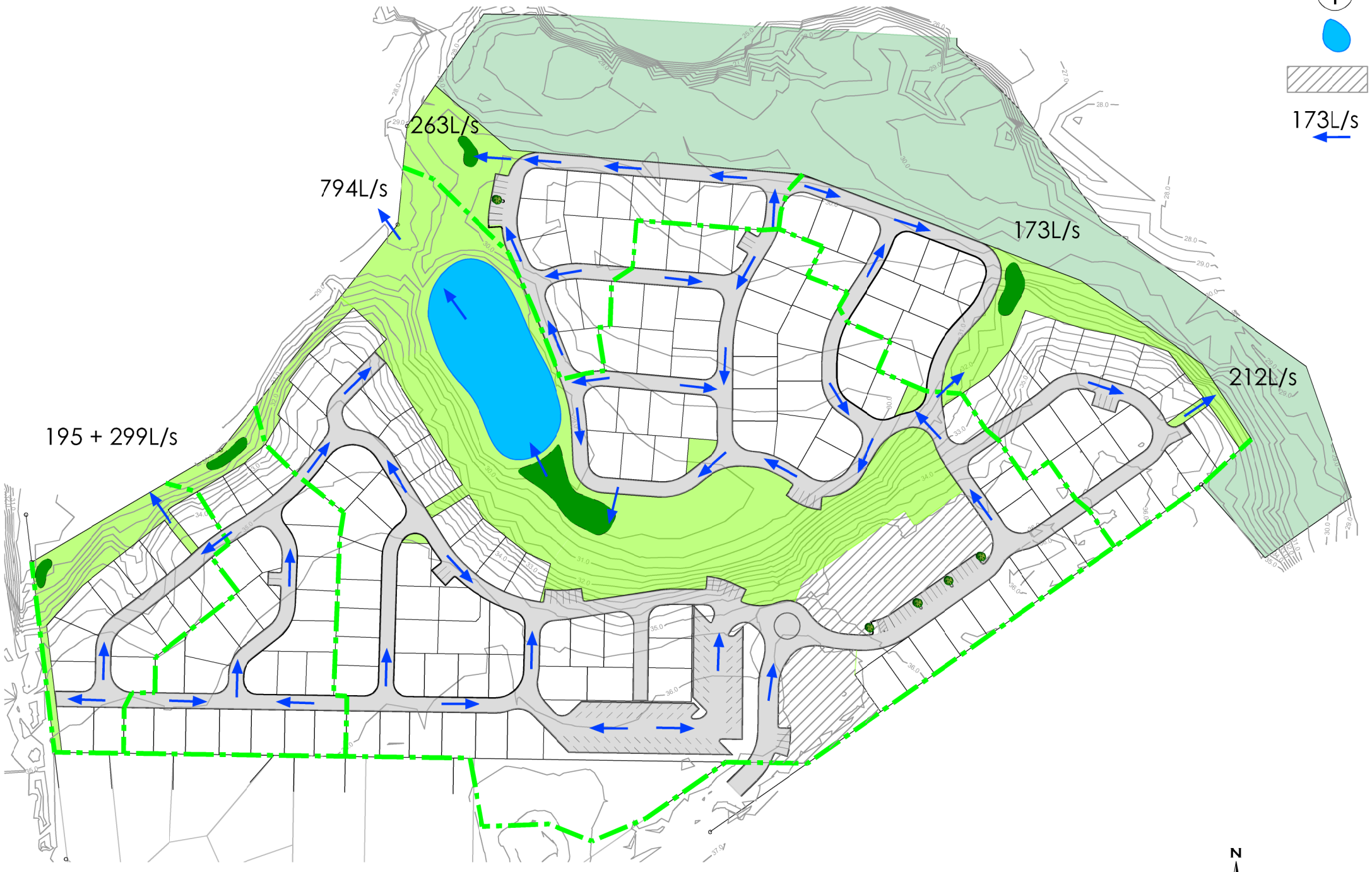
development consultants
Telephone: (08)97 214777
Email: reception@mpmdc.com.au

Project: MEADOWBROOKE LIFESTYLE ESTATE
Title: STORMWATER MANAGEMENT STRATEGY 1 IN 5
Plan: 14041 12
Do Not Scale

ATTACHMENT H
1 IN 100 YEAR EXTREME EVENT STRATEGY

mpm development consultants



LEGEND

- BIOFILTRATION BASIN
- POST DEVELOPMENT CATCHMENT
- 1 — CATCHMENT No.
- LAKE / DETENTION
- COMMUNITY INFRASTRUCTURE AREA
- 173L/s — 100 YEAR FLOW PATH AND PEAK FLOW (L/s)

N

mpm
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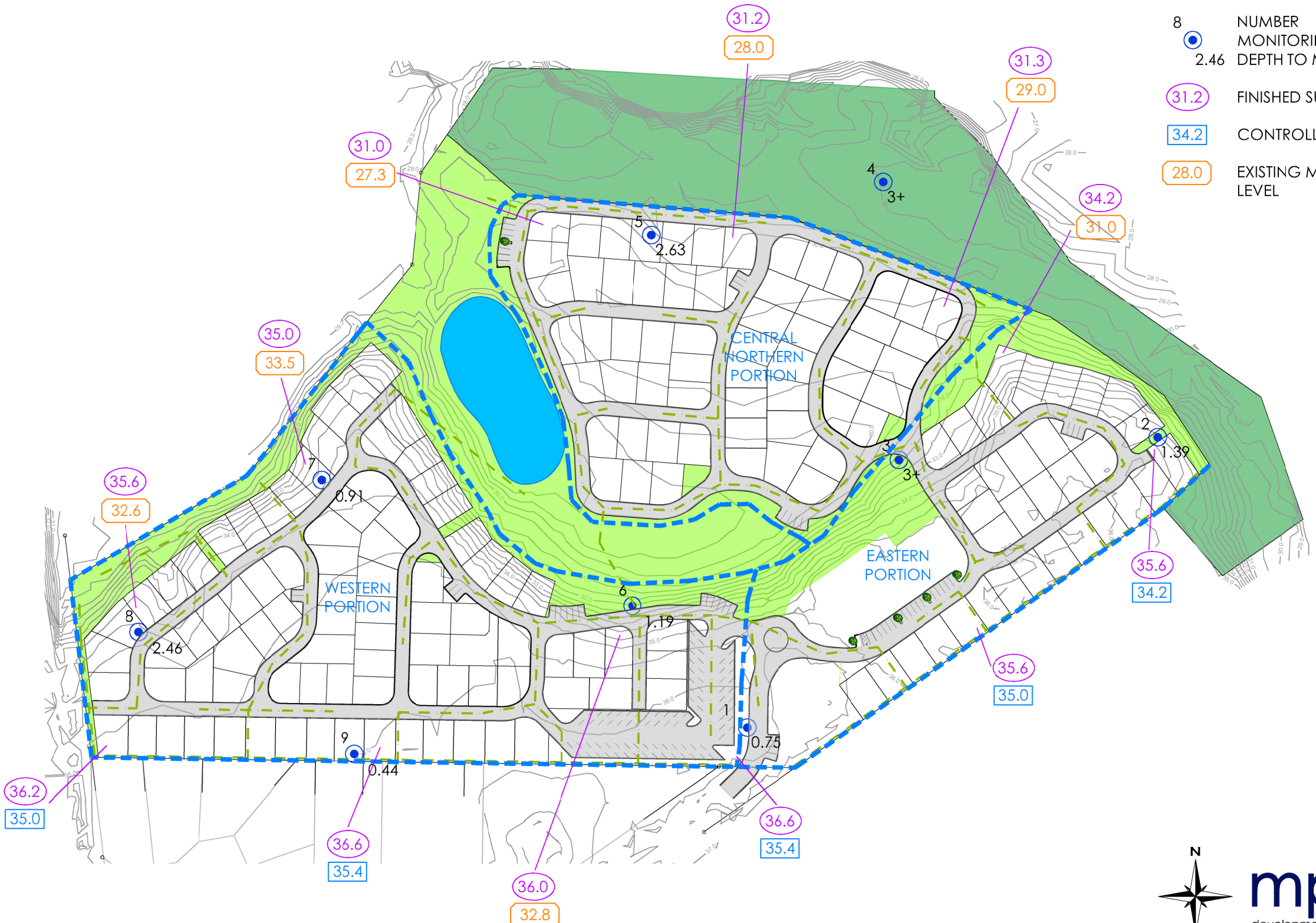
Project: MEADOWBROOKE LIFESTYLE ESTATE
Title: STORMWATER MANAGEMENT STRATEGY 1 IN 100
Plan: 14041 15
Do Not Scale

ATTACHMENT I
GROUNDWATER STRATEGY

development consultants



N

mpm
development consultants

Telephone: (08)97 214777
Email: reception@mpmdc.com.au

Project: MEADOWBROOKE LIFESTYLE ESTATE
Title: GROUNDWATER MANAGEMENT STRATEGY
Plan: 14041 13
Do Not Scale

ATTACHMENT J
PRESTON RIVER

mpm development consultants

hyd2o
HYDROLOGY

5 August 2011

Your Ref:
Our Ref: H11021Av1

MPM Development Consultants
Unit 1/33 Constitution Street
PO Box 2035
BUNBURY WA 6231

ATTENTION : Craig Pippin

Dear Craig,

RE: PRESTON RIVER FLOOD STUDY, MEADOWBROOKE ESTATE, BOYANUP

Please find below Hyd2o's report detailing the results of our field investigation and analysis to determine the 1 in 100 year average recurrence interval (ARI) flood levels for the Preston River adjacent to Meadowbrooke Estate at Boyanup.

1. BACKGROUND

Meadowbrooke Estate is located in Boyanup, approximately 20 km south east of Bunbury (Figure 1). The site is bounded by South Western Highway to the west, Turner St to the south and the Preston River to the north and east.

The site currently contains two function centres and a range of short stay accommodation options including self contained cottages and villas (Figure 2).

Further development of the site is proposed (Figure 2), which will include an upgrading of the existing facility and conversion into a Lifestyle Village style development.

This report provides estimates of 100 year ARI flood levels and floodplain mapping for the Preston River adjacent to Meadowbrooke Estate to assist the planning process for this development. The report also considers the impact on flood levels of the flow from the local catchment and tributary near the north western boundary of the site which flows to the Preston River.

No previous Department of Water (DoW) estimates of 100 year peak flows or flood levels exist for Boyanup.

2. FIELD INVESTIGATION

A field investigation of the site was conducted by Hyd2o on 13 May, 2011. During this visit, Hyd2o gained familiarity with the site, reviewed the local topography, assessed likely bankfull conditions for the river, and determined the local characteristics of the Preston River channel to enable assessment of Manning's n roughness coefficient for modelling purposes. Structures which were considered likely to affect flood levels were also identified and recorded.

Figure 3 provides a summary of the key hydrologic features and photo's showing typical river cross sections and vegetation both within the main channel and on the river floodplain. With the exception of grassed pasture areas, the river floodplain was observed to more densely vegetated than the main river channel.

Anecdotal information was also collected from employees at Meadowbrooke Estate regarding flood levels within the river to assist in model calibration. This information is also shown on Figure 3.

No significant debris outside of the main river channel was observed during the field investigation indicating recent flooding of the river outside of the main channel had not occurred. This was consistent with anecdotal evidence, which indicated the footpath/walk trail which runs adjacent to the river had not been inundated within the last 5 years.

3. SURFACE HYDROLOGY

As previously discussed the site has two watercourses which are considered in this analysis, the Preston River which runs along the north and eastern boundaries of the site and a smaller tributary which drains a local catchment and runs along the western boundary into the Preston River.

The locality of these watercourses and their catchments are shown in Figure 4.

A summary of the key catchment characteristics are shown in Table 1. These characteristics are used in Section 4 to estimate design flows.

The Department of Water Preston River Boyanup Bridge gauging station (611 004) is located immediately upstream of the site. This site has been operational since 1980.

Table 1: Catchment Characteristics

Catchment	Catchment Area (km²)	Cleared (%)	Equal Area Stream Slope (m/m)
Preston River	808	37	2
Local Tributary	0.76	80	

4. ESTIMATION OF DESIGN FLOWS

Design flow estimates for the Preston River were determined based on comparing outcomes from the application of a range of different hydrological techniques including:

- Rational and Index Flood methods via Australia Rainfall and Runoff (Engineers Australia, 2003). Note, that these methods cannot be directly applied to the catchment as it contains both loamy and lateritic soil types which are only calculated separately using these methods. These methods do however provide a range of values from which the results from other techniques can be validated and assessed against.
- Previously published Preston River estimates from the Water Authority's Preston River Flood Study Hydrology (1989) at Boyanup based on RORB runoff routing modelling and flood frequency techniques.
- Calculating a pro-rata Preston River flow at Boyanup based on Sinclair Knight Merz (2004) flow estimate for Picton Bridge near Bunbury (100 year estimate : 360 m^3/s).
- Using flood frequency analysis of the Boyanup Bridge (611 004) gauging station with data patched to include earlier large floods to 1955 using the Beelerup gauging station (611 049) located on the Preston river upstream of Donnybrook.

For the local watercourse, both XP–Storm modelling and the Rational and Flood Index methods were used to estimate design flows.

A summary of the adopted methods and the respective peak flow estimates for various average recurrence intervals (ARI's) are shown in Table 2, with the flood frequency analysis at Boyanup Bridge included as Figure 5.

For the Preston River at Boyanup, the flood frequency analysis is considered to provide the best estimate for use in design as it is based on gauged local data. This provides a 100 year ARI peak flow estimate of 241 m^3/s, which is very similar to the previous Water Authority (1989) estimate of 233 m^3/s. The pro-rata Preston River estimate based on Sinclair Knight Merz (2004) from Picton Bridge to Boyanup is considered likely to overestimate flow on the basis of the differences in catchment conditions and runoff characteristics on the cleared and partially urban coastal plain compared to runoff from upstream Darling Scarp areas.

