

21656E RB

11th July 2014

Attention: Mr Michael MacDonagh Principal Strategic Planner Greater Shepparton City Council Locked Bag 1000 Shepparton VIC 3632

Dear Michael,

RE: NORTH EAST GROWTH CORRIDOR DRAINAGE STRATEGY REPORTS

Please find attached two hard copies of the Drainage Strategy Report as per my email of 11th July 2014, in relation to the Shepparton North East Growth Corridor Precinct Structure Plan.

Should you have any queries regarding the above please do not hesitate to contact the undersigned to discuss.

Yours Faithfully, For Reeds Consulting Pty Ltd

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Enc.

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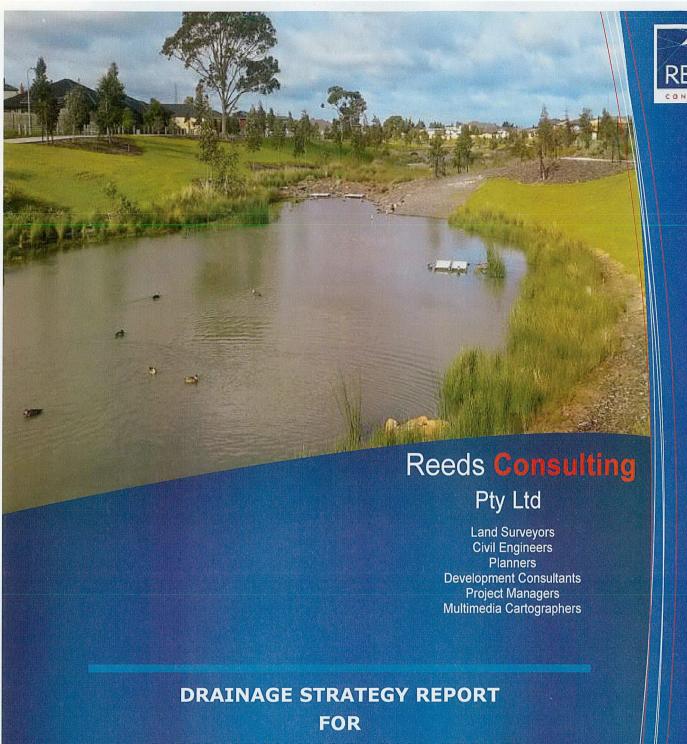
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SHEPPARTON NORTH EAST GROWTH **CORRIDOR PRECINCT STRUCTURE PLAN**

Prepared for: City of Greater Shepparton Project Ref: 21656E Date: July 2014

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1 INTRODUCTION

This report has been prepared to inform and assist the City of Greater Shepparton in relation to the stormwater drainage servicing issues and requirements associated with the development of the proposed Shepparton North East Growth Corridor Precinct Structure Plan.

The information contained in this report is based on investigations by Reeds Consulting Pty Ltd that have been facilitated by our inquiries with City of Greater Shepparton (CGS), Goulburn Murray Water (GMW) and the Goulburn and Broken Catchment Management Authority (GBCMA) and the information provided by these parties.

In addition to the above authority consultations, additional advice has been provided in relation to site levels and limited geotechnical investigation to assess current groundwater conditions.

Reeds Consulting have undertaken several inspections of the site and surrounding drainage infrastructure to better assess the constraints of the current conditions and the limitations that will be placed on the development of the land in its intended use of residential subdivision.

The report is based on both written and verbal advice from the abovementioned parties and our own calculations and assessments. The information has been prepared with due diligence and care however Reeds Consulting retains the right to alter this report should we become aware of a change in policy or advice that is contrary to the assumptions upon which this report has been prepared.

Prior to issue of this report Reeds Consulting has prepared interim documents in relation to the drainage strategy for the Shepparton North East Growth Corridor (NEGC), this document supersedes the previously issued reports dated September 2012 and January 2014.



2 **EXISTING CONDITIONS**

2.1 SITE DESCRIPTION

The subject area is approximately four kilometres north east of the Shepparton town centre.

The area is bounded by Ford Road to the north, Grahamvale Road and Goulburn Murray Waters irrigation channel to the east, Verney Road to the west and Goulburn Murray Waters Drain number 3 along the southern abuttal. A plan of the subject land is shown in Figure 1 below.

The subject land has a total area of approximately 172 Ha and consists of 8 major parcels of land, several smaller landholdings and contains two existing school sites. A number of existing irrigation channels bisect the site. The retirement of these channels will be a constraint on the full development of the PSP area as the channels will need to remain until all irrigation activity ceases in the precinct.



FIGURE 1: SITE LOCALITY PLAN.



2.2 EXISTING DRAINAGE CONDITIONS

The area has historically been used for fruit production and generally exhibits flat grades that have been artificially modified to facilitate gravity irrigation and drainage of land.

The land sheds runoff into two existing drainage catchments; these are demonstrated in figure 2 below. The southern portion of the site drains to Goulburn Murray Waters Drainage Channel No.3. The northern portion of the site drains to Goulburn Murray Waters Drainage Channel No. 4.

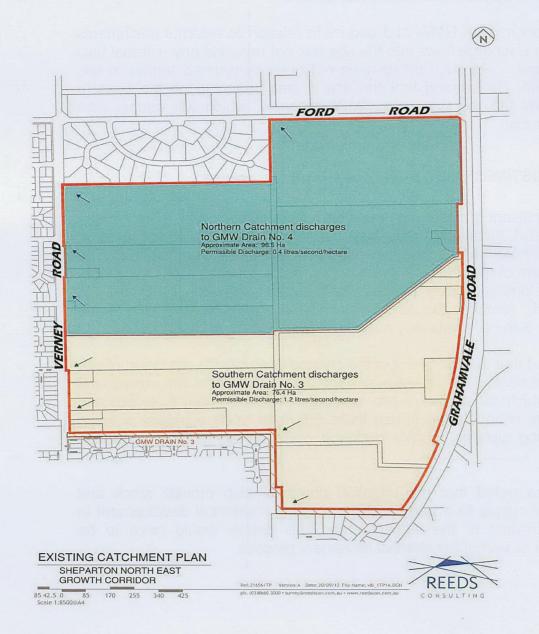


FIGURE 2: EXISTING DRAINAGE CATCHMENTS



Advice from Goulburn Murray Water indicates that the site currently has no formal drainage strategy and the current drainage outlets are limited to rural capacity and are not sufficient to provide any formal level of drainage or flood protection to the area.

The subject area is not identified as land subject to inundation in a 100Yr event on GBCMA's flood mapping of the Shepparton Area (refer Annexure A). In its current state the site is subject to localised flooding following more substantial rain events. In particular GMW has provided advice that Drain No 4 has an extremely limited capacity to receive water from the site or to accept stormwater when the drain is running partially full. This is discussed in more detail below.

Investigations with GMW and council in relation to external catchments that may discharge flows into the site has not revealed any external flow paths exist. As such these have not been considered further in this discussion. It is noted that the site is well protected on the Eastern abuttal by the rail lines and GMW channels, which will remain post development.

2.3 EXISTING IRRIGATION CHANNELS

Two significant irrigation channels bisect the subject land. The primary purpose of these channels has been to convey water for orchard irrigation from GMW's supply network. Whilst these channels are not a component of the drainage strategy they are a constraint that will control the development timing, as their continued use will impact the ability to effectively remodel the site to provide adequate drainage to some portions of the site until they are retired from service and abandoned.

It is noted that abandonment of the channels will require cessation of use and surrender of water rights as well as acquisition of the crown land within which the channels are located. If development is to proceed whilst the channels are in use there will need to be a bypass solution comprising siphons, gravity drainage or temporary pumped drainage lines.

It is also noted that the irrigation channels also provide stock and domestic supply to a portion of the existing residential development in the north-west of the subject area. This supply would need to be replaced as part of the channel retirement process.



3 PROPOSED DRAINAGE STRATEGY

The following section outlines the design constraints and methodology behind the development of the drainage strategy for the site.

The site has a number of design constraints, which include physical, aesthetic and social, these have all been considered during the development of the drainage strategy.

It became apparent during the process that the drainage solution for this site would have a controlling effect on the overall road and public open space network and to this end the drainage strategy has been developed in conjunction with the overall PSP layout to ensure that an integrated design solution is achieved that will permit the efficient and economic development of the site.

The constraints on the site are derived from three primary sources; these are natural topographic constraints, Goulburn Murray Water constraints in relation to outlet capacity and water quality treatment and City of Greater Shepparton constraints in relation to internal drainage requirements and a stated desire to integrate any storage / retarding basins in areas of open space. Each of these design controls is discussed below:

3.1 TOPOGRAPHIC CONSTRAINTS

The site is generally flat with minimal surface grades due to the historic agricultural use artificially shaping the land surface to provide efficient gravity flood irrigation of the orchards.

To develop the site for residential development it will be necessary to undertake significant site remodelling and bulk earthworks to meet required minimum grades for roads and allotments and to convey and control overland stormwater flow.

Filling of the site will be constrained by abuttal to existing development in the north west of the area and to a lesser degree by the interface with existing roads and channels that surround the site.

In order to provide an economic design solution and limit the extent of earthworks it is necessary to remodel the site into a series of subcatchments. Based on the geometry of the overall parcel the drainage strategy has proposed a series of five approximately equally sized subcatchments.

These sub-catchments are defined on the drainage strategy plan in Annexure B.



3.2 GOULBURN MURRAY WATER ADVICE

Goulburn Murray Water is the responsible drainage authority that manages the drainage and irrigation network in the Greater Shepparton area.

GMW defines both the treatment requirements for stormwater and the permissible discharge flows into their drainage network. Advice from GMW in relation to drainage of the subject area has confirmed that Drainage Channel No. 4 to the north of the site has significant discharge constraints and a maximum permissible discharge rate of 0.4 litres /second /hectare.

Drainage Channel No. 3 to the south of the subject land has a permissible discharge rate of 1.2 litres /second /hectare which is still a restrictive figure when considering the size of the catchment.

In discussions with GMW there has been confirmation that alteration of the existing drainage catchment boundaries would be supported to enable the majority of the site to be conveyed to Drain No. 3 provided that the maximum discharge rate is not exceeded. GVW have also advised that level monitoring of Drain No. 3 will be necessary and no outfall / discharge permitted when a pre-determined top water level is reached or exceeded. Given the extremely restrictive discharge rate permitted to Drain No 4, the drainage strategy for this precinct will be to discharge all flows, other than localised road flows in the Ford Road abuttal to Drainage Channel No 3.

During or following times of heavy rainfall GMW has advised that the drainage channel network does not have sufficient capacity to cater for any additional contributing flows. GMW has confirmed that a pump controller will be necessary to regulate discharges into Drain No. 3. As a result of this limitation it is a requirement that the drainage system within the PSP area be designed to store all discharge from a 1% AEP (100 Yr. ARI) storm for a 24 hour period. This is a significant factor in the development of the drainage strategy and requires the inclusion of significant storage basins within the site area.