For the local watercourse catchment, the XP-Storm model provided the largest flow estimate and this has conservatively been adopted for analysis purposes. A 100 year peak flow of 0.64 m^3/s was adopted for design purposes. Note that this flow estimate is of similar magnitude to the modelled capacity of the existing 375 mm diameter culvert on this watercourse under South Western Highway (Figure 3).

Table 2: Design Flow Estimates

Flow Estimation Method	Design Flow Estimate (m^3/s)				
	2	5	10	50	100
Preston River					
Rational Method (Lateritic Soils)	32	44	55	91	110 [1]
Index Flood Method (Lateritic Soils)	33	50	65	111	130 [1]
Rational Method (Loamy Soils)	69	112	153	281	340 [1]
Index Flood Method (Loamy Soils)	52	90	132	263	300 [1]
via Water Authority (1989)	-	-	123	-	233
via Sinclair Knight Merz (2004) [2]	-	-	140	190	290
Flood Frequency : DoW Station (611004)	53	91	120	201	241
Adopted for Design					241
Local Tributary					
Rational Method	0.11	0.16	0.19	0.35	0.40
Index Flood Method	0.15	0.20	0.24	0.36	0.40
XP-Storm	-	0.36	-	-	0.64
Adopted For Design					0.64

1. Graphically extrapolated based on 2 to 50 year ARI estimates via these methods
2. Pro rata based on catchment area ratio to the power of 0.7.

5. ESTIMATION OF 100 YEAR FLOOD LEVELS

A HECRAS model of the Preston River and tributary were developed based on LiDAR data obtained from the Department of Water (DoW) and peak flow estimates detailed in Section 4.

Figure 6 shows the extent of the modelling performed and the location of cross sections used. Modelled cross sections are shown in Appendix 1. The model was extended approximately 6 km downstream of the site to ensure the starting backwater of the model did not affect estimated flood levels at the site.

Manning roughness coefficients were estimated based on field observations and correlated to Chow (1959). A value of 0.08 was used to represent overbank flow and 0.06 was used for the main river channel for the Preston River. For the local tributary the Manning n varied considerably from 0.03 near South Western Highway where the form of the watercourse was a grass constructed drain, to 0.08 near the confluence of the Preston River where the watercourse had a more natural form.

Use of these Mannings values with flow estimates via Section 4, provided modelling outcomes for 2 and 5 year ARI events showing good general agreement to bankfull field observations and anecdotal evidence.

Estimated 100 year flood levels are shown in Figure 7 and Appendix 1 for each modelled cross section and summarised for several key locations in Table 3.

Adjacent to the site, the 100 year flood level of the Preston River was found to range from 29.72 mAHD at the downstream boundary to 30.24 mAHD at the upstream boundary.

Floodplain mapping is shown in Figure 7 in relation to existing natural surface levels based on LiDAR data and the proposed development area.

The results show the proposed development to be located outside the 100 year floodplain of the Preston River and existing natural surface levels to have a clearance of approximately 5 m – 6 m above the adjacent 100 year flood level.

A sensitivity analysis of the design flow rate indicated that a flow rate increase of 20% above that adopted for design in this study would only increase the 100 year flood level by approximately 0.3 m – 0.4 m adjacent to the site, and would therefore not impact on the extent of the proposed development area.

It should also be noted that the area within the site (outside of the main Preston River channel) which floods to 29.74 mAHD shown in Figure 7 occurs due to backflow from the flood level in the Preston River and not due to flow within the local watercourse. Filling of this area would prevent this from occurring without affecting the 100 year flood level of the Preston River.

The results indicate that there is additional land within the site located outside of the Preston River floodplain which may also be considered for development. With respect to the required development levels of this area, Hyd2o are aware that at Donnybrook DoW have adopted a 1.5m clearance requirement above the 100 year flood level of the Preston River based on observed flood levels in the 1964 event being greater than the estimated 100 year flood levels at this location (Simon Rodgers, DoW pers comm).

DoW typically require development levels to be 0.5m above the 100 year level, and no anecdotal evidence is known to exist for the site to indicate a higher clearance requirement is required. It is however recommended that advice on a suitable clearance above the 100 year flood levels be requested from DoW in review of this report to inform the potential development opportunity of the additional area identified in this document.

Table 3: 100 Year Flood Level Estimates at Key Locations

Location	100 Year Flood Level Estimate (m AHD)
Preston River Downstream Property Boundary	29.72
Preston River Upstream Property Boundary	30.24
Tributary Watercourse at South Western Highway	30.33

6. CONCLUSIONS/RECOMMENDATIONS

- The site has two watercourses requiring consideration in terms of flood management, the Preston River which runs along the north and eastern boundaries of the site and a smaller tributary which drains a local catchment running along its western boundary. The catchment areas of these watercourses are 808 km^2 and 0.76 km^2 respectively.
- Design flow estimates for the Preston River were calculated based on a range of different hydrological techniques. Flood frequency analysis based on gauged local data is considered to provide the best estimate for use in design. This provides a 100 year ARI peak flow estimate of 241 m^3/s at the site, which is similar to the Water Authority (1989) estimate.
- For the small tributary, a 100 year peak flow of 0.64 m^3/s is estimated based on XP-Storm modelling.
- A HECRAS model of the Preston River and small tributary was developed based on DoW LiDAR data and successfully calibrated using field observations and anecdotal information.
- Based on this model, the 100 year flood level of the Preston River is estimated to range from 29.74 mAHD at the downstream boundary of the site to 30.24 mAHD at the upstream boundary.
- Floodplain mapping indicates the proposed development is located outside the 100 year floodplain of the Preston River and small tributary, with existing natural surface levels having a clearance of approximately 5 m – 6 m above the adjacent 100 year flood level.
- The area within the site (outside of the main Preston River channel) which floods to 29.74 mAHD occurs due to backflow from the flood level in the Preston River, and filling this area would prevent this from occurring without affecting the 100 year flood level of the Preston River.
- The results indicate that there is additional land within the site located outside of the Preston River floodplain which may be also considered for development. It is recommended that advice on a suitable clearance above the 100 year flood level be requested from DoW in review of this report to inform the potential development opportunity of this land.

7. REFERENCES

Chow, V.T. (1959) Open Channel Hydraulics

Department of Water (2009), Water Balance Modelling of the Leschenault Catchment, Water Science Technical Series, Report No WST 10, August 2009

Engineers Australia (2003) Australian Rainfall and Runoff – A Guide to Flood Estimation Volumes 1&2

Sinclair Knight Merz (2004), Bunbury Flood Management Strategy, Appendix A Flood Modelling Report, September 2004

Water Authority of WA (1989) Preston River Flood Study Hydrology

Should you have any queries regarding this report, please do not hesitate to contact Sasha Martens or Suzanne Smart of this office.

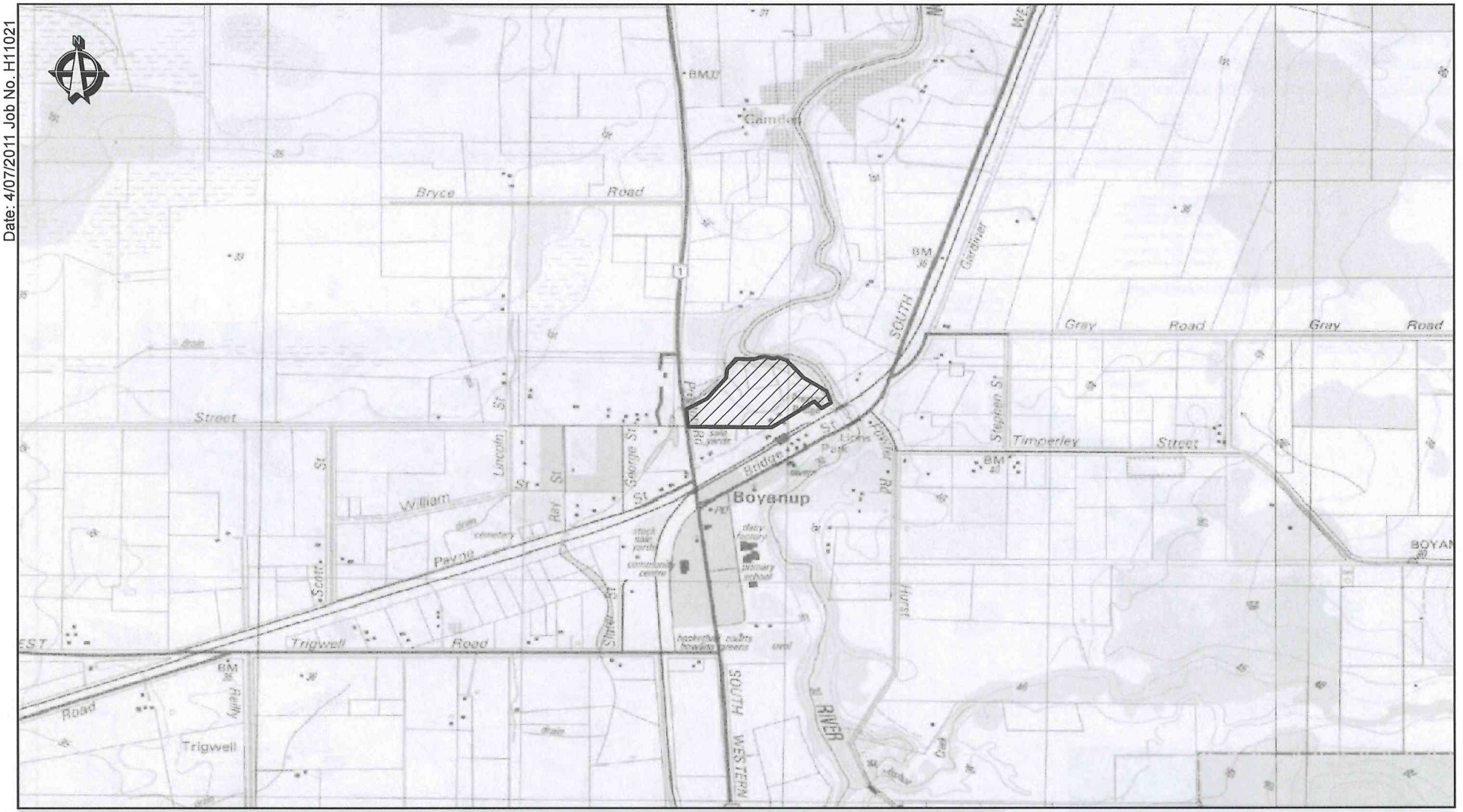
Yours sincerely,

Sasha Martens

Managing Director, Hyd2o

FIGURES

Date: 4/07/2011 Job No. H11021



1:25,000

0 200 400 600 800 Metres

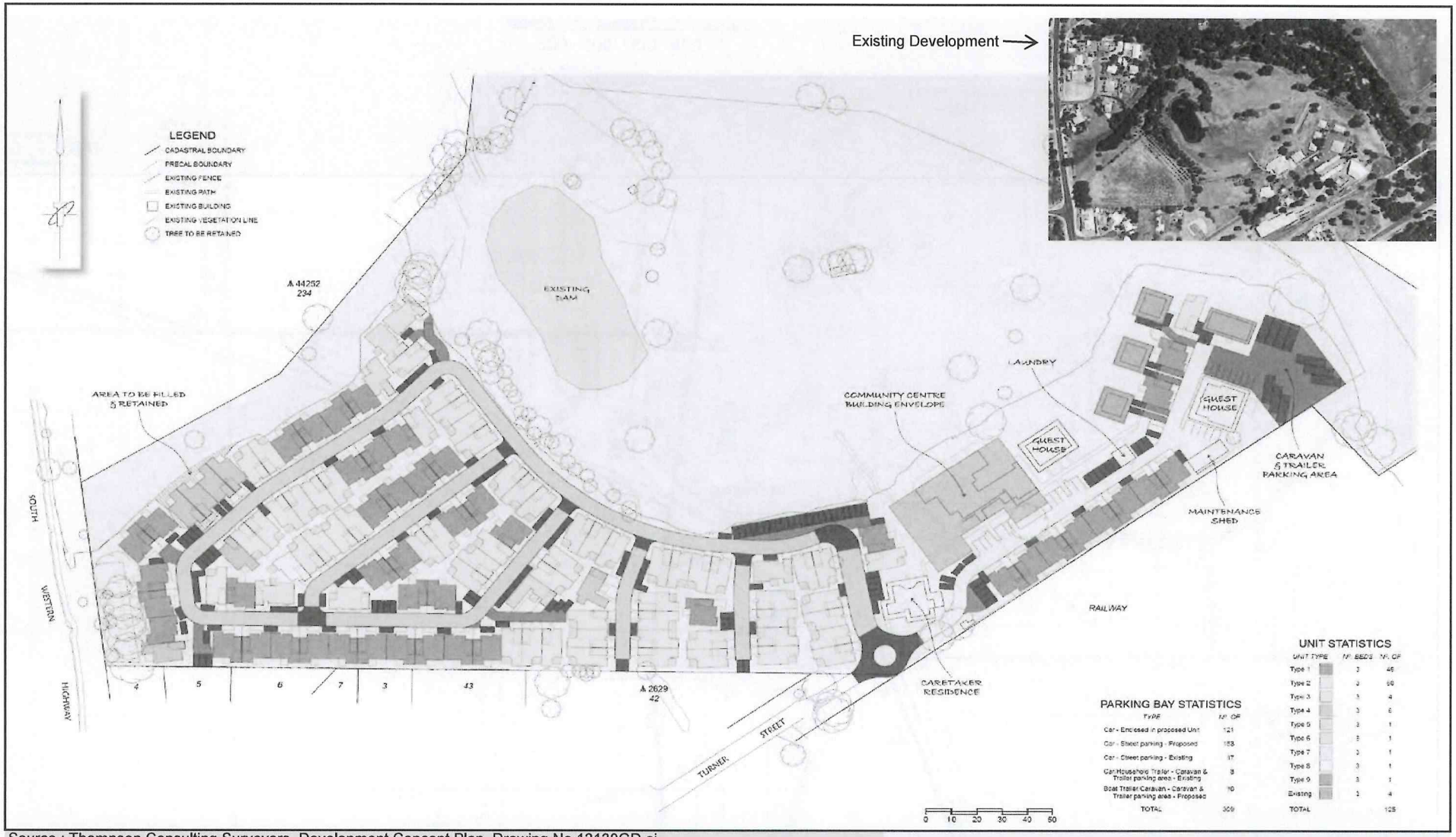
hyd2o

Preston River Flood Study Meadowbrooke Estate Boyanup

Location Plan

Figure 1

Date : 4/7/2011 Job No H11021



Source : Thompson Consulting Surveyors, Development Concept Plan, Drawing No 12130GD.ai

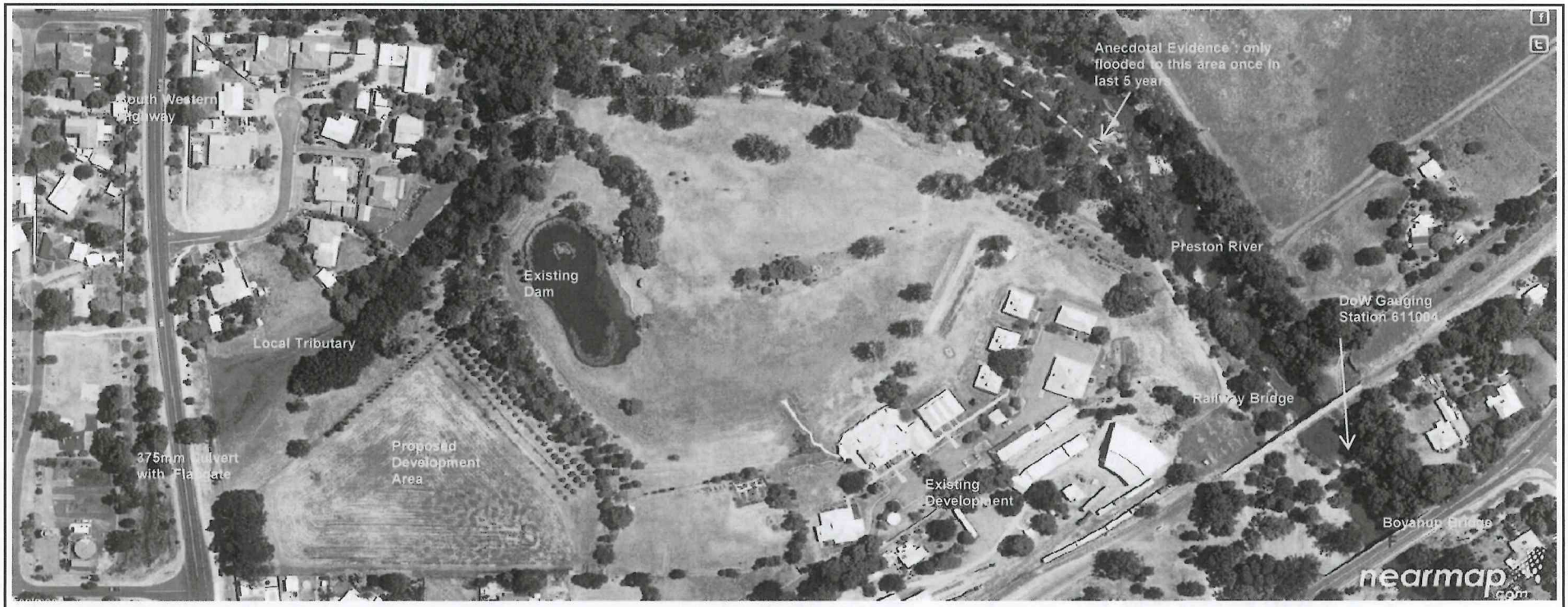
hyd$_2$o

Preston River Flood Study Meadowbrooke Estate Boyanup

Existing and Proposed Development

Figure 2

Date : 4/7/2011 Job No H11021



A B C D E F

source : Nearmap.com (photo date : 11 Dec 2009)

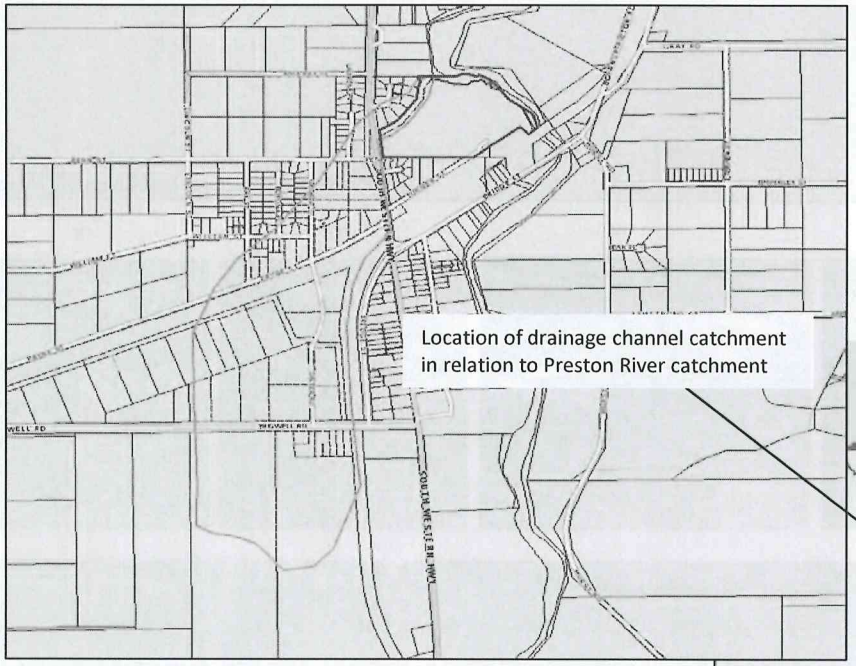
hyd2o

Preston River Flood Study Meadowbrooke Estate Boyanup

Field Investigation & Hydrological Features

Figure 3

Date : 4/7/2011 Job No H11021

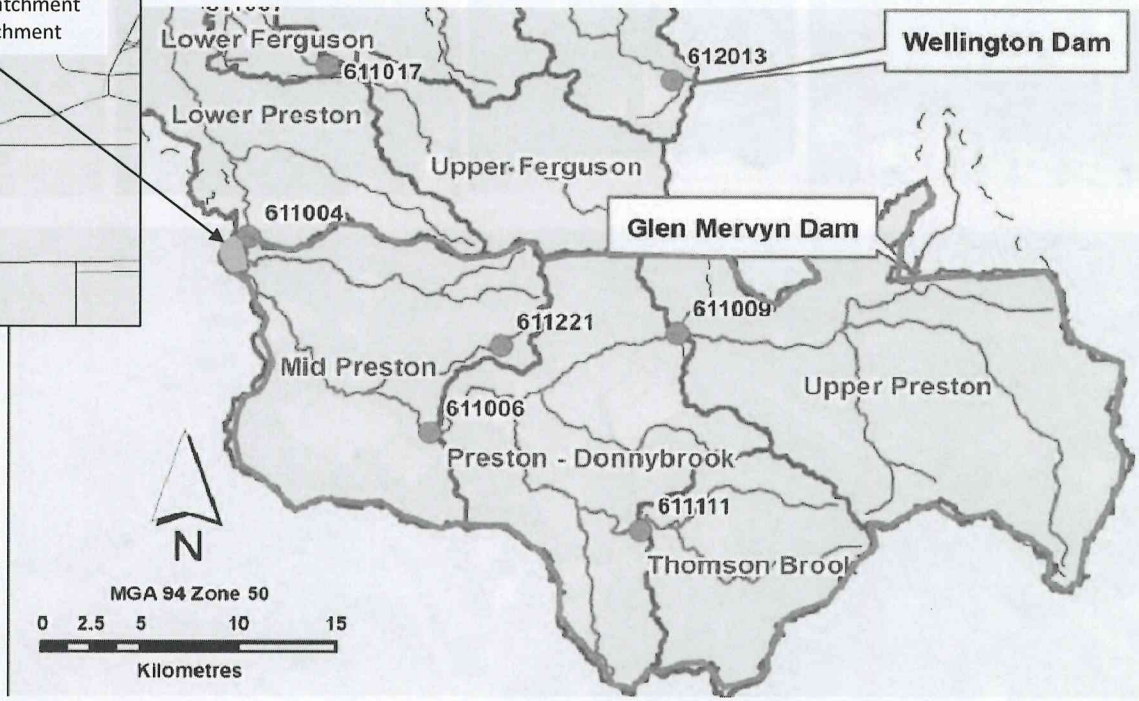


Location of drainage channel catchment in relation to Preston River catchment

Preston River catchment to the site

Drainage channel catchment to the site

Site



Source : Department of Water (2009)

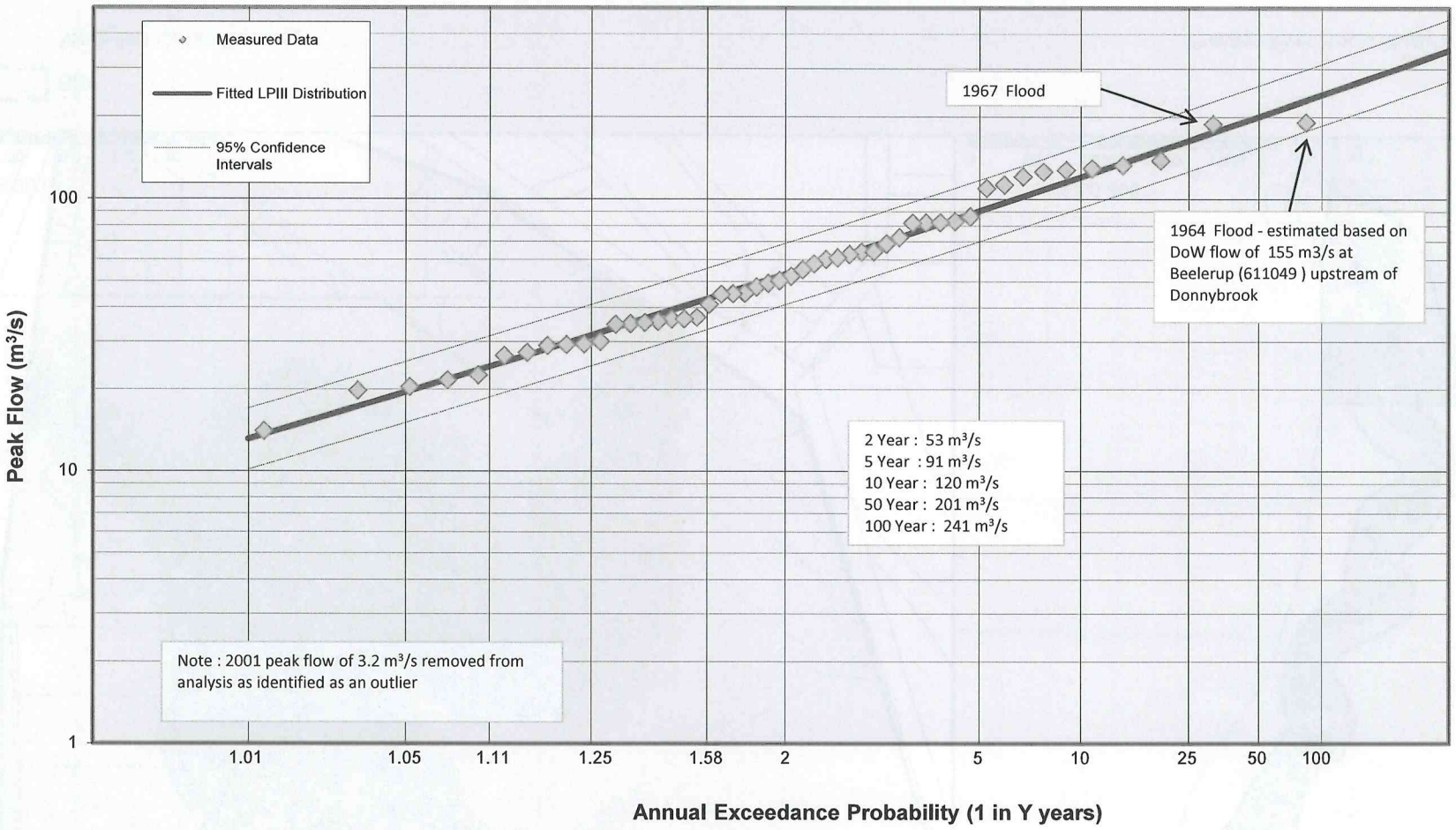
hyd$_2$o

Preston River Flood Study Meadowbrooke Estate Boyanup

Catchment Map

Figure 4

Date : 4/7/2011 Job No H11021



Data source : Department of Water

Boyanup Bridge (611004) period of record : 1980-2009 (catchment area : 808 km^2)

Beelerup (611049) period of record : 1955-1975 (catchment area 598 km^2)