In addition to the controls placed on the quantity of discharge from the site GMW have also stipulated that the quality of the discharged stormwater must meet industry benchmark practice with regard to the removal of suspended solids (80%), nitrogen (45%) and phosphorous (45%). To achieve the water quality targets for stormwater the drainage strategy will incorporate Water Sensitive Urban Design (WSUD) elements where possible into the road and storage basin design.



3.3 CITY OF GREATER SHEPPARTON ADVICE

In developing the drainage strategy Council has placed a number of design constraints on the site. These are a combination of technical constraints and desired outcomes with respect of landscape interface and integration of public amenity between proposed storage basins and public open space areas.

Councils technical design criteria is based on the requirements in the Infrastructure Design Manual (IDM) and includes the provision of a major / minor drainage system with a 5Yr ARI underground system and an overland flow path with capacity to convey and control 100Yr ARI runoff.

Council have indicated a desire to move away from past municipal practices of providing isolated water storage basins. Traditionally these have been located in fenced off reserves and have been excavated depressions with steep batters to maximise storage capacity. Council have stipulated that any stormwater storage basins be integrated with public open space. Such integration offers a range of community benefits including additional opportunity for landscape embellishment of open space, increased overall size of community reserve areas, improved visual amenity and sightlines within the reserve and opportunity to integrate shared pathways with the basin to enhance passive recreation opportunities.

The inclusion of the storage basins within public reserve areas increases design constraints due to the safety and maintenance requirements of flatter batter slopes and curvilinear geometry to give a more 'natural' footprint to the basins. Both of these factors reduce the efficiency of the storage area. The design compromise is to minimise the footprint of the storage area whilst providing a natural basin shape and gentle batters that are amenable to all reserve users.

3.4 SUB-CATCHMENTS

The drainage strategy for this site has been dictated by the various constraints discussed above. The site has been divided into 5 subcatchments that will each have an independent storage basin capable of storing a 1% AEP storm for a 24 hour period with no discharge to the receiving waters external to the site. The location of the storage basins is generally central within each catchment to ensure that the drainage lengths are not excessive which avoids unnecessarily deep basins.

Each storage basin will have a controlled pumped discharge as a gravity discharge will not be possible due to the site topography and relative water levels in the drainage channels.



Generally each sub-catchment will have a 5 Yr. ARI piped drainage network to convey flows to the storage basin area. Flows in excess of the 5Yr ARI event will be conveyed overland via the road network to the storage basin. Once piped flows reach the storage basin area they will need to discharge into a sediment pond to remove bulk sediment load.

The sediment pond will require a low flow (3 month capacity) outlet into a bio-swale treatment zone to remove nitrogen and phosphorous loads contained in the stormwater. Flows in excess of the 3 month ARI storm will be diverted from the sediment pond directly to the storage basin, so as to limit damage to the bio-swale area.

Preliminary drainage analysis of each sub-catchment has been undertaken and from this an estimated storage requirement has been determined for each basin based on the 100Yr storm. A summary of these results and preliminary basin storage volumes is presented in Fig 3 below sub-catchment identification is per Annexure B:

SHEPPARTON NEGC SUBCATCHMENT STORAGE REQUIREMENTS							
Sub-Catchment ID	Sub-catchment Approximate Area (Ha)	Storage Volume 100Yr ARI storm 24 Hour (cubic metres)	Basin Area 100Yr level (sq.m)				
1	32.2	31,000	14,720				
2	35.5	38,000	16,850				
3	34.5	33,800	16,200				
4	37	42,800	19,400				
5	25.8	27,500	14,350				
TOTAL	165	173,100	81,520				

FIGURE 3: BASIN STORAGE CAPACITY & INDICATIVE SIZING

Based on the required storage volumes and batter slopes of 1 in 8 an approximate footprint area for each storage basin has been calculated. These have been located approximately central to each sub-catchment area; the areas shown have been used for estate planning. The road network and public open space elements have been integrated in this strategy to provide the most efficient layout for the site. It should be noted that the above calculations are based on a 'regular' basin shape and the inclusion of a 'natural' shaping will be less efficient and increase the basin footprint. The treatment of the storage basins is discussed below. It is noted that the two school sites within the parcel have existing drainage connections. It is not proposed to alter the existing connections for the developed portion of the school sites. Where the school land may be sold off and its use altered to residential development then these areas of altered land use would be incorporated into the estate storage design.



3.5 STORAGE BASINS

The storage basins vary slightly in size due to variance in the subcatchment areas. In general these basins will be located within or directly adjacent to public open space reserves, such that the spaces become integrated community areas.

Each basin is expected to be in the order of four (4) to five (5) metres deep to provide the required storage volume. In higher order rain events these basins will be sized to fill to the level of the surrounding reserve; however the public open space areas will be above the 100 Yr. storage level and will maintain functionality. In times of low rainfall the basins will generally be 'dry' grassed areas with the exception of the sediment ponds which will always contain water due to them receiving all minor flows within the catchment. Appropriate signage will be required around the storage areas to alert users to the potential for inundation following rain events.

Council has stipulated that the five year storage level in the basin must be lower than the invert level of the local drainage network to ensure that a free draining network in the 5Yr ARI event. A preliminary design has been prepared in relation to Catchment No 1 to demonstrate the operation of the storage basins and provide a functional assessment of the catchment remodelling. This detailed assessment is provided in Section 4.0 of this report and additional data is provided in annexures.

The Shepparton area has high incidence of groundwater and this was a primary consideration in assessing the viability of such significant storage bodies. To address the concerns relating to groundwater and to confirm the feasibility of the storage basins, a geotechnical consultant was engaged to undertake field bores and assess ground water conditions.

Once preliminary assessment of likely basin location was determined the geotechnical engineer was provided co-ordinates of the proposed basin locations and drilling was undertaken at the proposed location of each basin. The testing revealed that there was no groundwater present at depths up to five (5) metres and as such the basin footprints as proposed in the Drainage Strategy plan are considered feasible in terms of the proposed depths. A full copy of the geotechnical report prepared by BM Consulting Engineers is included in Annexure C. The basin footprints proposed have been based on a batter slope of 1 in 8. This is a reasonably conservative figure but one that provides unimpeded pedestrian access to the basins. The ultimate landscape treatment of the basins will provide opportunities to increase this batter slope through intense localised landscape treatment or the incorporation of formal retaining walls, boardwalks and fences in other areas.



The successful integration of the basins into the public open space will rely upon the variability of the landscape treatments and the details of this concept will be fully developed during detailed design. The inclusion of areas of steeper batters has the beneficial impact of reducing the overall basin footprint, decreasing the area of land subject to regular inundation and creating or enhancing visual interest and overall aesthetics. Section 4 of this report has included a preliminary basin modelling exercise and contains cross sections of a design for catchment - Catchment No 1.

It is anticipated that the landscape treatments for the basins will be predominantly open grassed areas in the lower areas subjected to frequent inundation. The inclusion of open swales / dry creek beds and appropriate ephemeral plantings will be appropriate in the lower reaches of the swales.

The upper reaches of the basins can be planted with trees and species that will tolerate occasional inundation. The use of mulched garden areas should be restricted to the periphery of the basin areas to avoid transportation of the mulch and blockage of the drainage outlet systems and pumps.

Each storage basin will have a localised sump and pump station to enable discharge of collected runoff. The sump areas could be either underground chambers or incorporate small pondages.

Due to the already significant depth of the basins it is not anticipated that there will be significant opportunity for large water bodies to be incorporated into the storage basins. These would be required to be excavated below the required storage level (i.e. the top water level of any permanent water body would need to be below the 5 metre basin depth).

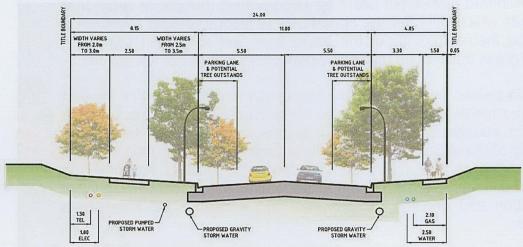
3.6 STORMWATER OUTLETS

As discussed in the above report ultimate discharge of stormwater runoff is to GMW's Drain No.3. This discharge will be via a pressurised discharge from each storage basin. After assessment of the likely development staging, landholdings, site topography and road network the most economic and flexible solution is to provide two linked pressurised systems, with two independent connection points to Drain No 3. GMW has offered in-principle support of two discharge points.

The proposed discharge system is shown in the Drainage Strategy plan provided in Annexure B. A combined discharge system will be constructed that links the basins in Catchments 1, 3 and 4 and discharges via Verney Road to Drain 3. Basins 2 and 5 could also combine to a localised discharge point part way along the Southern boundary of the site.



Such an arrangement will enable infrastructure costs to be rationalised and alleviate the need to install multiple pipelines within road reservations to cater for drainage discharge. A proposed street cross section is shown below which incorporates the pumped drainage outlet and demonstrates that the inclusion of this asset within a typical street is achievable.



CROSS SECTION 3 - 24m WIDE RESERVE LINK ROAD

3.7 WATER SENSITIVE URBAN DESIGN

Prior to discharge into GMW's drainage channel, stormwater flows will need to be treated to meet best practice targets for the removal of contaminants particularly suspended solids, dissolved nitrogen and phosphorous.

There are a number of treatment options available to reduce the pollutant load on receiving waters, these include:

- Household rainwater tanks connected to toilets or laundry;
- Localised rain gardens adjacent to carparks, community buildings or commercial precincts;
- Inclusion of gross pollutant traps (GPT's) on local drainage networks:
- Linear treatments such as grassed swales or bio-swales;
- End of line treatments such as wetlands.

Usually a combination of several treatments provides the optimal solution for a larger site. Within the Shepparton NEGC there is opportunity to implement a number of these solutions. Given the depth of the storage basins required to retard stormwater flows a wetland is not considered feasible as this option would require additional excavation below the level of the basin floor and would be subject to frequent inundation due to the lack of ability to bypass 'higher flow' events.



It is considered that the primary treatment feature of the drainage network will be the inclusion of grassed swales and / or bio-swales within edges of the storage basins, these would be linked to the piped drainage network via a sedimentation pond and would provide opportunity to create a natural appearance 'creek bed' style treatment.

The size of the basins will mean that swale lengths can be in excess of several hundred meters per basin by incorporating multiple or curvilinear alignments which will offer the opportunity to incorporate an appropriate landscape theme throughout the basin floor and still retain significant areas of grass that can be utilised by park users in times of low rainfall.

The basin swales could potentially be supplemented by swales located within road medians or as discussed by incorporating elements into site design for commercial and community precincts. Detailed design and modelling of the WSUD elements will be undertaken during the detailed design phase of the project and will need to consider not only the physical constraints of the site but also the financial impact of both initial construction and ongoing maintenance of the various treatment train elements.

4 CATCHMENT No.1 ANALYSIS AND BASIN DESIGN

During the process of developing the drainage strategy Council Officers requested that a further level of detail design be undertaken to provide surety to council that the servicing strategy proposed could be successfully integrated within the public open space reserves as described.

In particular council sought investigation on the following aspects of the strategy:

- 1. Detailed analysis of storage basin sizing and shape;
- 2. Water Sensitive Urban design elements including sizing and treatment level:
- 3. Integration of the WSUD elements in the basin / reserve area;
- 4. Integration of basins within the public open reserve area and details of the operation of the system.

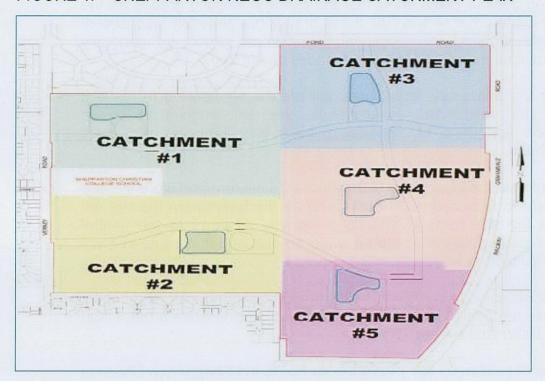
The design presented below is not intended as a final detailed design of the subdivision and is a high level functional design assessment of potential operation of all elements of the drainage system. Final detailed design will be undertaken following issue of planning permits and may have other constraints that need to be considered that do not form part of the assumptions of this report. It is anticipated that the design of all storage basins within the Shepparton NEGC will generally be of the form detailed in this report. Base assumptions have been listed in this report in order that assessment of applicability can be made.



4.1 SITE DESCRIPTION

Shown is a copy of the overall site with the five (5) drainage catchments highlighted. The proposed storage basin location is also shown within each sub-catchment, the locations have been selected generally to be central to each catchment to minimise the length of drainage pipelines to each basin and hence limit the depth of incoming lines to the basin and ultimately control basin depth.

FIGURE 1: SHEPPARTON NEGC DRAINAGE CATCHMENT PLAN



In some cases the basin location has also been dictated by other planning constraints, such as collector road location, community facilities and existing schools. In these cases the basins have sometimes been shown to be 'off centre' to the catchment. It is noted that in the case of Catchment 1 the basin is noticeably 'off centre'.

For the purposes of undertaking this analysis catchment No.1 has been selected on the basis that its 'off centre' basin location will aggravate basin depth due to the longer controlling drainage reaches required to reach the outlet location.

This catchment also has a number of existing constraints such as abuttal to existing development, an existing school and an intersection with Verney Road. The above elements all add constraints that are at least equivalent to those of the other catchments and for the purposes of this type of assessment provide suitably conservative assessment criteria to ensure that the operation of the other basins is functional.



4.2 CATCHMENT 1 DESCRIPTION

Catchment No 1 is located in the North West portion of the site and is approximately 32.1 hectares in area. It is bounded to the North by the existing Matilda Drive residential development, to the south by the existing Shepparton Christian College school site and to the West by Verney Road.

Due to its historic use for fruit production the existing surface levels have been artificially graded to uniformly fall from East to West. Examination of existing contour plans show that the average existing grades on the land are in the order of 1 in 700; these grades are generally inconsistent with those required for residential development which will generally require minimum road and allotment grades of 1 in 200.

As such the entire catchment area will require remodelling to make it suitable for residential development, this will require extensive excavation and filling of the site to make is suitable for residential development.

The requirement by Goulburn Murray Water to capture and store the 100 year storm for a period of 24 hours with no discharge from the site will result in the site being re-shaped to convey all flows to the central reserve / basin area rather than provide an overland flow route that will convey flows off-site.

Further discussion is contained below in relation to the logic and impact on the site remodelling, and also the impact of storm events greater than the 1 in 100Yr ARI event.

The area of catchment No 1 includes abuttal to the Shepparton Christian College site; a portion of the school site is already developed and has existing drainage to Verney Road. This area has been excluded from the catchment analysis and its existing drainage arrangements are proposed to remain in place.

For the purpose of this catchment analysis the undeveloped portion of the school land has been included as there is future possibility that this could ultimately form part of the residential development.

A preliminary layout of the elements of the storage and treatment system is shown in Annexure D; this includes various cross sections of the ponds to give an indication of levels.

The assumptions behind the development of this plan are discussed below.



4.3 ASSUMPTIONS

The preliminary storage basin sizing listed in Section 3.3 above were determined based on with regard to catchment No.1 this is now further refined.

The following data and assumptions have been used to undertake this more detailed analysis:

Catchment Area:	32.1 Ha	
Initial Time of Concentration:	6 minutes	
Maximum length of reach to basin:	700m	
Assumed grading of pipelines:	1 in 400	
Assumed surface grading:	1 in 200 (herringbone)	
Basin discharge limit in 5 Yr event:	1.2 litres/sec/Ha	
Basin discharge limit in 100Yr event:	Nil	
100Yr Storage period with no discharge:	24 Hours	

The storage analysis was undertaken using RORB flood modelling software. Annexure E shows a copy of the raw data results of this analysis, a summary is provided below.

4.4 RESULTS

Based on the above assumptions and input data the flood storage required for Basin 1 in a 100Yr event with no discharge for a 24 Hour period is 28,500 cubic metres.

This volume is the required storage in a 1 in 100Year event and such a rainfall event will see the entire basin area fill to a depth of approximately three metres. In such an event the public reserve area will not be subject to inundation for storage purposes , however, overland flows will be conveyed to the basin via the reserve are during such a storm event.

4.5 BASIN DESIGN - CONTROLS AND ASSUMPTIONS

The storage analysis and discussion in Section 3.5 determined a basin size based on constraints of limiting the depth to five meters and assuming a batter slope of an average of 1 in 8. This then allowed a determination of the basin 'footprint' such that an area could be defined for estate planning purposes.

In order to provide greater surety about the basin / reserve outcome council has required additional analysis and modelling to be undertaken to model a preliminary basin solution taking into account the likely road pavement and allotment levels, the invert of incoming drainage pipelines and the impact and Water Sensitive Urban Design (WSUD) treatments.



All of these elements will impact the potential shape and depth of the storage basins and the successful integration with the adjacent reserve area.

Per above discussion, catchment 1 has existing constraints on three abuttals. These elements limit the extent of earthworks possible on the abuttal boundaries. In general where the land abuts existing development future ground levels will need to match existing conditions or be managed via integrated fencing and low retaining walls. The abuttal to Verney Road allows for some level difference that can be remediated via landscaping however the intersection with Verney Road is a 'fixed' control that provides initial control for internal road grading.

A model was generated using the existing Verney Road levels as a control point. A high point was located within the site entry to ensure that Verney Road flows remain within the existing reservation and do not enter Catchment No 1. The road grading then generally grades to a low point located adjacent to the reserve and rises to the abuttal boundary with Catchment No's 3 and 4.

The collector road grading was then used as the basis for minor road gradings and setting of allotment control levels around the abuttal of the catchment zone. Road grading controls used were all based on the minimum grading of 1 in 200 defined in the Infrastructure Design Manual (IDM) road design guidelines, this was considered a conservative approach and flatter grades could be achieved by incorporating a herringbone grading design in the ultimate detailed design process. The approach outlined here provides a surface model framework for further assessment of drainage pipelines. From the above surface model a number of drainage pipeline alignments were assessed to determine the controlling reach. Generally the longer the reach the deeper the pipeline will be at the basin outlet, hence this will have a direct impact on the ultimate basin depth.

Following determination of a pipeline invert level at the storage basin a further constraint was considered, this was the council requirement to that a 1 in 5 Year storm event must be stored at a level below the invert of the incoming drainage line. This constraint needs to be considered as it may be a controlling factor in the basin footprint if the incoming drainage lines are excessively deep. Modelling outputs for the 5Yr storage level have been included in Annexure F and in the 1 in 5 Year event assumes that the system is still discharging at a rate of 1.2 litres / sec / Ha. A number of iterations were required to produce a representative surface model and pipeline network. Following the initial work on this element other factors were considered, primarily these were constructability issues and flood events greater than a 100Yr event; discussion of these elements is expanded below.



4.6 EARTHWORKS BALANCE

The design methodology described above is based on a physical constraints only, such as existing surface, minimum grades of pipes road and allotment, it is a necessary first step in determining the physical constraints of the ultimate basin, however other factors need to be given consideration in shaping the end result.

A review of this preliminary framework was undertaken from a constructability perspective and it was revealed that the remodeling of Catchment No 1 would require in excess of 320,000 cubic meters of fill material. This presented both potential supply issues in the local area and had significant cost and timing implications for the efficient development of this site. A revised model was prepared which lowered the finished surface level of the public reserve to approximately 1.0-1.2 metres below the existing surface level. An appropriate adjustment was made to the local street network and associated drainage pipelines and a resultant earthworks balance of less than 40,000 cubic meters of fill was Given the area of the catchment this is considered an achieved. approximate balance and will result in the bulk of the site remodeling being completed as a cut to fill exercise within the site. This will result in a more efficient development process from both cost and timing perspectives.

Despite the public reserve area being lowered below the current surface level the limiting factor for the base of the storage basin was still capped at generally 4.5 metres below the original ground surface level, this will result in a general maximum level differential between the public reserve and base of the storage basin of around 2.8 metres, which will provide greater opportunity for successful integration between the two areas. The level difference between the basin areas and the road reserve will be in the order of 3.5-4.0 m. The detailed modelling of the storage basin has adopted a general batter slope of a maximum of 1 in 6. This can varied during detailed design when more formal elements can be considered.

4.7 FLOOD CONTROL AND MITIGATION

A potential negative impact of shaping the catchment to direct flows towards a central basin is the remove the ability for catchment 'overflow' to occur in greater than the 100Yr ARI events.

As discussed in the preceding section the central reserve in this catchment will be generally 1.2m metres below the current surface level, this is approximately 800mm below the existing road levels in Verney Road. A high point within the site entry will prevent excess flows from Verney Road entering the site however this will also prevent excess flows within the site from 'overflowing' to Verney Road.



The catchment layout which has the storage basins adjacent to public reserve areas provides significant opportunity for 'extreme event' storage such that once the 1 in 100Yr design storage within the basins is exceeded there will be a significant level of storage available within the reserve area and surrounding road reservation to provide protection to surrounding allotments. All abutting allotments will then be elevated above the road reserve for additional protection from 'extreme rainfall events'.

An extreme event scenario of a 1 in 500 Year event was modelled based on the above, the additional volume of storage required was approximately 10,500 cubic metres this would in effect result in an increased depth of flooding of 450mm. This would cause a portion of the public reserve area to become inundated. Allotment levels are proposed to be generally a minimum of 600 mm above the 100 Year storage level and would be above even a 500 Year event.

Annexure G has a plan showing the flooding level in a 1 in 100 Year storm event. Annexure H shows the extent of flooding in a 1 in 500 year storm event on the modelled basin; all allotments are protected from inundation in this scenario as the overflow flooding will be captured in the reserve area. The calculations made assume there are no external or downstream controls on the inundation of the land and consider only runoff from within this catchment. Previous advice has indicated that the PSP area is not currently subject to inundation in a 1 in 100Yr event.

4.8 WSUD - BACKGROUND AND ASSUMPTIONS

The above discussion considers the hydraulic and topographic constraints of the basin, catchment and future allotments, the final element in determining the operation of the drainage system is the treatment of storm water flows to remove pollutants prior to discharge into receiving waters.