Beelerup scaled to Boyanup Bridge based on (ratio of catchment areas)$^{0.7}$

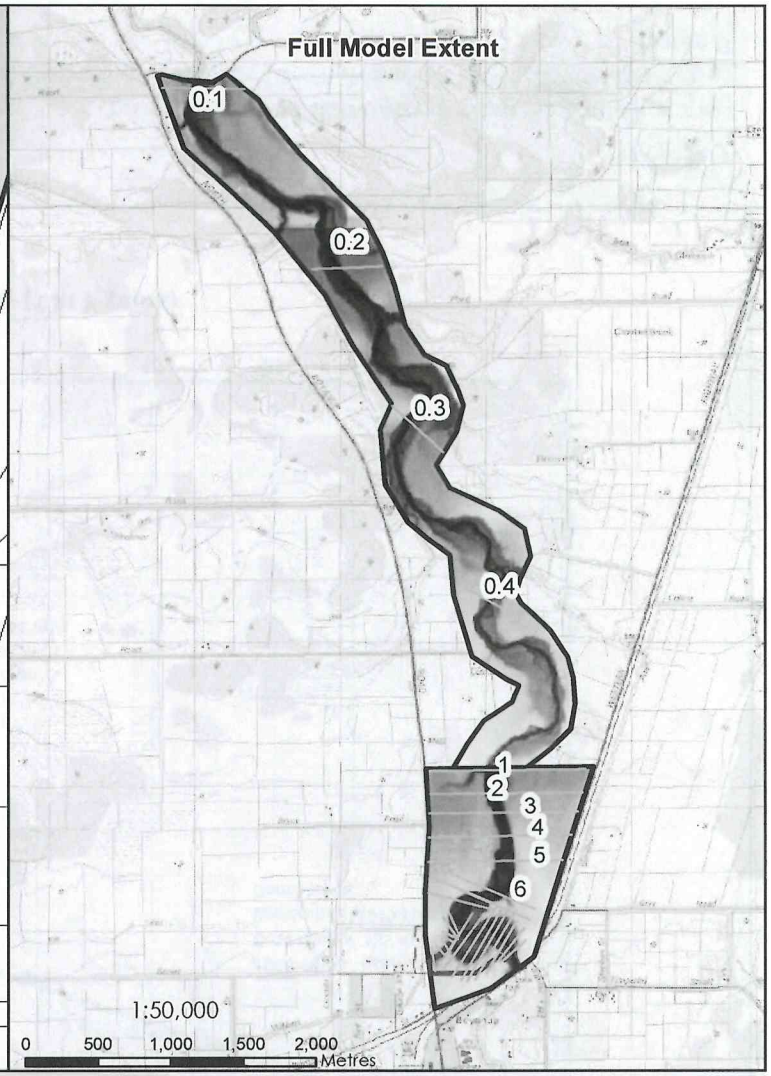
hyd$_2$o

Preston River Flood Study Meadowbrooke Estate Boyanup

Flood Frequency Analysis (DoW Station 611004 : Boyanup Bridge)

Figure 5

Date: 27/07/2011 Job No. H11021



Site

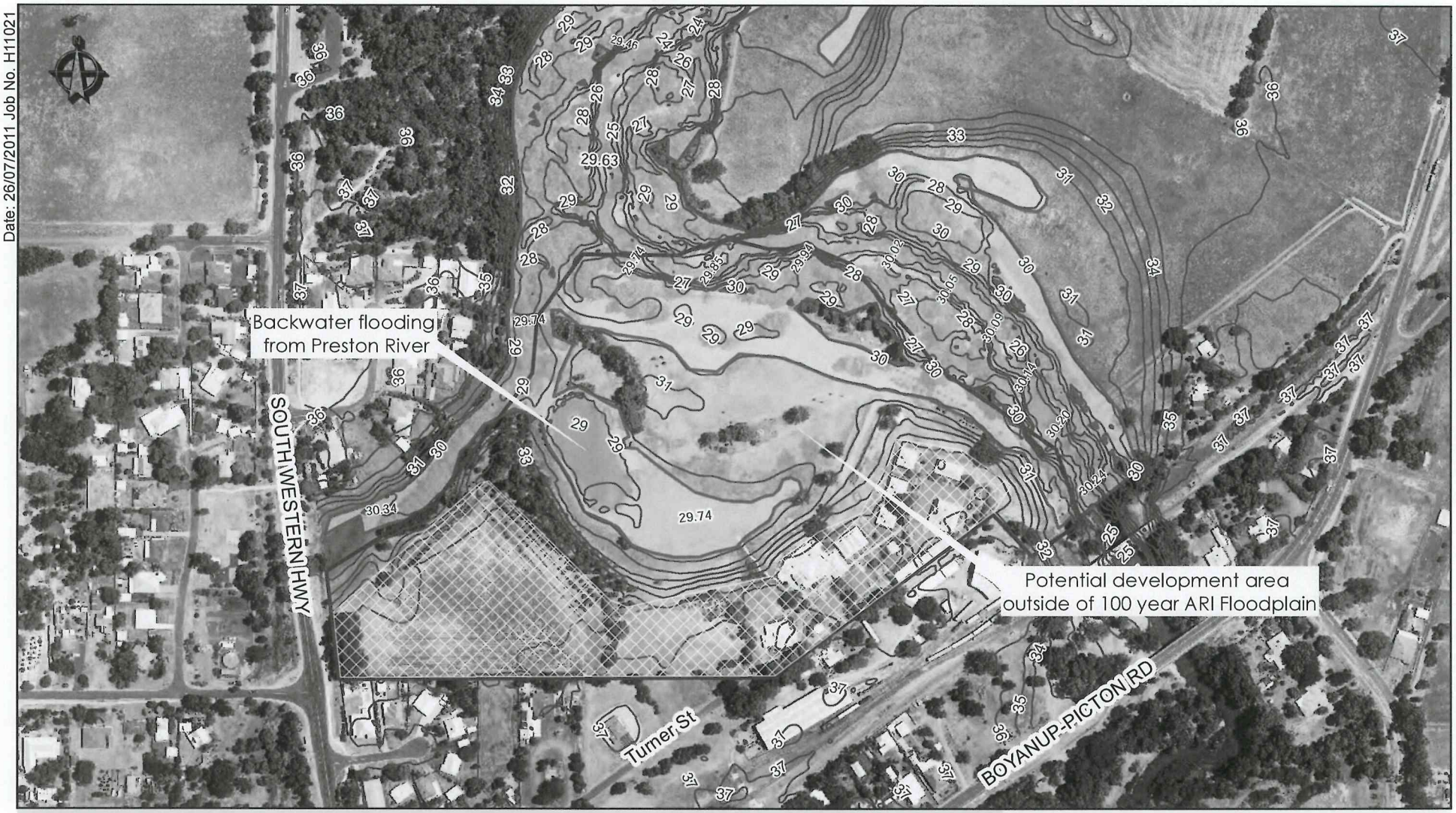
Modelled Cross Section

hyd2o

Preston River Flood Study Meadowbrooke Estate Boyanup

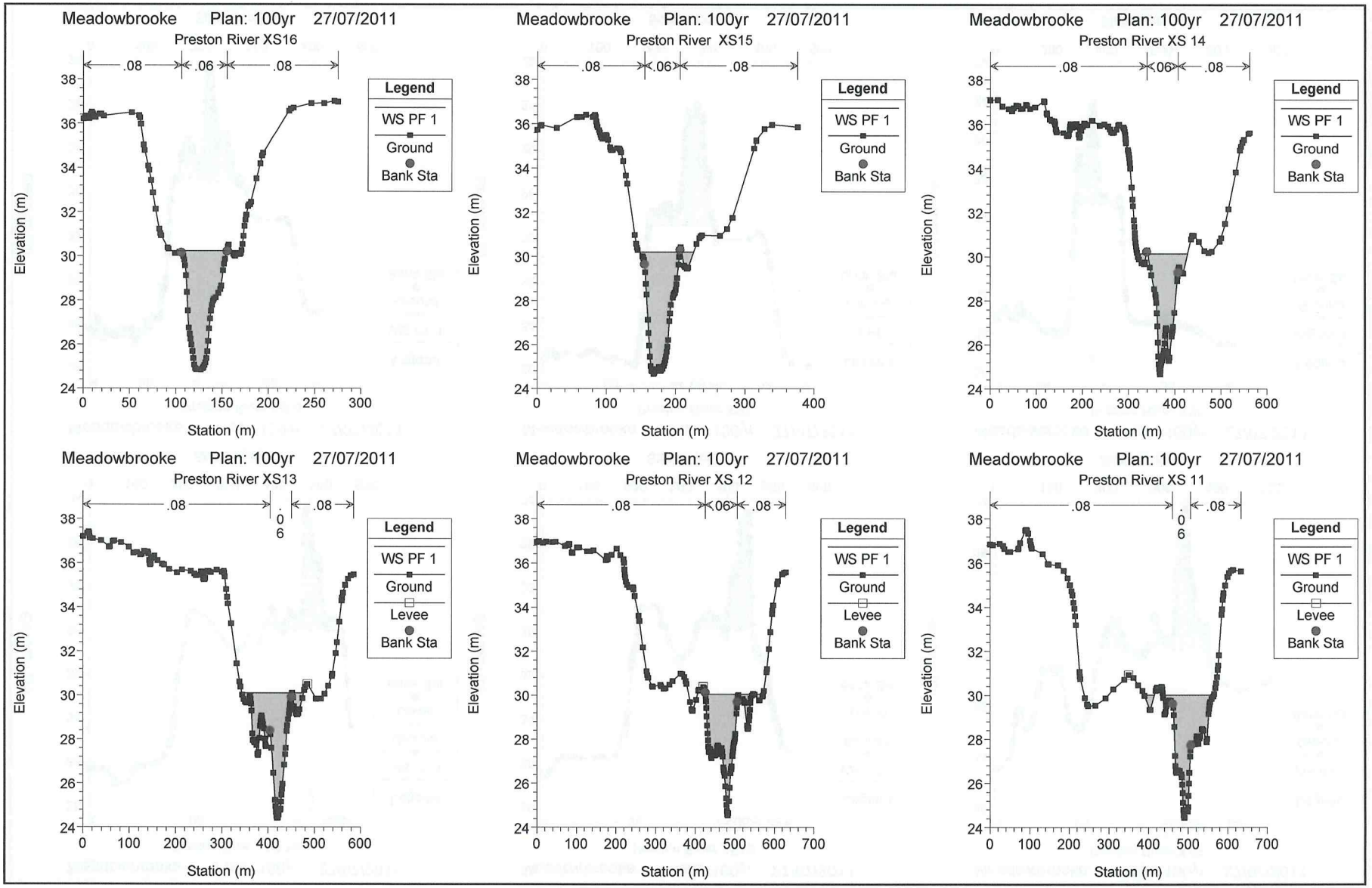
Cross Section Locations

Figure 6


Date: 26/07/2011 Job No. H11021
Backwater flooding from Preston River
Potential development area outside of 100 year ARI Floodplain
SOUTH WESTERN HWY
Turner St
BOYANUP-PICTON RD
Site
Topography
1 in 100 ARI year Floodplain
30.22 1 in 100 year ARI Flood Level (mAHD)
Proposed Development Area
1:4,000
0 25 50 100 150 200
Metres
hyd2o
Preston River Flood Study Meadowbrooke Estate Boyanup
1 in 100 ARI Year Floodplain Map
Figure 7