In line with industry best practice, storm-water flows are to be treated prior to discharge from the site to remove the following pollutants in all events up to a 3 month ARI storm:

- Suspended solids 80% reduction
- Nitrogen 45% reduction
- Phosphorous 45% reduction

There are several methods of achieving these targets: these are generically discussed section 3.7 above. In the preparation of the detailed analysis preliminary WSUD design has been undertaken using MUSIC modelling software. A copy of the results and inputs is provided in Annexure I and a summary is provided below.



When considering the suitability of WSUD treatment options, there are several constraints that control the suitability of one treatment over another. Given the storage function of the basins and the likelihood of regular inundation, in-line treatments were not considered suitable as frequent flooding and or high velocity flows will scour treatment zones and re-suspend sediment material within the treatment area.

The treatment considered most suitable is an offline bio-retention zone and sediment pond, with a bypass weir for storm events greater than the 3 month ARI design event.

4.9 ALTERNTIVE OPTIONS

The treatment proposed is still considered to be an 'end of line' style treatment and could be supplemented by upstream measures such as swales in road reserves or water tanks within properties connected to dwellings for toilet flushing or laundry supply.

The option of swales in road reserves has not been modelled in this exercise as it requires a significant area of land and can only practically treat flows from road reserve areas. Hence in a residential setting provides limited benefit for the additional land required for implementation. There are also potential issues created for property access and traffic movement.

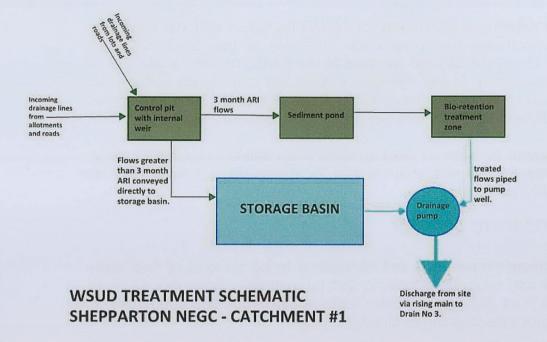
The inclusion of rainwater tanks connected to dwellings has also not been modelled in this assessment as it would require regulatory controls to be imposed on all allotments within the Growth Corridor and can potentially push a significant additional cost back to homeowners, particularly on smaller allotments where tanks may need to be constructed underground due to limited space within the allotment.

The exclusion of both of these upstream measures means that the assessment of treatment area within the reserve and storage basin is conservative as the calculated treatment zones will be larger that otherwise required if supplementary treatments such as those listed were included.

4.10 WSUD TREATMENT TRAIN

The treatment train adopted in this design assessment is that of an 'off line' bio-retention zone, located within the basin but with protective measures in place to divert high flow events and avoid damage to the treatment zone. A schematic of the treatment train adopted is shown below to describe the various elements of the treatment process.





All flows are conveyed via the underground pipe network to a control pit located within the reserve area. This pit has an internal weir arrangement that will divert all flows up to a 3 month ARI storm towards the bio-retention zone; flows in excess of this event will then bypass and be conveyed directly into the storage basin, with no treatment. After consideration of several options a single discharge point and consolidated treatment zone design was adopted as this minimised future maintenance for council and only had a minor impact on depth of incoming drainage lines.

4.10.1 Sediment basin

Low flows that are diverted from the control pit will be directed to a sediment pond that will allow primary settling of suspended sands and sediment within the stormwater.

The sediment pond has been sized based on Melbourne Water guidelines. The volume of storage required in the sediment pond is 670 cubic metres. This equates to a normal water level (NWL) area of approximately 1000 sqm. The sediment pond will generally be a permanently wet area as all low flow events will be directed through the sediment pond, as such it will received regular 'top –up' flows and will provide opportunity for landscape embellishment.

The basin water level will generally be 2.5 metres below the adjacent road reserve however with planting and appropriate alignment of shared path networks within the reserve, views of the pond could be incorporated into the final reserve design.



Sediment ponds require periodic maintenance, the sediment pond modelled in this design will require de-silting every five (5) years based on typical sediment removal and flows. To facilitate the maintenance requirements an access ramp has been modelled into the design to ensure that this will be a practical consideration during the detailed design process. This access is currently shown on the south eastern side of the sediment pond accessed from the adjacent minor street.

There would be opportunity in detailed design to include formal landscape treatments such as retaining walls or platforms close to the edge of these sediment ponds. Such treatments would allow for vertical banks and reduce the required footprint. Such treatments would require consideration of public safety fencing as these are best dealt with during detailed design. In order to maintain the conservative approach during the town planning phase the model has allowed for 1 in 6 batters between the road reserve / sediment pond and storage basin.

4.10.2 Bio-retention treatment zone

Following primary treatment in the sediment pond to reduce suspended solids, flows will then be conveyed to the bio- retention treatment zone. This zone is again protected from high velocity flows which will damage the treatment medium. The treatment zone will be located lower than the adjacent sediment pond but above the general base of the storage basin. Annexure J contains a plan of the basin area as modelled and shows cross sections to better demonstrate the relativity of the various elements and their connectivity.

The bio-retention zone will receive flows from the sediment pond via a low flow pipe line, with higher flows being diverted via a weir or spillway arrangement that will deliver a sheet flow over a wide area rather than a concentrated flow at one point. This ensures that treatment area is maximised and assists in protecting against localised scour of the filter medium as flows become more intense during a storm event.

The bio-retention zone is a relatively flat area, filled with a filter medium and planted with appropriate plants to aid the removal of nitrogen and phosphorous from stormwater flows. Generally these are 'reed' type plantings that will tolerate high variance in moisture conditions at their roots. Flows will be retained in this area for a period of time and will percolate through the filter medium and root systems and be collected via a perforated drain network under the treatment zone that will convey flows to the ultimate outlet at the discharge pump. In the event that storage within the basin area is exceeded, flows would be diverted directly to the basin via controlled weir flow. The MUSIC modelling undertaken in relation to Catchment No 1 indicates that a treatment area of 1800 square metres will be required to achieve best practice reduction figures.



5 SITE MODELING AND LANDSCAPE OPTIONS

A digital terrain model has been prepared based on the detailed design undertaken during the preparation of this report; this model includes the road network, reserve area, storage basins, sediment ponds and bioretention zone. This model has been prepared to assist in visualizing the potential outcomes for the Catchment No 1 reserve and basin.

This report has been prepared to determine the constraints, dimensions and levels of the various elements required to successfully provide drainage to this site. The successful integration will rely on appropriate landscape treatments to ensure that the outcomes of both the reserve and storage basins can be met.

As discussed earlier in this report, the use of mulches within the area impacted by a 1 in 100Yr storm event should be avoided and tree plantings should be appropriate for the level of inundation that a particular area may receive.

Tree plantings in the base of the storage areas should be avoided and species that are able to withstand some inundation can be planted within batter areas between the 1 in 5 Yr and 1 in 100Yr inundation extents.

Dense 'grassy' plantings adjacent to the sediment ponds will discourage access to the permanent water area but still provide opportunity for sightlines to the water areas as well as encourage wildlife to inhabit these areas of relatively permanent water.

The additional areas required for the sediment pond and bio-retention zone have been added to the basic basin footprint originally calculated.

The 100Yr ARI storm has been re-calculated based on the detailed basin incorporating the additional elements and a top water level determined. The depth of flooding in a 100Yr event will be approximately 2.65 metres.

In this event both the sediment pond and bio-retention zone will be inundated however the inundation will occur via indirect means and after several hours duration of storm event, as such high velocity linear flows through either of these elements will be avoided and as such scour and damage to the elements minimized.

To further aid the visualization of the impact of flood events and the level of inundation anticipated a series of inundation plans have been prepared for a 5 year, 100Yr and 500 Year event, these are included in Annexures G & H.



6 CONCLUSION

This report has sought to outline the physical and statutory constraints that impact provision of drainage facilities to the Shepparton NEGC as well as consider the desired outcomes from a public amenity perspective. The site requires significant remodelling and the inclusion of storage basins that will be a major visual feature of the redevelopment of the site.

A number of opportunities exist to incorporate Water Sensitive Urban Design elements into drainage infrastructure to ensure that stormwater runoff from the development of the land meets current best practice requirements for the removal of pollutants.

The design presented in Section 4 of the report is based on reasonable assumptions to determine the potential for the functional operation of the drainage strategy. The design presented is not intended to be a final detailed design and will be subject to variation during the subsequent planning permit and staged subdivision design phases of the project. Options exist to relocate the storage basin and other public reserve elements such that efficiencies in the drainage system may be achieved. This functional design has sought to provide a conservative assessment of the likely built form of the basins and reserves in order to confirm the viability of the proposal.

This assessment has demonstrated that the integration of various elements of the drainage strategy can be successfully incorporated into a public reserve area and the need for isolated and visually unappealing storage basins can be eliminated and a higher order land use afforded these areas which can complement the adjacent public reserve areas and improve public amenity in these areas.

Prepared by:

REEDS CONSULTING PTY LTD

RICHARD BREWSTER Engineering Director

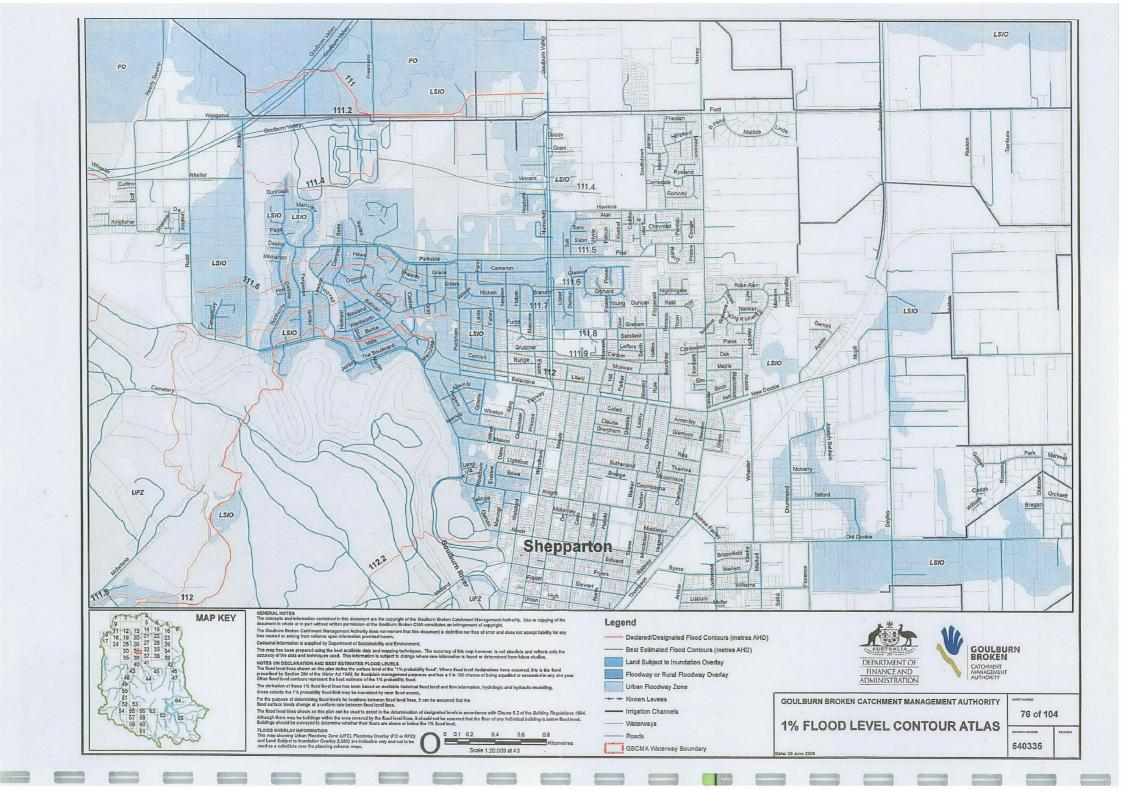
Disclaimer

The information contained within this report has been obtained from various servicing Authorities either verbally or in writing however, until such time as formal applications made, conditions and the appropriate approvals obtained, it should only be used as a guide. Any party wishing to use the material contained within this report should make their own inquiries to satisfy themselves to the accuracy of the information.



ANNEXURE A

Goulburn and Broken Catchment Management Authority (GBCMA) 1% AEP Flood Inundation plan





ANNEXURE B

Shepparton North East Growth Corridor Drainage Strategy Plan



Traffic Lights Local Town Centre Roundabout Precinct Structure Plan Area Conventional Residential Community Facilities Existing School Reserve Area Retarding Basin (Q100) & 20 year Event (Q20 - Shown indicatively) 34m Connector Street 26m Connector Street - Option 1 26m Connector Street - Option 2 24m Connector Street 16m Residential Street Bus Route Shared Path Temporary Common Access For Access to School & Mondous Coolstore Non DCP item Shared Path Within Reserve 400m Walkable Catchment 100m Shed Buffers Damien and Sali sheds (all sheds) Interface Zone Opportunities for 14m wide road (cross section 6) fronting drainage reserve

Total Site Area 170 ha (approx) Existing Schools 10.67 ha 2.50 ha 6.675 ha 8.340 ha

Pumped Drainage Lines

Mixed Use Encumbered Reserves Unencumbered Reserves Area of Connector Streets 10.97 ha Net Developable Area 130.85 ha

NORTH EASTERN GROWTH CORRIDOR, SHEPPARTON

VERSION K

DATE 18/06/2014 2:656/OFFICE WORK/ PLANS! IN PROGRESS, SHEPPARTON PSP K.DGN SCALE 1:4000





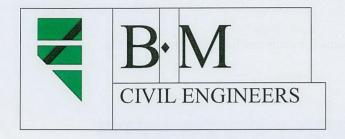
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ANNEXURE C

Groundwater Investigation BM Consulting Engineers



B.M CONSULTING ENGINEERS PTY.LTD.

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20-Apr-11

CLIENT: Reeds Consulting

JOB DESCRIPTION: Provide Site Investigation for proposed Stormwater Retardation

Basins.

PROJECT ADDRESS: Shepparton North East Growth Area.

OUR JOB NO: 30170

REPORT BACKGROUND:

Rezoning of farmland to residential land is proposed as part of the North East growth area of Shepparton. As part of this process up to five stormwater retardation basins may be required. John McKernan of Reeds Consulting has requested this investigation in order to determine the suitability of the nominated sites for the proposed use and also to provide the soil parameters necessary for the basin designs.

REPORT OBJECTIVES:

Two boreholes are to be drilled at each of the proposed retention sites. Soil profiles are to be logged and an assessment of soil type and porosity undertaken. Permeable soils or unsuitable water retaining soils such as filling, dispersive or granular soils are to be identified. The presence of groundwater or other factors that may impact on the design of basins and on the construction techniques are to be identified.

1.0 SITE DESCRIPTION:

- 1.1 There are five (5) proposed construction sites. All sites are currently within orchards. Their locations are illustrated on figure 1 and pictured in the photos.
- 1.2 Geologically the soils of the area are fine grained soils of Quaternary Pleistocene alluvium of the Shepparton Formation. These are sediments of sands, silts and clays laid down in lens like deposits. There can be variations in soil types over short distances with the discontinuity of the lenses.

2.0 SITE INVESTIGATION:

Boreholes of general depth 5000mm and down to 6000mm were drilled using 100mm diameter continuous flight mechanical augering — two at each site. The



locations and logs as well as GPS co-ordinates for each test hole are shown on the attached borehole log sheets.



Photo1: Site 1 boreholes 1&2.



Photo 2: Site 2 Boreholes 3&4



Photo 3: Site 3 Boreholes 5 & 6.



Photo 4: Site 4 Boreholes 7&8.



Photo 5: Site 5 Boreholes 9&10.

Logged soils were hand and visually classified. Soil shear strength was assessed in the field using shear vane measurements. Soils were sampled and returned to the laboratory for comparison and confirmation of the classification and to indicate other soil properties typical of those in the classified group. Particle size distribution and Plasticity testing was undertaken as part of the testing process. Maximum dry densities of the pre-dominant soil type were assessed. All tests were undertaken to our NATA accredited procedures. (Laboratory Registration Number 5023)

Borehole Descriptions: Soils recovered were of similar texture from all test holes with minor variations in sand and clay content and colour.

Site 1

Borehole 1: There is light brown clay of sand traces to 3400mm with moist brown clay with sand traces extending to the end of the bore.

Borehole 2: Beneath shallow clayey fine sand, there is light brown silty clay with sand traces to 1500mm with light brown clay extending to the end of the bore at 5000mm.

Site 2

Borehole 3: There is light brown silty clay with sand extending to the end of the bore at 5000mm.

Borehole 4: There is light brown silty clay with sand extending to the end of the bore at 5000mm.

Borehole 5: Beneath shallow clayey sand there is stiff brown clay to 500mm and overlying light brown silty clay with sand. The light brown silty clay of sand traces extends to the end of the bore.

Borehole 6: Beneath shallow clayey sand there is stiff brown clay to 500mm and overlying light brown silty clay with sand. There is a seam of clayey sand between 1800mm and 2400mm before the light brown silty clay of sand traces extends to the end of the bore.

Site 4

Borehole 7: Beneath shallow clayey sand there is stiff red brown clay to 800mm and overlying clayey sand of medium density to 2000mm. Beyond this, light brown silty clay with sand traces extends to the end of the bore.

Borehole 8: Beneath 200mm of shallow clayey sand there is stiff red/ brown clay which becomes increasingly sandy with depth to become red/brown sandy clay from 800mm to 2000mm. Beyond this, there is light brown silty clay of sand traces which extends to the end of the bore.

Site 5

Borehole 9: There is light brown silty clay with sand to 1500mm. Beyond this, there is very stiff light brown clay to the end of the bore at 5000mm.

Borehole 10: There is light brown silty clay with sand to 1500mm. Beyond this, there is very stiff light brown clay to the end of the bore at 5000mm.

2.3 Laboratory Testing and Classification: The soils encountered are within the range of medium plasticity with minor variations in liquid limits yielded across the entire site. The results of site 2 (BH3 & BH4) reflect the sandier soils encountered in this area and are of lower plasticity or CL soils. There is a significant sand content in all soils analysed. The soils of the site 1 (BH1 & BH2) are of a heavier clay and this was also reflected in the higher plasticity test results for this site.

In summary, all samples analysed are classified as clays with the lesser components of silt and sand. The sand and silt will enhance the soils' workability while the clay will contribute to the impermeability properties.

These results are typical of soils gathered and tested by this company in the alluvial soils of the Shepparton area. The Plasticity testing on samples from each test hole are summarised in table 1. Particle size distribution analyses results are summarised in Table 2.

Based on the correlation of soil properties, the estimated seasonal soil surface movement is moderate. It is estimated to be between between 20mm and 40mm.

For construction of residential parameters, the site classification for the site is **M-D Moderately Reactive** in accordance with AS2870-12011.

Borehole No.	Depth (mm) %	LL	PL	PI	LS	Class
1	1000-1500	49	17	32	16	CI-CH
2	500-1600	44	16	28	14.5	CI
4	200-2000	31	13	18	10	CL-CI
5	500-2000	44	16	28	14	CI
8	2000-3000	41	15	26	13.5	CI
10	800-1500	47	17	30	15	CI-CH

Table 1: Plasticity Test Results

Special Information		Australian Standard Sieve Sizes(mm)				
Borehole No.	Depth (mm)	2.36	0.6	0.3	0.075	
	(mm)			%		
i di nun san an	1000-1500	100	98	97	92	CI-CH
2	500-1600	100	99	98	92	CI
4	200-2000	99	96	92	74	CL-CI
5	500-2000	100	99	97	89	CI
8	2000-3000	99	98	96	87	CI
10	800-1500	97	95	92	87	CI-CH

Table 2: Particle Size Distribution Test Results

- 2.5 Ground Water: Bore holes were monitored over a 4 hour period. No infiltration of ground water occurred within this time in any of the test holes. It is reasonable to assume that groundwater will not be encountered in any excavations down to at least 5000mm and up to 6000mm across the site. There were no gravelly seams carrying perched water encountered in any of the bores. There were no dry gravelly seams of potential to carry water during different climatic conditions encountered in any of the bores across the site.
- 2.6 Soil Moisture Content: Soils were observed in the field to be moist (but not wet) over all of the soil profiles. Measured moistures were of the range 12.2% -18.4%. At these values the soils are pre- moistened and are within 4% of respective optimum moisture contents. Addition of moisture during construction would be nominal in magnitude and easily applied at these levels where some curing is already inherent in the soils.
- **2.7 Bulk Densities:** Samples from most sites and representative of the major soil types were laboratory tested to determine the moisture density relationship. The results are tabulated in table 3.

Report No.	Borehole No.	Depth (mm)	Moisture-Density				
			Bulk Density	Max.Dry Density	OMC		
			ρ_s	ρ_d			
11721	1	1000-1500	1976 kg/m ³	1717 kg/m ³	18.7		
11723	4	200-2000	2076 kg/m ³	1849 kg/m ³	14.5		
11724	5	500-2000	1969 kg/m ³	1712 kg/m ³	19.4		
11725	8	2000-3000	2012 kg/m ³	1760 kg/m ³	16.5		
11726	10	800-1500	1994 kg/m ³	1684 kg/m ³	20.3		

Table 3: Dispersion test results summary

2.8 Bearing Capacity: Shear vane testing was carried out at intervals within the natural soils to establish soil shear strengths. For shallow pad and strip footings bearing on natural soils below any surface silt, the estimated maximum allowable bearing capacities are as follows:

Depth (natural soils) Below t	
(mm)	Bearing Capacity (kPa.)
400mm	80
600mm	100
900mm	150
1200mm	200

Table 4: Allowable Bearing capacities All Sites.