APPENDIX 1

Modelled Cross Sections


Meadowbrooke Plan: 100yr 27/07/2011
Preston River XS16
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Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Meadowbrooke Plan: 100yr 27/07/2011
Preston River XS15
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.06
.08
Legend
WS PF 1
Ground
Bank Sta
Elevation (m)
Station (m)
Meadowbrooke Plan: 100yr 27/07/2011
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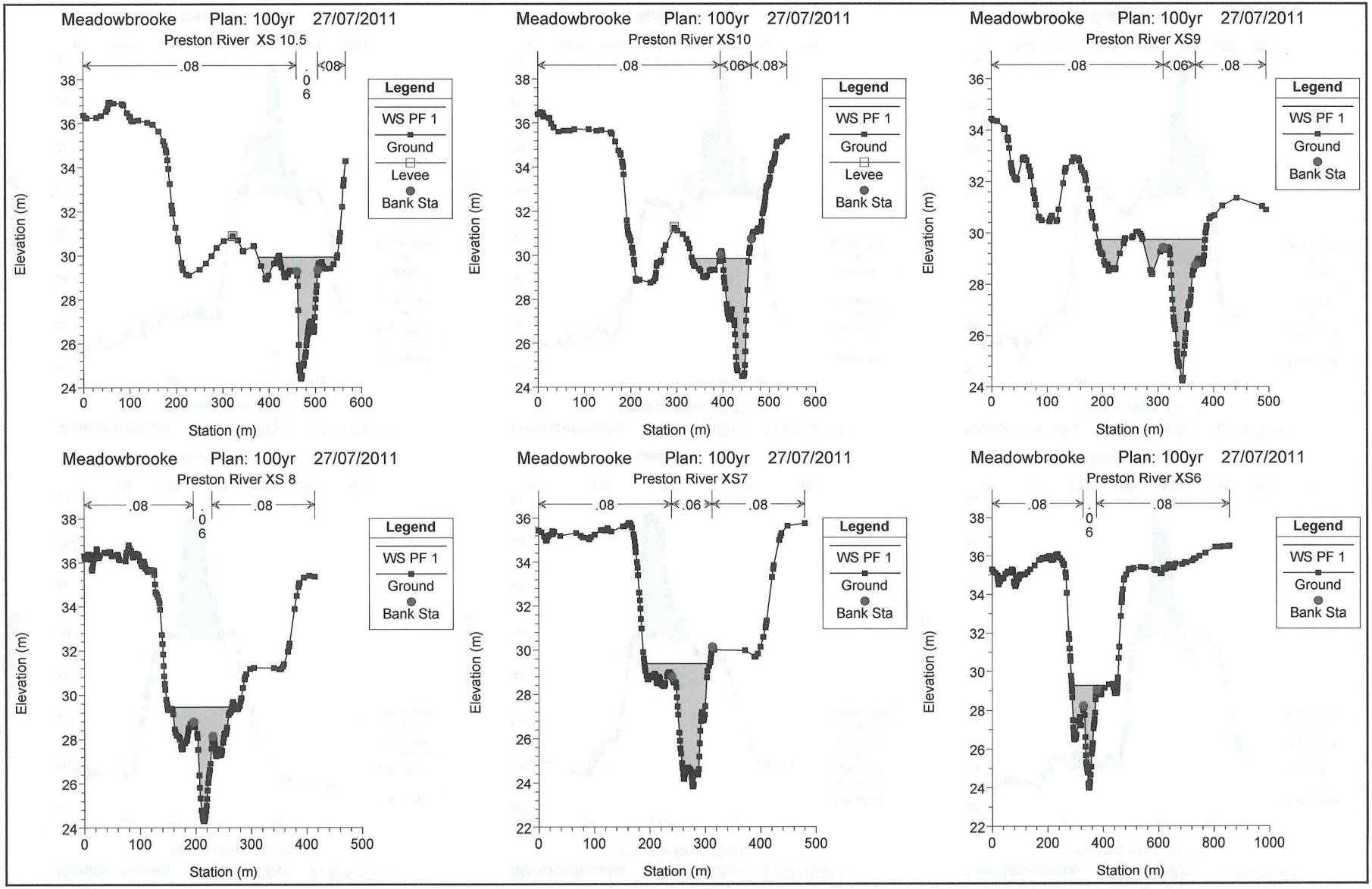
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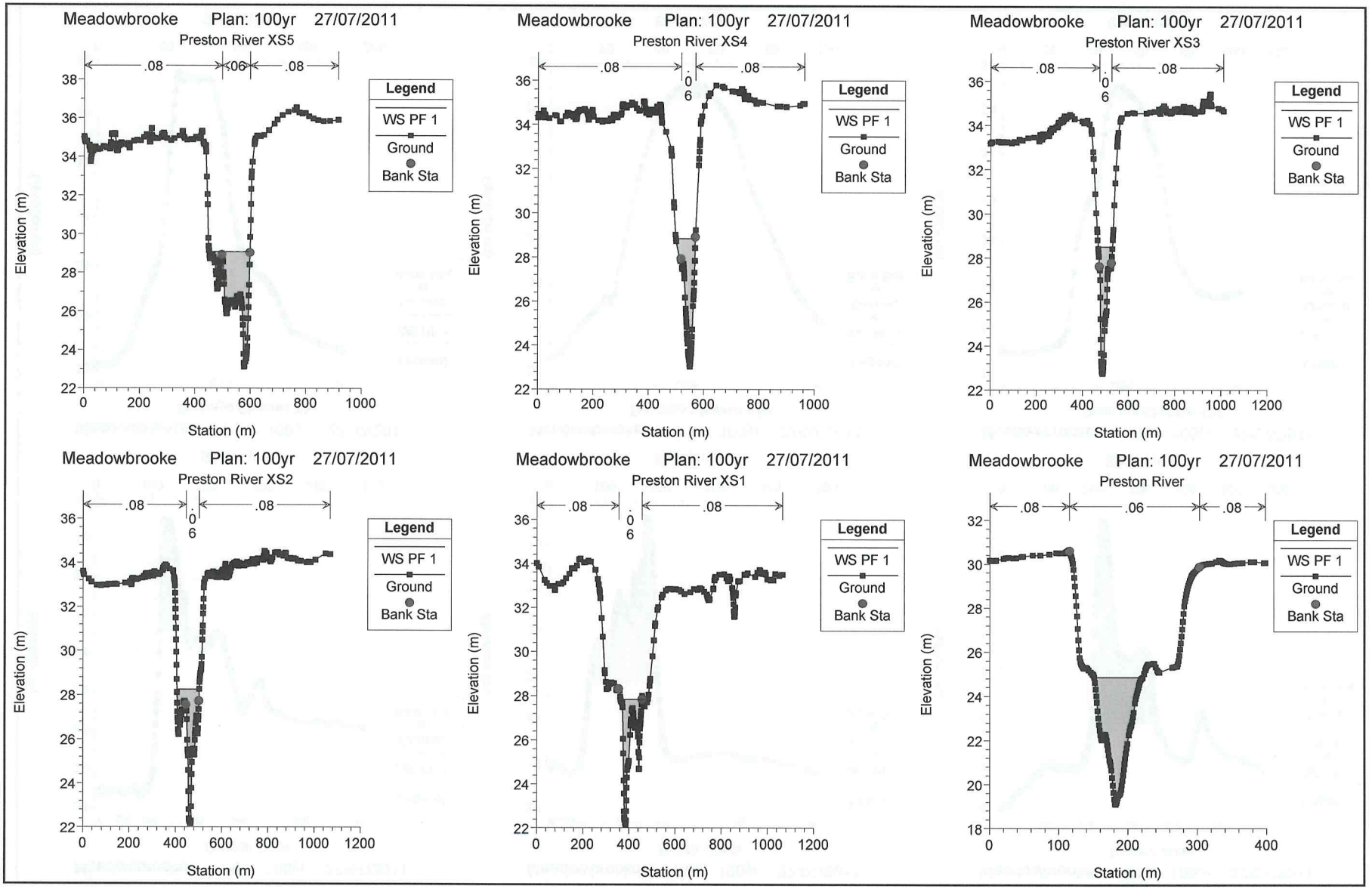
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Meadowbrooke Plan: 100yr 27/07/2011
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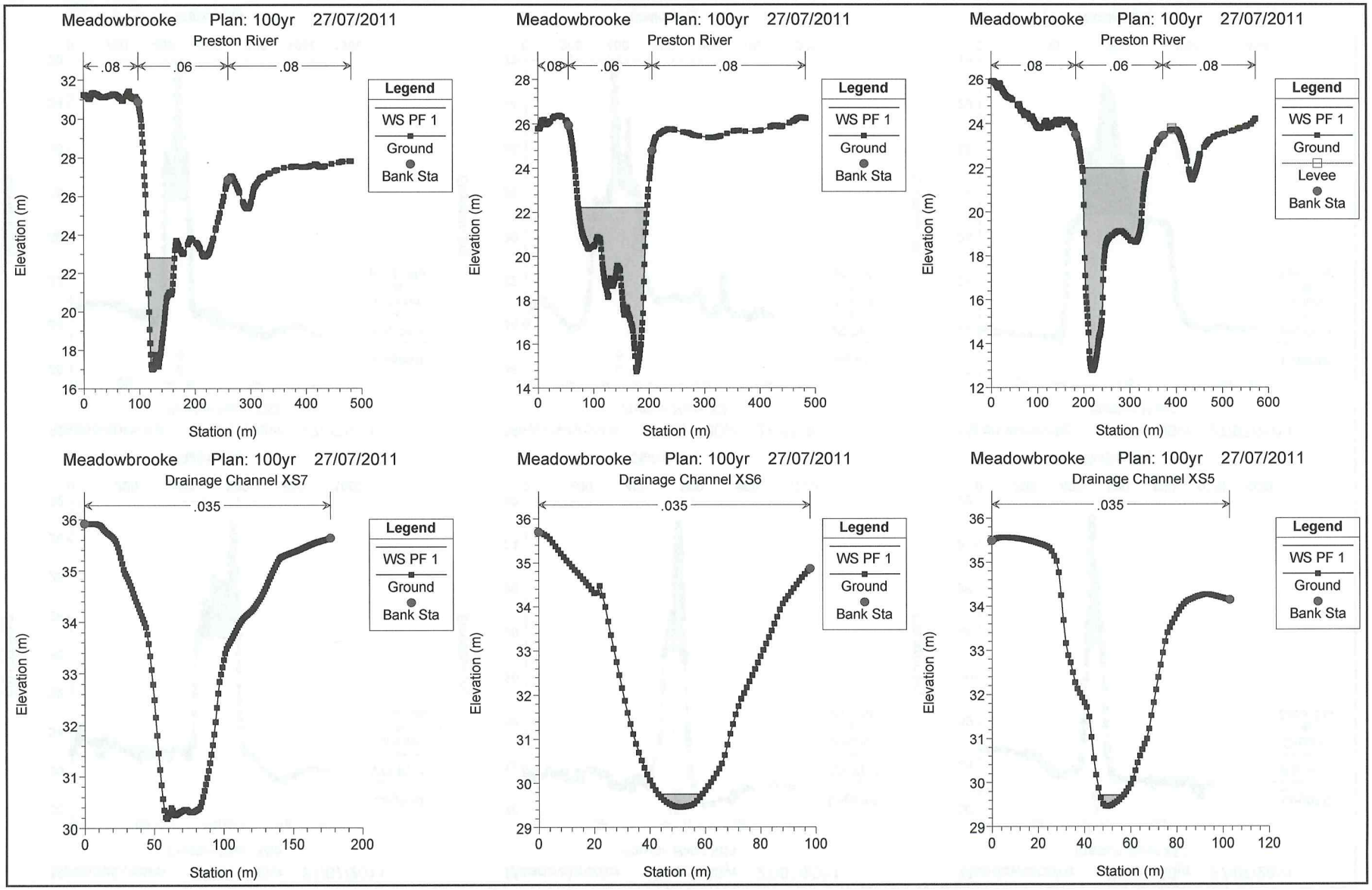
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Drainage Channel XS6
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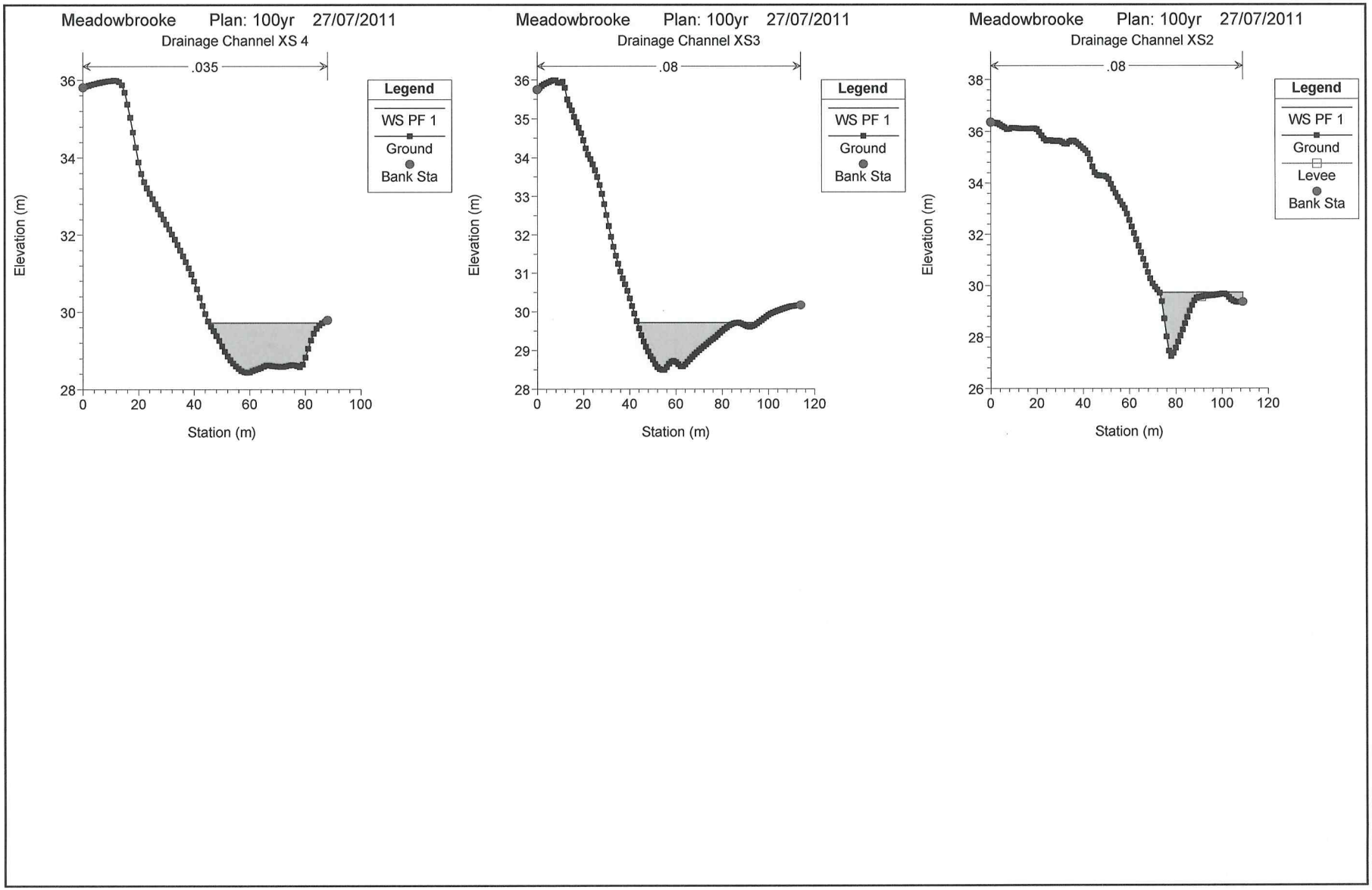
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Meadowbrooke Plan: 100yr 27/07/2011
Drainage Channel XS3
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Meadowbrooke Plan: 100yr 27/07/2011
Drainage Channel XS2
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Ground
Levee
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Elevation (m)
Station (m)

hyd2o
HYDROLOGY

22 August 2011

Your Ref:
Our Ref: H11021Bv1

Department of Water
PO Box K822
PERTH WA 6842

ATTENTION : Simon Rodgers

Dear Simon,

RE : PRESTON RIVER FLOOD STUDY, MEADOWBROOKE ESTATE, BOYANUP.
MODELLING OF ESTIMATED 1964 FLOOD EVENT

Following from our previously submitted report (Hyd2o, 2011) and the Department of Water's (DoW) assessment and advice on this report, please find below the results of modelling of a flow of 400 m^3/s in the Preston River, estimated by DoW as the likely flow at Boyanup during the 1964 flood event.