2.9 Deep structures and Soil retention (manholes and pumpwells): As a guide, typical values for cohesion and angle of shearing resistance are estimated based on the correlation of soil properties for the sandy clay soil as classified.

$$c = 12kPa$$

$$\phi = 29^{\circ}$$

 ϕ_g = 0.45 max. (capacity reduction factor based on the level of investigation)

- **2.9** Adhesion: The silty clay and clay soils have estimated adhesion of at least 10kPa.
- 2.30 Dispersion: Samples were laboratory tested using the Emerson Dispersion Classification number method. The solutes of distilled water and tap water were used. Tap water is representative of the stormwater—that may be retarded in the basins while distilled water is representative of the soils' behaviour under direct rainfall runoff. Dispersive behaviour of the soil during storage conditions may result in slumping and a loss of storage geometry and therefore operating capacity. It may also allow seepage of stored from the basin. Dispersive behaviour of the

soil surface slopes under the action of rainfall travelling down it will result in rutting and erosion of the banks. The eroded soils will be washed into the storage with subsequent reductions in design capacities.

Table 4 is a summary of the emerson number test results. The values indicate that the soils are non dispersive in the water storage mode. Soils form sites 1 and 4 may erode easily with rainfall possibly rutting exposed slopes.

Report No.	Borehole No.	Depth (mm)	Emerson Cla	ss Number
			0 ppm	120ppm
11721	1	1000-1500	4	4
11722	2	500-1600	2	5
11723	4	200-2000	5	6
11724	5	500-2000	5	5
11725	8	2000-3000	2	4
11726	10	800-1500	6	6

Table 5: Dispersion test results summary

2.31 Permeability:

Silty clay soils and clay soils of sand traces and plasticity properties of those recovered from all the sites are practically impermeable when constructed at the prescribed density and moisture content. By correlation of soil properties, the permeability of all samples tested at 95% of standard density is anticipated to be less than 1×10^{-9} m/s.

In their natural state, the soils are affected by the root zone and deep seasonal cracks and fissures would be prevalent. Reworking the lining of basin soils would create an homogeneous mass of compacted soil as required for impermeable conditions.

3.0 CONCLUSIONS, DESIGN and CONSTRUCTION:

3.1 General: The test bores and laboratory testing yielded similar results across the entire site. Soil profiles as encountered are typical of those of the Shepparton area on Shepparton Formation alluvial soils. Soils are generally silty clays with sand traces and of medium plasticity. These soils will be impermeable as a reworked and compacted liner in the retardation basins.

The sandy clay and clayey sand soils are of good workability properties. They are readily excavated and easy to place by conventional earth moving equipment. The soils exist at moisture contents close to optimum and nominal moisture addition will be required for compacted placement. The soils in this state are pre-cured and additional moisture will be efficiently absorbed as required. The soils' sand content facilitates the addition of moisture and the ability to be readily compacted.

There was an absence of groundwater at all of the sites tested. An awareness that water may be encountered in deeper than 6.0m excavations is important as ground water levels are subject to seasonal and climatic variations. Excavations beyond 6.0m may strike groundwater under a nominal pressure head which may lead to water rising closer to the surface. There is no evidence to suggest that this will be the case from this investigation.

There was no rock encountered in any of the test sites as would be expected in this site of deep alluvium. There are areas of surface soil which will require removal and nominal stripping to avoid vegetable matter. There is a clayey sand seam which was encountered in borehole 6 of site 4. This seam does not represent a prior stream or serious point of escape or influx of water. Such clayey sand seams if encountered during construction will need to be chase excavated, blended with the clayey soils and replaced under compaction. No other factors which may limit the selection of a particular site for the proposed new construction were encountered.

The frequency of borehole sites and the intensity of the testing program is considered reasonable and comprehensive for the requirements of this project and in the context of a subsurface investigation. It remains possible that there may be variations in the geotechnical conditions from those described in this report as no geotechnical investigation can be considered exhaustive. The results and recommendations are therefore a reasonable platform upon which to base subsequent site selection and preliminary design decisions with a flexibility to change course should there be variations in the conditions beyond a more intensive investigation within the actual construction envelope.

3.2 Design Recommendations:

Beds of the Storages: Losses and seepage form retention basins are usually through the base under the storage water pressure head. It is important that the base be impervious and constructed of appropriate materials. In the current format the natural soils are suitable at the proposed base depth. A liner of minimum layer depth 600mm is recommended. This can be constructed by reworking and compaction of the natural soils of the site with the aforementioned properties taken into account.

Reworking requires that the liner soils be conditioned to an appropriate texture and moisture content and then placed under compaction. Compaction cannot be achieved using earthmoving traffic alone — an articulated pad foot roller would be the minimum requirement for these soil types.

The design levels of the basins: The proposed design levels being no greater than 4.0m below existing surfaces will be satisfactory as no groundwater has been encountered within this range.

Batter slopes: are recommended to be 2.5: 1 on the upstream faces of basins. These values are appropriate for the soil types. Compaction equipment should be able to negotiate slopes of this magnitude. Compaction of the batters and reinstatement of protective grasses will minimise potential erosion due to rainfall. Flatter slopes may be adopted if there is a plan to use the basins recreationally or regular grass mower traffic is planned.

3.3 Construction and Maintenance Recommendations:

Stripping: Strip the area beneath the bed and embankment construction of any topsoil and vegetable matter. Stockpile this material for spreading across the finished embankments as required. Material containing vegetable matter or humus must be avoided as structural filling.

Compaction: All of the recommendations given are based on the materials being compacted to engineering density standards for earthworks. This is important to counteract the potential for some site soils to be dispersive on batter slopes and it will also develop the impermeability of the soils. Re-work the bases in shallow layers of no greater than 200mm and compact using a vibrating pad foot roller.

Moisture Content : The filling should be placed within -2% to +1% of its optimum moisture content. Within these limits the soils will be able to be compacted to maximum densities with impermeability and using the least compactive effort.

Compaction Control: In order to maintain control over density and moisture content it is recommended that a compaction testing program be undertaken during construction to establish an effective placement procedure. The earthworks code AS3798 can be used as a guide for the frequency of testing. Compaction should be such that no test is less than 95% of the maximum dry density as determined in the laboratory. With a proven test success record and therefore proven construction process, the frequency of testing may be relaxed. Obviously the most critical areas for control are within the lower embankments and the storage beds.

Maintenance: Desirably plant binding type grasses on the finished topsoiled surfaces in order to minimise erosion and the seasonal drying of storage base soils. This will assist in preventing propagation of surface cracking in the liners.

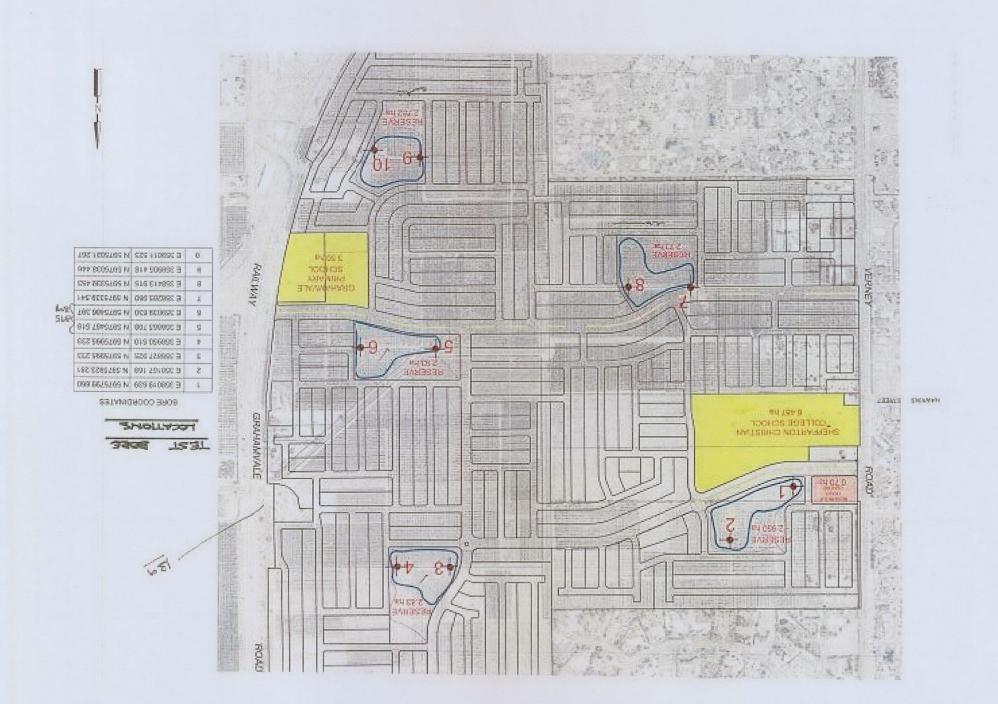
Carry out maintenance checking over the duration of the storage's operational lifetime using the techniques offered in the publication "Your Dam - an asset or a liability" (DSE-Victoria website)

Please contact the undersigned for any further enquires.

David Melrose.

D. Muran







Job No.: 28565 Date: 1.4.2011

Location: NE Shepparton Growth Corridor

Client: Reeds Consulting

No.:

Easting: E 358019 **Northing:** N5975799

Depth	Descripti	on Plasticity	Cohesion Density	Moistu
100			× ×	
200				
300				
400				
500	I. P. Cl. (I.	MID	VCT	NA
600	Lt. Br. Clay (sand traces	s) M-HP	VST	M
700				
900				
1000				
1100				
1200				
1300	LL=49%			
1400	PL=17%			
1500	PI=32%			
1600	LS=16%			
1700	25 1070			
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				District to
2700				
2800				
2900				
3000				
3100				
3200				
3300				
3400				
3500				
3600				
3700				
3800	Brown Clay with sand tr	races MP	ST	M
3900				Market State
4000				
4100				
4200				
4300				
4400				
4600				Maria Silvania
4700				
4800				
4900				
5000				
5200				
5300				
5400				
5500				
5600				
5700				
5800				
5900				DE L
6000	EOB			
PLASTICITY	TOTAL CONTROL	LP- LOW MP- MEDIUM HP- HIGH		
		VS- very soft S-soft F-firm ST - stiff VST - very stiff H-		
		VL very loose L- loose MD-medium dense DS-dense N	/D-very dense	
IOISTURE CONDITION		D-dry M- moist W-wet SA-saturated		



Job No.: 30170 Date: 1.04.2011

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

No.: 2

Easting: 358167E **Northing:** 5975923N

Depth	Descript		Plasticity	Cohesion Density	Moisture
100 200	Clayey Fine Sand			And the second second second second	
300	Clayey I life Sand				
400					
500					
600	Lt. Br. Silty Clay with sa		MP	ST	M
700					
800 900	LL=44%				
1000	PL=16%				
1100	PI=28%		Letters 1		
1200	LS=14.5%				
1300					
1400 1500					
1600	AND THE PROPERTY OF THE PROPER				
1700					
1800					
1900					
2000					
2100					
2200 2300			4		
2400					
2500					
2600					
2700					
2800					
2900 3000					
3100					
3200					
3300	Lt. Br Clay		MP	VST	M
3400					
3500	and the construction of th				
3600 3700					
3800					
3900					
4000					
4100					
4200					
4300 4400					
4500					
4600					
4700					
4800					
4900	EOD				
5000 5100	EOB				
PLAS	TICITY	LOW MP- MEDIUM	HP- HIGH		
		very soft S-soft F-firm ST - sti		hard	
0011010		very loose L- loose MD-mediur			
MOISTURE		y M- moist W-wet SA-satura			
		X hand auger			



Date: 1.04.2011 **Job No.:** 30170

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

No.:

3

Easting:

358827E

Northing: 5975995N

Depth	Descri	ption		Plasticity	Cohesion Density	Moisture
100						
200						
300						
400 500						
600	Lt. Br. Silty Clay wi	th sand		LP-MP	ST	M
700	Et. BI. Shity Clay WI	tii saiid		Lr-Wir	31	IVI
800						
900	LL=31%					
1000	PL=13%					
1100	PI=18%					
1200	LS=10%					
1300						
1400						
1500 1600						
1700						
1800						
1900						
2000						
2100						
2200						
2300						
2400 2500						
2600						
2700						design and the
2800						
2900						
3000						
3100						
3200						
3300						
3400 3500						
3600						
3700						
3800						
3900						
4000						
4100						
4200						
4300						
4400						
4600						
4700						
4800						
4900						
5000	EOB					
5100						
PLASTICIT		LP- LOW	MP- MEDIUM	HP- HIGH		
CONSISTEN	CY COHESIVE SOILS NON COHESIVE SOILS		i-soft F -firm ST - st loose MD -mediu			nea
IOISTURE CO			t W -wet SA -satura		v D-very de	iis e
						against a
DRILLING ME	HOD continuous flight auger	X	hand auger			



Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

No.:

4

Easting: 358950E **Northing:** 5975995N

Depth	Descrip	tion		Plasticity	Cohesion Density	Moisture
100						
200						
300						
400						
500	La De Gile Glee id			IDMD	C/T	16
700	Lt. Br. Silty Clay with	sand		LP-MP	ST	M
800						
900	LL=31%					
1000	PL=13%					
1100	PI=18%					
1200	LS=10%					
1300						
1400						
1500						
1600						
1700						
1800						
1900						
2000						
2100						
2300						
2400						
2500						
2600						
2700						
2800						
2900						
3000						
3100						
3200						
3300						
3400						
3500						
3600						
3700 3800						
3900	K. Periniferance					
4000						
4100						
4200						
4300						
4400						
4500						
4600						
4700						
4800						
4900	FOR					
5100	EOB					
5100						
PLASTICITY		LP- LOW		HP- HIGH		
CONSISTENCY	COHESIVE SOILS		S-soft F-firm ST - stiff \			The state of the s
MOISTURE CONDITY	NON COHESIVE SOILS		L- loose MD-medium of bist W-wet SA-saturated		vu-very dense	
MOISTURE CONDITION				,		
DRILLING METHOD	continuous flight auger	X	hand auger		Mariner .	



Job No.: 30170 Date: 1.04.2011

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

No.:

5

Easting: Northing: 358865E 5975487N

Depth	Descrip	tion		Plasticity	Cohesion Density	Moisture
100	Clayey Sand			The state of the s		
300	Clayey Sand					
400	Br CLAY			HP	VST	M
500				Million Committee		
600	Lt. Br. Silty Clay with	sand		MP	ST	M
700						
900	LL=44%					
1000	PL=16%					
1100	PI=28%					
1200	LS=14%					
1300						
1400 1500						
1600						
1700						
1800						
1900				LP	D	M
2000						
2100 2200						
2300						
2400						
2500						
2600						
2700	I D CH Ch			MD	VCT	M
2800	Lt. Br. Silty Clay with	sand		MP	VST	M
3000						
3100						
3200						
3300						
3400						
3500 3600						
3700						
3800						M
3900						
4000						
4100						
4300						7
4400						
4500						
4600						
4700						
4800						
5000	ЕОВ					
5100						
PLASTICIT	Υ	LP- LOW	MP- MEDIUM	HP- HIGH		
CONSISTEN		VS- very soft S	-soft F-firm ST - stiff V	ST - very stiff H-	-hard	
	NON COHESIVE SOILS		loose MD-medium d			
MOISTURE CO			t W-wet SA-saturated			
DRILLING ME		X	hand auger			



Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Borehole

Client: R

Client: Reeds Consulting

No.: 6

Easting: Northing:

359039E 5975486N

Depth	D	escription		Plasticity	Cohesion Density	Moisture
100	Cl G 1					
300	::::::: Clayey Sand					
400	Br., CLAY			HP	VST	М
500	Bin elair				,51	111
600	Lt. Br. Silty Cl	ay with sand		MP	ST	M
700						
800						
900	LL=44%					
1000	PL=16% PI=28%					
1200	LS=14%					
1300	BS 1170					
1400	-					
1500						
1600						
1700						
1800						
1900	Br. Clayey Sar	d		LP	D	M
2000						
2200						
2300						
2400						
2500						
2600						
2700						
2800	Lt. Br. Silty Cl	ay with sand		MP	VST	M
2900						
3000						
3100						
3200 3300						
3400						
3500						
3600						
3700						
3800						M
3900				100,000		
4000						
4100						
4200						
4300						
4500						
4600	Market State of the State of th					
4700						M
4800						
4900						
5000	ЕОВ					
5100						
PLAS	TICITY	LP- LOW		HP- HIGH		
CONSIS	COHESIVE SOILS NON COHESIVE SOILS		-soft F-firm ST - stiff V L- loose MD-medium d			
MOISTURE	CONDITION		st W -wet SA -saturated		-very defise	
	METHOD continuous flight au		hand auger			
DIVILLING	continuous night au	901	I mand adger			



Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

No.: 7

Easting: 359039E **Northing:** 5975486N

Depth		Descrip	tion		Plasticity	Cohesion Density	Moisture
100							
200	Claye	y Sand					
300 400	P.od/D	r CLAY					
500	Red/E	I CLA I			The State of Long St		
600	Red/B	Frown Sandy Cla	av		MP	ST	M
700							
800							
900							
1000							
1100 1200	Claya	y Sand			LP	ST	M
1300	Claye	y Sand			LI	31	IVI
1400							
1500							
1600							
1700							
1800							
1900 2000							M
2100	000000000						
2200							
2300							
2400							
2500							
2600							
2700	I + D.	Cit Cl '41	h and d		MP	ST	
2800 2900	Lt. Br	. Silty Clay with	n sand				M
3000							IVI
3100							
3200							
3300							
3400							
3500							
3600 3700							
3800							
3900							M
4000							
4100							
4200							
4300							
4400							
4500 4600							
4700							
4800							
4900							M
5000	EOB						
5100							
PLAST			LP- LOW	MP- MEDIUM	HP- HIGH		
CONSIS				S-soft F-firm ST - st			
	NON COHESIVE	SOILS		e L- loose MD-mediu		se VD-very de	nse
MOISTURE	CONDITION		D-dry M- m	oist W-wet SA-satura	ated		



Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

No.: 8

Easting: Northing:

358414E

5975339N

Depth		Descr	ription		Plasticity	Cohesion Density	Moisture
100 200		Clayey Sand					
300		Clayey Sand					
400		Red/Br CLAY					
500		Dad/Duoren Condre	Class		MP	ST	M
600 700		Red/Brown Sandy	Clay		MIP	51	IVI
800							
900							
1000 1100							
1200		Clayey Sand			LP	ST	M
1300							
1400							
1500 1600							
1700							
1800							
1900 2000							M
2100							
2200							
2300							
2400 2500							
2600							
2700							
2800		Lt. Br. Silty Clay w	rith sand		MP	VST	M
2900 3000		LL=41%					
3100		PL=15%					
3200		PI=26					
3300 3400		LS=13.5%					
3500							
3600							
3700							
3800 3900							M
4000							141
4100							
4200							
4300 4400							
4500					E TENEDO		
4600							
4700							
4800 4900							М
5000		EOB					
5100							
PLAS	TICITY		LP- LOW	MP- MEDIUM	HP- HIGH		
CONSIS		OHESIVE SOILS ON COHESIVE SOILS		-soft F-firm ST - stiff '			
MOISTURE	E CONDITION	5 55.1.E5.17.E 55.1E5		t W-wet SA-saturate		,,,,,,,	
	3 METHOD	continuous flight auger	X	hand auger			



Job No.: 30170 **Date:** 1.04.2011

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

No.: 9

Easting: Northing: 358905E 5975038N

Depth	Description	Plasticity	Cohesion Density	Moisture
100				
200				
300				
400				
500	Lt. Dr. Citte Class with and	MB	ST	M
700 	Lt. Br. Silty Clay with sand	MP	51	M
800				
900			arren i	
1000			Land Barrier	
1100				
1200				
1300				
1400				
1500				
1600				
1700				M
1800				
1900				
2000				
2100				
2200				
2300				
2400				
2500				
2600				
2700				M
2800				
2900				
3000				
3100				
3200	I A Du Class	MP	VST	М
3300 3400	Lt. Br Clay	IVII	VSI	IVI
3500				
3600				
3700				
3800				
3900				
4000				
4100				
4200				
4300				
4400				
4500				
4600				
4700				M
4800				
4900				
5000	EOB			
5100				AN AREA STATE OF THE PARTY OF T
PLASTICIT	LP- LOW	MP- MEDIUM HP- HIGH		
CONSISTEN		S-soft F-firm ST - stiff VST - very stiff H		
		L- loose MD-medium dense DS-dense	VD-very dense	
MOISTURE CON	D-dry M- mo	pist W-wet SA-saturated		
DRILLING MET	OD continuous flight auger X	hand auger		



Date: 1.04.2011 **Job No.:** 30170

Location: NE. Shepparton Growth Corridor

Borehole

Client: Reeds Consulting

10 No.:

Easting:

359011E

Northing: 5975021N

Depth	Descri	otion		Plasticity	Cohesion Density	Moisture
100						
200						
300 400						
500						
600	Lt. Br. Silty Clay with	cand		MP	ST	M
700	Et. Br. Shiy Clay Will	Salid		IVII	51	IVI
800						
900	LL=47%					
1000	PL=17%					
1100	PI=30					
1200	LS=15					
1300						
1400						
1500 1600						
1700						M
1800						IVI
1900						
2000						
2100						
2200						
2300						
2400						
2500						
2600						
2700 2800						M
2900						
3000						
3100						
3200						
3300	Lt. Br Clay			MP	VST	M
3400						
3500						
3600						
3700						
3800						
3900						
4000						
4200						
4300						
4400						
4500						
4600						
4700						M
4800						
4900						
5000	EOB					
5100						
PLASTICITY	0011201/2-00110			HP- HIGH	trand	
CONSISTENCY	COHESIVE SOILS	VS- very soft S-soft				
MOISTURE CONDI	NON COHESIVE SOILS	VL very loose L- loo D-dry M- moist W-			very dense - טע	
DRILLING METHO	D continuous flight auger	X	hand auger			