Flood levels are shown in Appendix 1 and in Table 1 at the upstream and downstream boundaries of the property in relation to the previously estimated 100 year average recurrence interval (ARI) flood levels presented in Hyd2o(2011). In summary, modelling of the 1964 event results in flood levels approximately 0.9 m above the estimated 100 year flood level.

Based on this result, we seek formal advice from DoW on a suitable clearance to be adopted above the 100 year flood level for development at Meadowbrooke.

This clearance will be used to inform the establishment of finished lot levels for the site and to consider opportunities for filling and developing the additional land identified as outside the 100 year floodplain of the Preston River.

Table 1: Comparison of 100 Year ARI and 1964 Flood Level Estimates

Location	100 Year Flood Level Estimate (flow ~241 m^3/s) (m AHD)	1964 Flood Level Estimate (flow ~400 m^3/s) (mAHD)	Relative Flood Height Increase (m)
Preston River Downstream Property Boundary	29.72	30.64	0.92
Preston River Upstream Property Boundary	30.24	31.12	0.88

Suite 6b 103 Rokeby Rd Subiaco WA 6008 | PO Box 1055 Subiaco WA 6904
p +61 8 9382 8683 | f +61 8 6380 1910 | www.hyd2o.com.au

REFERENCES

Hyd2o (2011), Preston River Flood Study Meadowbrooke Estate Boyanup, August 2011

Should you have any queries regarding this letter, please do not hesitate to contact Sasha Martens or Suzanne Smart of this office.

Yours sincerely,

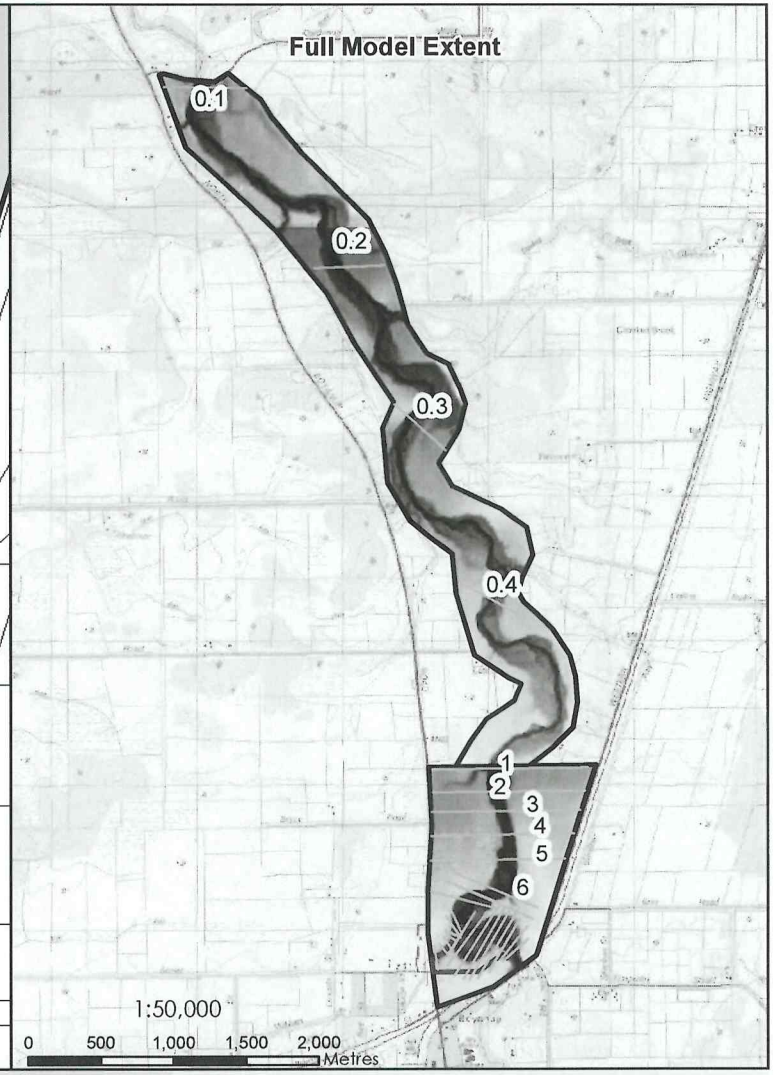
Sasha Martens

Managing Director, Hyd2o

APPENDIX 1

Modelled Cross Sections 1964 Flood Event

Date: 27/07/2011 Job No. H11021



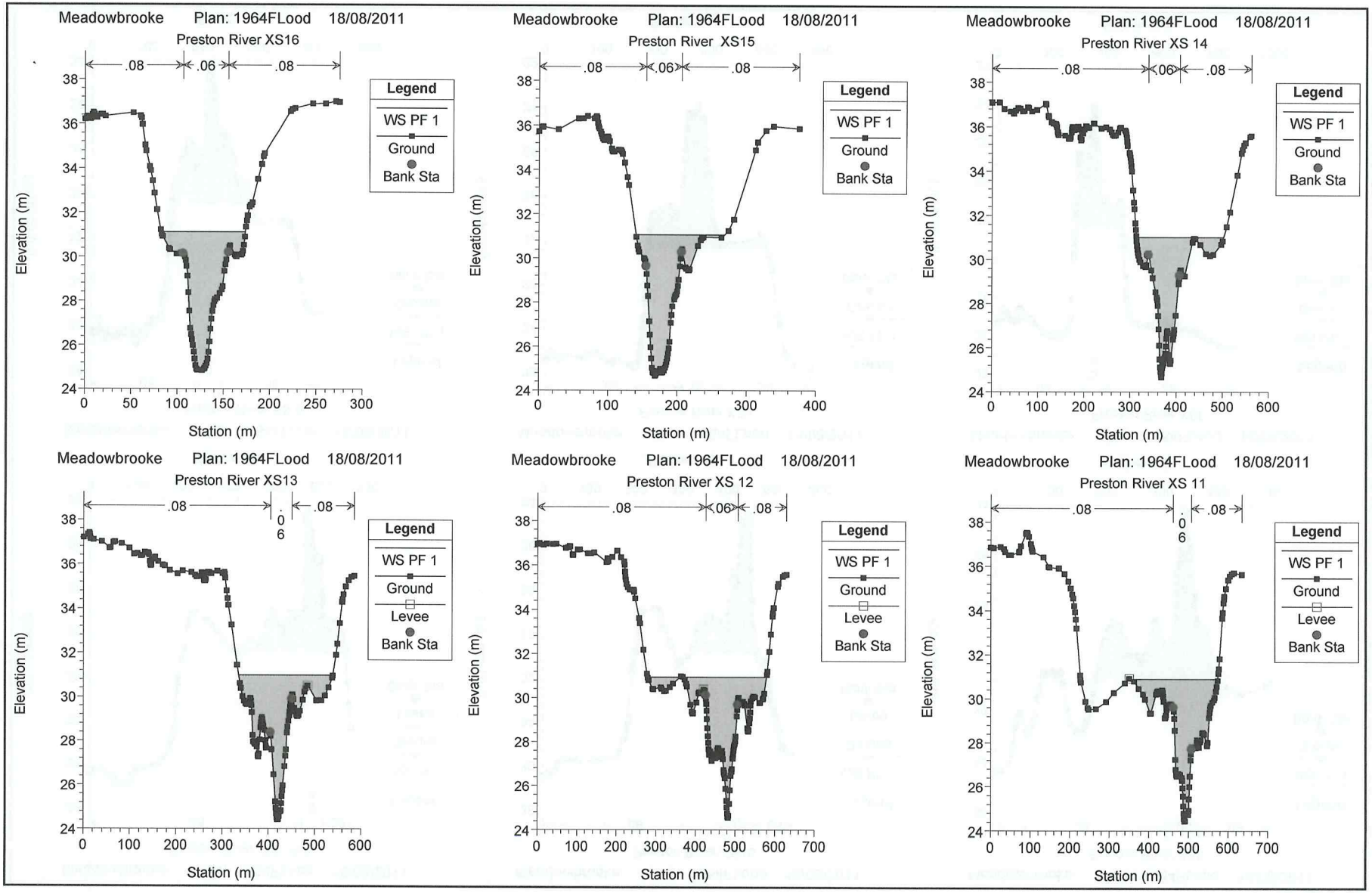
Site

Modelled Cross Section

hyd2o

Preston River Flood Study Meadowbrooke Estate Boyanup

Cross Section Locations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Meadowbrooke Plan: 1964FLood 18/08/2011
Preston River XS15
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Meadowbrooke Plan: 1964FLood 18/08/2011
Preston River XS 14
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Elevation (m)
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Meadowbrooke Plan: 1964FLood 18/08/2011
Preston River XS13
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Elevation (m)
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Preston River XS 12
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Elevation (m)
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Meadowbrooke Plan: 1964FLood 18/08/2011
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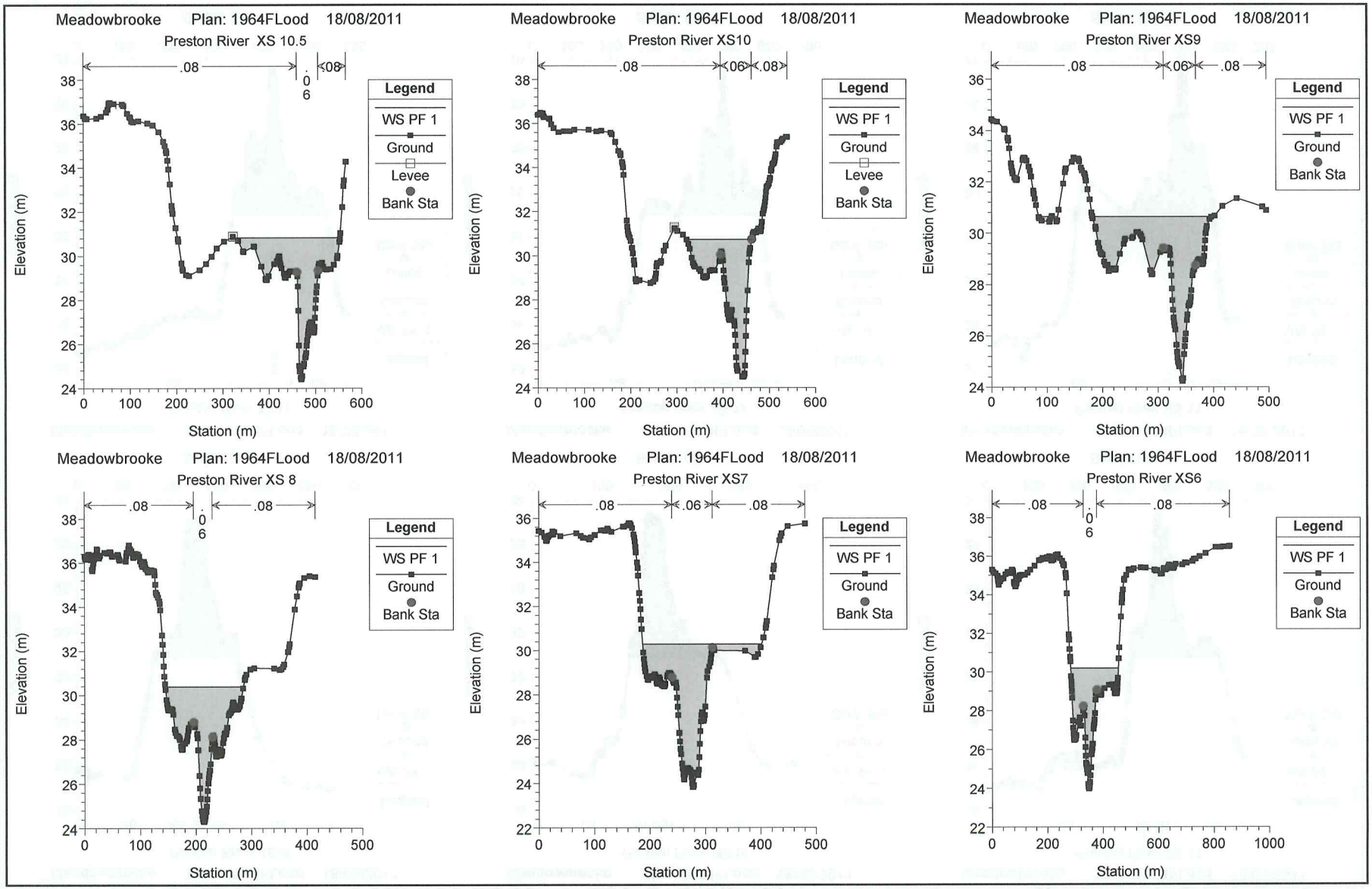
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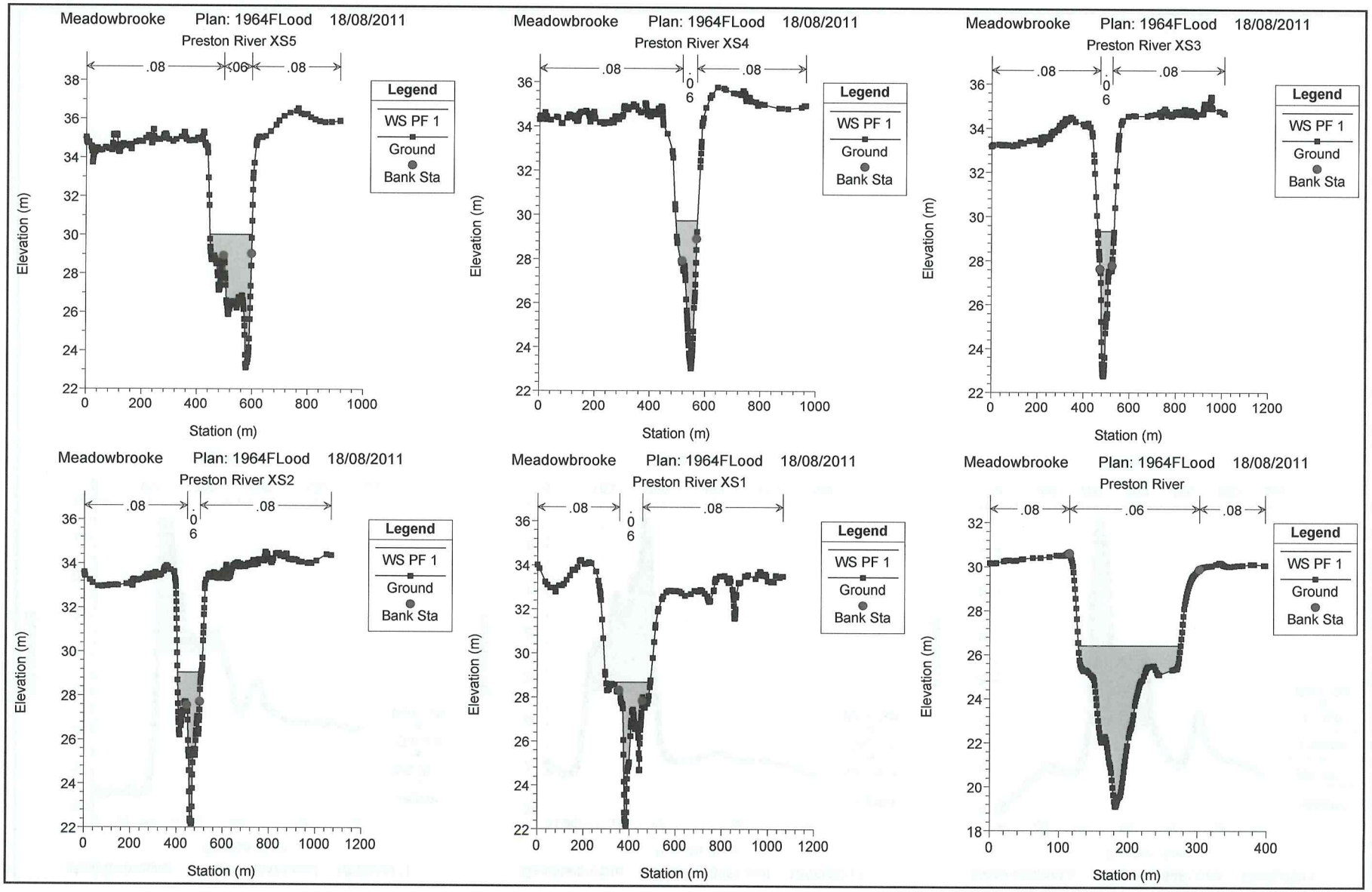
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Preston River XS2
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Meadowbrooke Plan: 1964FLood 18/08/2011
Preston River XS1
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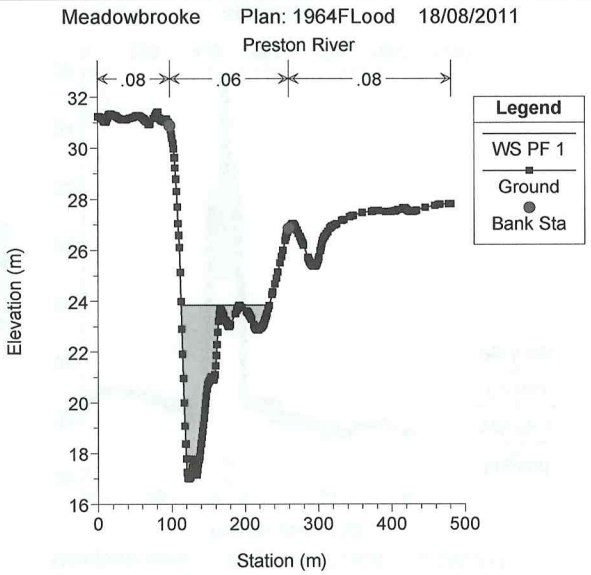
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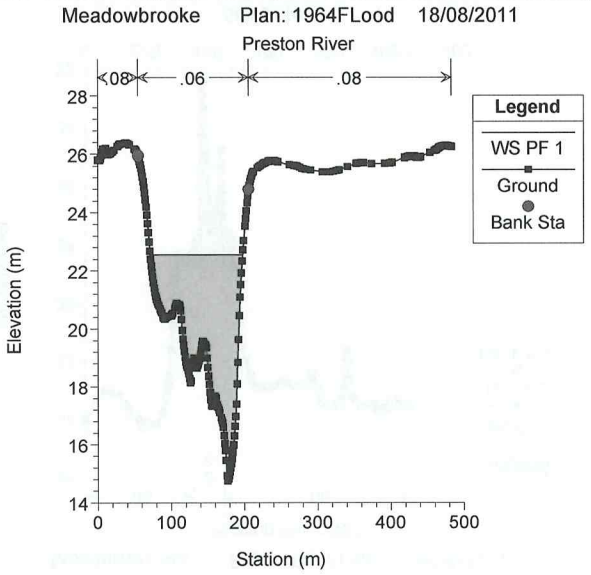
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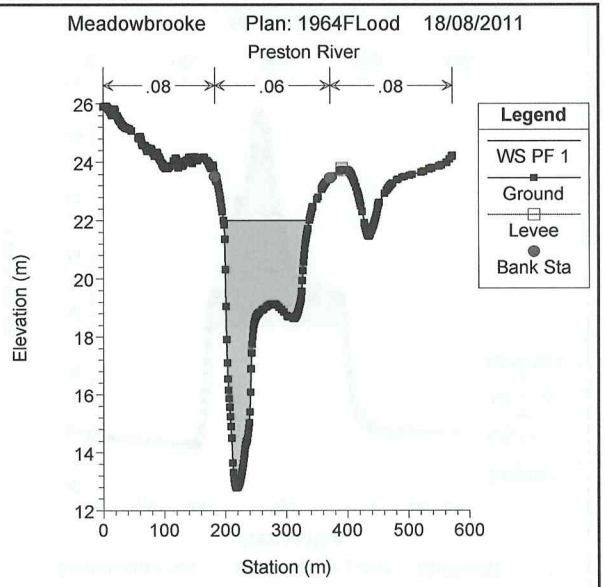
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Craig Pippin

From: Sasha Martens [sasha@hyd2o.com.au]
Sent: Thursday, 25 August 2011 2:36 PM
To: Craig Pippin
Cc: Andrew McRobert
Subject: FW: Meadowbrooke Modelling of 1964 Flood Event
Attachments: H11021Bv1.pdf

Hi Craig,

Advice for development levels via DoW below (Ive attached a copy of our letter to DoW on the 1964 flood modelling – as not sure if I forwarded you a copy earlier this week).

Overall a good outcome, and should provide the flexibility to consider some development in the lower area if required.

Give me a call if need to discuss or if we can be of any further assistance on the project.

Regards,
Sasha

Sasha Martens
Principal Engineering Hydrologist

hyd2o

Suite 6B, 103 Rokeby Rd Subiaco WA 6008
PO Box 1055, Subiaco WA 6904
p +61 8 9382 8683 | f +61 8 6380 1910 | m 0419 510 073

From: RODGERS Simon [mailto:Simon.RODGERS@water.wa.gov.au]
Sent: Thursday, 25 August 2011 1:44 PM
To: 'Sasha Martens'
Subject: RE: Meadowbrooke Modelling of 1964 Flood Event

Hi Sasha

We recommend a minimum habitable floor level of 1.20 m above the 100 year ARI flood level to ensure adequate flood protection is provided.

Regards

Simon Rodgers

Supervising Engineer, Floodplain Management
Water Resource Assessment Branch
Department of Water (WA)
Ph: 08 6364 6923
fax: 08 6364 6515
email: simon.rodgers@water.wa.gov.au

From: Sasha Martens [mailto:sasha@hyd2o.com.au]
Sent: Monday, 22 August 2011 4:23 PM
To: RODGERS Simon
Subject: Meadowbrooke Modelling of 1964 Flood Event

Hi Simon,

Brief letter report regarding 1964 event flood modelling at Boyanup attached. Advice from DoW regarding suitable clearance above 100 year flood level would be appreciated.
Similar to Donnybrook, we found 1964 event resulted in ~ 0.9m flood level above 100 year event.

Regards,
Sasha

Sasha Martens
Principal Engineering Hydrologist

hyd2o

Suite 6B, 103 Rokeby Rd Subiaco WA 6008
PO Box 1055, Subiaco WA 6904
p +61 8 9382 8683 | f +61 8 6380 1910 | m 0419 510 073

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Craig Pippin

From: RODGERS Simon [Simon.RODGERS@water.wa.gov.au]
Sent: Wednesday, 17 August 2011 11:23 AM
To: 'Sasha Martens'
Subject: RE: Preston River Flood Sudy at Boyanup

Sasha

In this instance we would not consider it necessary to undertake pre and post development modelling as the current modelling suggests that the area is not an active flow area during major flooding up to the 100 year ARI event. However, estimated flood levels for a flow similar in magnitude to the 1964 event would be necessary to establish appropriate minimum habitable floor levels that would protect against a recurrence of this event. This is similar to the approach we have adopted for the Preston River in Donnybrook.

Regards

Simon Rodgers

Supervising Engineer, Floodplain Management
Water Resource Assessment Branch
Department of Water (WA)
Ph: 08 6364 6923
fax: 08 6364 6515
email: simon.rodgers@water.wa.gov.au

From: Sasha Martens [mailto:sasha@hyd2o.com.au]
Sent: Wednesday, 17 August 2011 10:03 AM
To: RODGERS Simon
Subject: RE: Preston River Flood Sudy at Boyanup

Thanks Simon, much appreciated.

I will advise my client, and see if they wish to proceed with further considerations of the "backwater flooding" area.

I presume from DoW's perspective we would need to run our model with ~400 m3/s (1964 flow estimate) and provide an assessment of the difference in flood levels within the main Preston River channel if this area was filled.

Regards,
Sasha

Sasha Martens
Principal Engineering Hydrologist

hyd2o

Suite 6B, 103 Rokeby Rd Subiaco WA 6008
PO Box 1055, Subiaco WA 6904
p +61 8 9382 8683 | f +61 8 6380 1910 | m 0419 510 073

From: RODGERS Simon [mailto:Simon.RODGERS@water.wa.gov.au]
Sent: Tuesday, 16 August 2011 4:51 PM
To: 'Sasha Martens'
Subject: RE: Preston River Flood Sudy at Boyanup

Hi Sasha

We have reviewed your report (H11021Av1 – dated 5 August 2011) and provide the following comments:

- The hydrologic/hydraulic assessment are considered adequate in estimating the 100 year ARI flow / levels
- The Preston River Beelerup gauge was inundated during the 1964 flood and the peak level/discharge for this event is considered doubtful.
- The 1964 flow estimate at Boyanup is expected to be ~ 400m3/s based on the estimates at Donnybrook (370m3/s) and Picton Bridge (430 m3/s) – refer to attached
- Based on some recently obtained anecdotal information for the 1964 flood event, a peak flood level of ~33.0 m AHD was observed at a site ~ 500 metres upstream of the Boyanup – Picton Road Crossing
- The current proposed development area is located outside of the 100 year ARI flood extent and is also expected to be above the peak 1964 flood level.
- Future development within the area described as backwater flooding in Figure 7 would need further assessment to ensure
    - It has adequate flood protection against an event similar in magnitude to the August 1964
    - The existing flooding regime during an event similar in magnitude to August 1964 is not detrimentally affected.

Consequently, the proposed development is considered acceptable with regard to major flooding.

Please note that a failure to adhere to these recommendations will result in a greater exposure to risks of flood damage. It should be noted that this advice is related to major flooding only and other planning issues, such as environmental and ecological considerations, may also need to be addressed.

Regards

Simon Rodgers

Supervising Engineer, Floodplain Management
Water Resource Assessment Branch
Department of Water (WA)
Ph: 08 6364 6923
fax: 08 6364 6515
email: simon.rodgers@water.wa.gov.au

From: Sasha Martens [mailto:sasha@hyd2o.com.au]
Sent: Friday, 5 August 2011 1:32 PM
To: RODGERS Simon
Cc: ANDERSON Carol
Subject: Preston River Flood Sudy at Boyanup

Hi Simon,

Following from our meeting earlier this week, please find attached a copy of our report and analysis of the 100 year flood levels at Boyanup adjacent to Meadowbrooke Estate for your consideration.
Should you have any queries, please do not hesitate to call to discuss.

Regards,

Sasha

Sasha Martens
Principal Engineering Hydrologist

hyd2o

Suite 6B, 103 Rokeby Rd Subiaco WA 6008
PO Box 1055, Subiaco WA 6904
p +61 8 9382 8683 | f +61 8 6380 1910 | m 0419 510 073

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ATTACHMENT K
SWCS

development consultants

SWCS
Environmental & Analytical Consulting

Sept 25, 2011

MPM Development Consultants
Unit 1, 33 Constitution Street
Bunbury, WA, 6230

Attn: Craig Pippin

Dear Craig

Attached are the analysis results for the Monitoring Bore and Surface Water samples collected from Meadowbrooke, Boyanup on August 29, 2011

The results show nothing outstanding, no Petroleum Hydrocarbons , no Polynuclear Aromatic Hydrocarbons and no Organochlorine or Organophosphate pesticide residues.

Monitoring Bore MB2 is significantly different to the others, it has a higher Total Dissolved Salts, high Sulphates, high Alkalinity, and significantly higher Calcium and sodium than the other monitoring bores.
MB2 and MB8 have very high Total Nitrogen levels which are primarily made up of NOx-N. This is usually as a result of fertilizer application.

Best regards

David Dodds
Dip App Chem A. G.Inst. Tech

South West Chemical Services,
Unit 5, 4 Mummery Cres, Bunbury, WA, 6230
ABN 71 111 052 218 Phone/Fax 08 9721 7170 Mobile 0417 149 645
Email admin@swchemservices.com.au

South West Chemical Services
Unit 5, 4 Mummery Cres.,
Bunbury, WA, 6230
ABN 71 111 052 21
Phone/Fax 08 9721 7170
Mobile 0417 149 645
Email admin@swchemservices.com.au

Certificate of Analysis

Client Name:	MPM Development Consultants
Address:	Unit 1, 33 Constitution Street, Bunbury, WA, 6230
Tel No:	9721 4777
Job No:	5769
Date Sampled:	29-Aug-11
Test Method:	Samples are analysed on an as received basis, using methods Inorg-001, 002, 006, 018, 055, 057, 060, Metals-020, 024, Org-003, 005, 008, 013/014
Sample Locations	Meadowbrooke, Boyanup, WA
Certification:	This analysis was performed to NATA certification Accreditation No 2901 Analytical report reference number 114273

Results are attached

David Dodds
Dip. App. Chem. A.G.Inst.Tech

25-Sep-11

South West Chemical Services
Unit 5, 4 Mummery Cres.,
Bunbury, WA, 6230
ABN 71 111 052 218
Phone/Fax 08 9721 7170
Mobile 0417 149 645
Email admin@swchemservices.com.au

Client Name:	MPM Development Consultants Attn: Craig Pippin	Job No:	5769
Address:	Unit 1, 33 Constitution St., Bunbury, WA 6230	Mobile:	0488 910 222
Tel No:	9721 4777	Sample Date:	29/08/2011
		Sampled By:	D. Dodds

Meadowbrooke, Boyanup sampling

Analyte	Limit of Detection	Unit	MB2	MB6	MB7	MB8	MB9
Easting			382243	382012	381868	381785	381804
Northing			6294996	6294922	6294976	6294909	6294854
On Site sampling							
SWL		m	2.29	2.81	1.94	2.91	2.57
Temperature		°C	17.2	18.7	17.5	18	16.8
pH	0.05		6.4	6.2	5.6	5.55	6.25
Dissolved Oxygen	0.1	mg/l	2.7	4.0	1.1	2.4	2.6
Dissolved Oxygen	0.1	%sat	27.7	43.3	11.6	25.3	26.5
Electrical conductivity	1	µS/cm	1150	330	420	250	860
Redox Potential	1	RmV	421	426	459	443	419
Laboratory Testing							
pH	0.05		6.4	6.0	5.4	5.6	6.2
Electrical conductivity	0.1	µS/cm	1200	270	440	270	940
Total Dissolved Solids (180°C)	100	mg/l	960	590	350	210	680
Chloride	1	mg/l	89	64	120	53	210
Sulphate	1	mg/l	150	13	29	9	100
Bicarbonate as CaCO3	1	mg/l	220	40	6	10	57
Carbonate as CaCO3	1	mg/l	<1	<1	<1	<1	<1
Hydroxide as CaCO3	1	mg/l	<1	<1	<1	<1	<1
Total Alkalinity as CaCO3	1	mg/l	220	40	6	10	57
Calcium	0.1	mg/l	30	7.7	6.2	1.5	5.8
Potassium	0.1	mg/l	1.1	1.5	3.3	0.8	0.4
Magnesium	0.1	mg/l	24	12	16	6.9	17
Sodium	0.5	mg/l	190	41	40	40	150
Hardness		mg/l	170	70	83	32	86
Aluminium	0.02	mg/l	<0.02	<0.02	0.03	<0.02	<0.02
Arsenic	0.001	mg/l	0.001	<0.001	<0.001	0.002	<0.001
Cadmium	0.002	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt	0.005	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	0.005	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	0.005	mg/l	0.013	0.009	0.011	0.009	0.01
Iron	0.02	mg/l	<0.02	<0.02	0.02	<0.02	<0.02
Mercury	0.0001	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	0.005	mg/l	<0.005	0.01	<0.005	<0.005	0.03
Nickel	0.005	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	0.001	mg/l	<0.001	0.002	0.002	0.002	<0.001
Selenium	0.001	mg/l	0.002	<0.001	0.001	0.002	0.002
Zinc	0.01	mg/l	<0.01	<0.01	0.01	0.01	<0.01
Total Nitrogen	0.05	mg/l	36	0.05	0.85	19	0.1
NOx as N	0.005	mg/l	28	0.023	0.6	14	0.011
Ammonia as N	0.005	mg/l	0.02	0.01	0.02	0.01	0.02
Total Phosphorus	0.01	mg/l	0.02	<0.01	0.02	0.02	<0.01
Phosphate as P	0.005	mg/l	0.02	0.006	0.02	0.005	<0.005
Benzene	1	µg/l	<1	<1	<1	<1	<1
Toluene	1	µg/l	<1	<1	<1	<1	<1
Ethylbenzene	1	µg/l	<1	<1	<1	<1	<1
m+p Xylene	2	µg/l	<2	<2	<2	<2	<2
o Xylene	1	µg/l	<1	<1	<1	<1	<1
TRH C6-C9	10	µg/l	<10	<10	<10	<10	<10
TRH C10-C14	50	µg/l	<50	<50	<50	<50	<50
TRH C15-C28	100	µg/l	<100	<100	<100	<100	<100
TRH C29-C36	100	µg/l	<100	<100	<100	<100	<100

South West Chemical Services
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Client Name:	MPM Development Consultants Attn: Craig Pippin	Job No:	5769
Address:	Unit 1, 33 Constitution St., Bunbury, WA 6230	Mobile:	0488 910 222
Tel No:	9721 4777	Sample Date:	29/08/2011
		Sampled By:	D. Dodds

Meadowbrooke, Boyanup sampling

Analyte	Limit of Detection	Unit	MB2	MB6	MB7	MB8	MB9
Polynuclear Aromatic Hydrocarbons							
Naphthalene	1	µg/l	<1	<1	<1	<1	<1
Acenaphthylene	1	µg/l	<1	<1	<1	<1	<1
Acenaphthene	1	µg/l	<1	<1	<1	<1	<1
Fluorene	1	µg/l	<1	<1	<1	<1	<1
Phenanthrene	1	µg/l	<1	<1	<1	<1	<1
Anthracene	1	µg/l	<1	<1	<1	<1	<1
Fluoranthene	1	µg/l	<1	<1	<1	<1	<1
Pyrene	1	µg/l	<1	<1	<1	<1	<1
Benz(a)anthracene	1	µg/l	<1	<1	<1	<1	<1
Chrysene	1	µg/l	<1	<1	<1	<1	<1
Benzo(b) &(k)fluoranthene	2	µg/l	<2	<2	<2	<2	<2
Benzo(a)pyrene	1	µg/l	<1	<1	<1	<1	<1
Indeno(123-cd)pyrene	1	µg/l	<1	<1	<1	<1	<1
Dibenz(ah)anthracene	1	µg/l	<1	<1	<1	<1	<1
Benzo(g,h,i)perylene	1	µg/l	<1	<1	<1	<1	<1
OrganoChlorine Pesticide Residues							
HCB	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
alpha-BHC	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
gamma-BHC(Lindane)	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
beta-BHC	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Heptachlor	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
delta-BHC	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Aldrin	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Heptachlor epoxide	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
gamma-Chlordane	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
alpha-Chlordane	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan I	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
p,p-DDE	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Dieldrin	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
p,p-DDD	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan II	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
p,p-DDT	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin aldehyde	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Endosulfan sulfate	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Methoxychlor	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
OrganoPhosphate Pesticide Residues							
Diazinon	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyriphos-methyl	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Ronnel	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyriphos	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Fenitrothion	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Bromophos ethyl	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2
Ethion	0.2	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2

David Dodds
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22-Sep-11

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Client Name:	MPM Development Consultants Attn: Craig Pippin	Job No:	5769
Address:	Unit 1, 33 Constitution St., Bunbury, WA 6230	Mobile:	0488 910 222
Tel No:	9721 4777	Sample Date:	29/08/2011
		Sampled By:	D. Dodds

Meadowbrooke, Boyanup sampling

Analyte	Limit of Detection	Unit	Preston River	Lake			
Easting			381968	381973			
Northing			6295177	6295001			
On Site sampling							
SWL		m					
Temperature		°C	18	19			
pH	0.05		7.5	7.05			
Dissolved Oxygen	0.1	mg/l	5.7	4.0			
Dissolved Oxygen	0.1	%sat	55.4	43.3			
Electrical conductivity	1	µS/cm	470	750			
Redox Potential	1	RmV	376	375			
Laboratory Testing							
pH	0.05		6.2	6.2			
Electrical conductivity	0.1	µS/cm	780	490			
Total Dissolved Solids (180°C)	100	mg/l	550	370			
Chloride	1	mg/l	220	120			
Sulphate	1	mg/l	<1	15			
Bicarbonate as CaCO3	1	mg/l	36	34			
Carbonate as CaCO3	1	mg/l	<1	<1			
Hydroxide as CaCO3	1	mg/l	<1	<1			
Total Alkalinity as CaCO3	1	mg/l	36	34			
Calcium	0.1	mg/l	7.7	8.8			
Potassium	0.1	mg/l	8.2	2.4			
Magnesium	0.1	mg/l	16	12			
Sodium	0.5	mg/l	110	73			
Hardness		mg/l	85	70			
Aluminium	0.02	mg/l	<0.02	<0.02			
Arsenic	0.001	mg/l	0.001	0.001			
Cadmium	0.002	mg/l	<0.002	<0.002			
Cobalt	0.005	mg/l	<0.005	<0.005			
Chromium	0.005	mg/l	<0.005	<0.005			
Copper	0.005	mg/l	0.01	0.009			
Iron	0.02	mg/l	0.05	0.16			
Mercury	0.0001	mg/l	<0.0001	<0.0001			
Manganese	0.005	mg/l	0.09	0.047			
Nickel	0.005	mg/l	<0.005	<0.005			
Lead	0.001	mg/l	<0.001	<0.001			
Selenium	0.001	mg/l	<0.001	<0.001			
Zinc	0.01	mg/l	<0.01	<0.01			
Total Nitrogen	0.05	mg/l	0.21	1			
NOx as N	0.005	mg/l	0.009	0.77			
Ammonia as N	0.005	mg/l	0.01	0.04			
Total Phosphorus	0.01	mg/l	<0.01	<0.01			
Phosphate as P	0.005	mg/l	<0.005	0.007			
Benzene	1	µg/l	<1	<1			
Toluene	1	µg/l	<1	<1			
Ethylbenzene	1	µg/l	<1	<1			
m+p Xylene	2	µg/l	<2	<2			
o Xylene	1	µg/l	<1	<1			
TRH C6-C9	10	µg/l	<10	<10			
TRH C10-C14	50	µg/l	<50	<50			
TRH C15-C28	100	µg/l	<100	<100			
TRH C29-C36	100	µg/l	<100	<100			

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Meadowbrooke, Boyanup sampling

Analyte	Limit of Detection	Unit	Preston River	Lake			
Polynuclear Aromatic Hydrocarbons							
Naphthalene	1	µg/l	<1	<1			
Acenaphthylene	1	µg/l	<1	<1			
Acenaphthene	1	µg/l	<1	<1			
Fluorene	1	µg/l	<1	<1			
Phenanthrene	1	µg/l	<1	<1			
Anthracene	1	µg/l	<1	<1			
Fluoranthene	1	µg/l	<1	<1			
Pyrene	1	µg/l	<1	<1			
Benz(a)anthracene	1	µg/l	<1	<1			
Chrysene	1	µg/l	<1	<1			
Benzo(b) &(k)fluoranthene	2	µg/l	<2	<2			
Benzo(a)pyrene	1	µg/l	<1	<1			
Indeno(123-cd)pyrene	1	µg/l	<1	<1			
Dibenz(ah)anthracene	1	µg/l	<1	<1			
Benzo(g,h,i)perylene	1	µg/l	<1	<1			
OrganoChlorine Pesticide Residues							
HCB	0.2	µg/l	<0.2	<0.2			
alpha-BHC	0.2	µg/l	<0.2	<0.2			
gamma-BHC(Lindane)	0.2	µg/l	<0.2	<0.2			
beta-BHC	0.2	µg/l	<0.2	<0.2			
Heptachlor	0.2	µg/l	<0.2	<0.2			
delta-BHC	0.2	µg/l	<0.2	<0.2			
Aldrin	0.2	µg/l	<0.2	<0.2			
Heptachlor epoxide	0.2	µg/l	<0.2	<0.2			
gamma-Chlordane	0.2	µg/l	<0.2	<0.2			
alpha-Chlordane	0.2	µg/l	<0.2	<0.2			
Endosulfan I	0.2	µg/l	<0.2	<0.2			
p,p-DDE	0.2	µg/l	<0.2	<0.2			
Dieldrin	0.2	µg/l	<0.2	<0.2			
Endrin	0.2	µg/l	<0.2	<0.2			
p,p-DDD	0.2	µg/l	<0.2	<0.2			
Endosulfan II	0.2	µg/l	<0.2	<0.2			
p,p-DDT	0.2	µg/l	<0.2	<0.2			
Endrin aldehyde	0.2	µg/l	<0.2	<0.2			
Endosulfan sulfate	0.2	µg/l	<0.2	<0.2			
Methoxychlor	0.2	µg/l	<0.2	<0.2			
OrganoPhosphate Pesticide Residues							
Diazinon	0.2	µg/l	<0.2	<0.2			
Dimethoate	0.2	µg/l	<0.2	<0.2			
Chlorpyriphos-methyl	0.2	µg/l	<0.2	<0.2			
Ronnel	0.2	µg/l	<0.2	<0.2			
Chlorpyriphos	0.2	µg/l	<0.2	<0.2			
Fenitrothion	0.2	µg/l	<0.2	<0.2			
Bromophos ethyl	0.2	µg/l	<0.2	<0.2			
Ethion	0.2	µg/l	<0.2	<0.2			

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