WHI SE DE BOY BOY TOTAL

6 Clarke Street, Shepparton, 3630 P.O. Box 6577, Shepparton, 3632

David Melitise of my demonstrations recent

Durid Batt a ing gwas uni cascerpass

Peter Williams in the scale bill absorptions

Ph: (03) 5821 7393 Fax: (03) 5831 3042

			Fax: 100	1583 (3042	
	Quality	of Materia	als Repo	rt	
Client: Client Address: Job Number:	Reeds Consulting Level 6, 440 Elizabeth S 30170	treet Melbourne VIC	3000	Report Number:	30170 - 1 18/04/2011
Project:	Geotechnical Investigat	ion		Order Number:	
Location	NE Shep Growth Area , :			SACTO AMERICAN	e 1 of 6
Lab No:		11721			
Date Sampled: Date Tested: Sampled By: Sample Method:	1/04/2011 14/04/2011 David Melrose AS1289.1.2.1	/04/2011 4/04/2011 avid Melrose		Sample Location Bore Hole : 1 Start Depth (mm) : 1000 End Depth (mm) : 1500 Clay with trace Sand (CI-CH)	
Material Source:	Site			Spec Description:	2
For Use As:	Investigation			Lot Number:	-
Remarks:	-			Spec Number:	
Test Metho	el gerana a .	A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
rest medic	d: A\$1289.3.6.1	75.00 mm		100	
7	THE RESERVE TO A STATE OF THE	53.00 mm		100	
		37.50 mm		100	
		26.50 mm		100	
		19.00 mm		100	
		13.2 mm		100	
		9.50 mm		100	
		6.7 mm		100	
No.		4.75 mm		100	
		2.36 mm		100	
		1.18 mm		99	
		0.600 mm		98	
		0.425 mm		98	
		0.300 mm		97	
		0.150 mm		95	
L War	u <u>a</u> data la usu	0.075 mm		92	
Atterberg Tests		Test Method	Specification Minimum	Result	Specification Maximum
iquid Limit (%)		AS1289.3.1.2		49	
lastic Limit (%)		AS1289.3.2.1		17	
lasticity Index		AS1289.3.3.1		32	
inear Shrinkage (%)		AS1289.3.4.1		16.0	

NATA

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Approved Signatory

David Sleep NATA Accred No: 5023 Form Number



A IB N Se 415 ASS 451

6 Clarke Street, Shepparton, 3630 P.D. Box 6577, Shepparton, 3632

David Malrosa 1.8 squeens title contracted

David Earl oraș manore ou recos.
Peter Willmott is no rean seri pourte con

Ph: (00) 5821 7393 Fax: (03) 5831 3042

Quality of Materials Report Client: Reeds Consulting Report Number: 30170 - 1 Client Address: Level 6, 440 Elizabeth Street Melbourne VIC 3000 Job Number: 30170 Report Date: 18/04/2011 Project: Geotechnical Investigation Order Number: NE Shep Growth Area, Shepparton Location Page 2 of 6 Lab No: 11722 Sample Location Date Sampled: 1/04/2011 Bore Hole: 2 14/04/2011 Start Depth (mm): 500 Date Tested: Sampled By: David Melrose End Depth (mm): 1600 AS1289.1.2.1 Sample Method: Silty Clay with trace Sand (CI) Material Source: Site Spec Description: For Use As: Investigation Lot Number: Remarks: Spec Number: A.S. Sieve Sizes Specification Percent Specification Minimum Passing Maximum Test Method: AS1289.3.6.1 75.00 mm 100 53.00 mm 100 37.50 mm 100 26.50 mm 100 19.00 mm 100 13.2 mm 100 9.50 mm 100 6.7 mm 100 4.75 mm 100 2,36 mm 100 1.18 mm 100 0.600 mm 99 99 0.425 mm 0.300 mm 98 0.150 mm 96 tan a marriage and a 0.075 mm 92 Atterberg Tests Test Method Specification Result Specification. Minimum Maximum Liquid Limit (%) AS1289.3.1.2 Plastic Limit (%) A51289.3.2.1 16 Plasticity Index AS1289.3.3.1 28 Linear Shrinkage (%) AS1289.3.4.1 14.5

1	
-	
NATA	
7	
THE RESIDENCE AND THE PERSON NAMED IN	
MODBER OF A FROM	

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Approved Signatory

May

David Sleep NATA Accred No:5023 Form Number



6 Clinke Street, Shepparton, 3630 P.O. 1900 6377, Shepparton, 3632

David Melsone on the cost will star necess

Dayid Earl in the street state productions

Peter William a new constitution access

Ph: (00) 3821 7393 East (03) 5831 7042

			Fax: (03	5 5831 3042	
	Quality	of Materia	als Repo	rt	
Client:	Reeds Consulting			Report Number:	30170 - 1
Client Address:	Level 6, 440 Elizabeth S	treet Melbourne VIC	3000		
Job Number:	30170			Report Date:	18/04/2011
Project:	Geotechnical Investigat	los		Order Number:	10,00,1011
Location					. 2
carles time il mando de la recolation non consecuent accommendance accommen	NE Shep Growth Area , :	snepparton			e 3 of 6
Lab No:	11723				Location
Date Sampled:	1/04/2011			Bore Hole : 4	
Date Tested:	14/04/2011			Start Depth (mm)	
Sampled By:	David Melrose			End Depth (mm):	
Sample Method:	AS1289.1.2.1			Sity Clay with Sa	nd (CL-CI)
Material Source:	Site			Spec Description:	-
For Use As:	Investigation			Lot Number:	
Remarks:	-			Spec Number:	
		A.S. Sieve Sizes	Specification	Percent	Specification
			Minimum	Passing	Maximum
Test Methi	od: AS1289.3.6.1		and the second second		
		75.00 mm		100	
		53.00 mm		100	
- /		37.50 mm		100	
/		26.50 mm		100	4
		19.00 mm		100	
		13.2 mm		100	
		9.50 mm		100	
		6.7 mm		100	
		4.75 mm		100	
		2.36 mm		99	
		1.18 mm		98	
		0.600 mm		96	
		0.425 mm		94	
		0.300 mm		92	
		0.150 mm		74	
FR 10 10 14 1		O.U/S INFIL		/4	A-1-3/4-1-1-1-1-1
itterberg Tests		Test Method	Specification	Result	Specification
			Minimum		Maccimum
Iquid Limit (%)		AS1289.3.1.2		31	
fastic Limit (%)		A51289.3.2.1		13	
lasticity Index		AS1289.3.3.1		18	
inear Shrinkage (%)		AS1289.3.4.1		10.0	

NATA

This document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025. The results of the tests, calibrations and/or measurements included in this document are triscoable to Australian/national standards.

Approved Signatory

Dilige

David Sleep NATA Accred No:S023 Form Number



6 Clarke Street, Shapparton, 3630 p.c., 1908 6577, Snepparton, 3632

David Malrosa (16 mg over lette prespector)

David Fort of the standard descriptions

Peter Williams in the steam will present your Phr: (607) 5821 7393 Fax: (037) 5831 3042

Quality of Materials Report

Client: Client Address: Job Number: Project:	Reeds Consulting Level 6, 440 Elizabeth St 30170	treet Melbourne VIC	3000	Report Number:	30170 - 1
Job Number: Project:		treet Melbourne VIC	3000		
Project:	30170				
				Report Date:	18/04/2011
	Geotechnical Investigati	ion		Order Number:	-
Location	NE Shep Growth Area , Shepparton			Page	4 of 6
Lab No: Date Sampled: Date Tested:	11724 1/04/2011 14/04/2011		Sample Location Bore Hole : 5 Start Depth (mm) : 500		
Sampled By:	David Melrose			End Depth (mm):	2000
Sample Method:	AS1289.1.2,1			Silty Clay with trac	te Sand (CI)
Material Source:	Site			Spec Description:	
For Use As:	Investigation			Lot Number:	
Remarks:				Spec Number:	-
Test Method	: A\$1289.3.6.1	A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
rest red for		75,00 mm		100	
		53.00 mm		100	
-		37.50 mm		100	
		26.50 mm		100	
		19.00 mm		100	
		13.2 mm		100	
		9.50 mm		100	
		6.7 mm		100	
		4.75 mm		100	
		2.36 mm		100	
-		1.18 mm 0.600 mm		100	
		0.425 mm		98	
		0.300 mm		97	
		0.150 mm		93	
	# * * * * * * * * * * * * * * * * * * *	0.075 mm		89	
uterberg Tests		Test Method	Specification Minimum	Result	Specification Maximum
iquid Limit (%)		AS1289.3.1.2		44	
lastic Limit (%)		A51289.3.2.1		16	
lasticity Index		AS1289.3.3.1		28	
Linear Shrinkage (%)		AS1289.3.4.1		14.0	



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Approved Signatory Mily

David Sleep NATA Accord No:5023 Form Number



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Pht. (03) 5821 7983 Proc. (03) 5831 7983

Quality of Materials Report Report Number: Client Address: Level 6, 440 Elizabeth Street Melbourne VIC 3000 Job Number: Report Date: 18/04/2011 Project: Geotechnical Investigation Order Number: Location NE Shep Growth Area, Shepparton Page 5 of 6 Lab No: 11725 Sample Location Date Sampled: 1/04/2011 Bone Hole: 8 Date Tested: 14/04/2011 Start Depth (mm): 2000 Sampled By: David Melrose End Depth (mm): 3000 Sample Method: AS1289.1.2.1 Sity Clay with trace Sand (CI) Material Source: Site Spec Description: -For Use As: Investigation Lot Number: Remarks: Spec Number: A.S. Sieve Sizes Specification Percent Specification Minimum Passing Maximum Test Method: AS1289.3.6.1 75.00 mm 100 53.00 mm 100 37.50 mm 100 26.50 mm 100 100 19.00 mm 13.2 mm 100 9.50 mm 100 6.7 mm 100 4.75 mm 100 2.36 mm 99 1.18 mm 99 0.600 mm 98 0.425 mm 97 0.300 mm 96 0.150 mm 91 0.075 mm 87 Atterberg Tests Result Test Method Specification Specification Minimum Maximum A51289.3.1.2 Liquid Limit (%) 41 Plastic Limit (%) AS1289.3.2.1 15 Plasticity Index A\$1289.3.3.1 26 Linear Shrinkage (%) AS1289.3.4.1 13.5

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Approved Signatory

David Sleep

NATA Accred No:5023

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Page 6 of 6

David Earl in the open test see our recessor Peter Willmott a my committee constitute

Ph; (93) 5821 7393 Fax: (93) 5831 3042

Quality of Materials Report

Client: Reeds Consulting Report Number: 30170 - 1 Client Address: Level 6, 440 Elizabeth Street Melbourne VIC 3000 Job Number: Report Date: 18/04/2011 Project: Geotechnical Investigation Order Number:

NE Shep Growth Area, Shepparton Location Lab No: 11726

Sample Location Date Sampled: 1/04/2011 Bore Hole: 10 Date Tested: 14/04/2011 Start Depth (mm): 800

David Melrose Sampled By: End Depth (mm): 1500 Sample Method: AS1289.1.2.1 Clay with trace Sand & Gravel (CI-CH)

Material Source: Site Spec Description: For Use As: Investigation Lot Number: Remarks:

Test Method:	AS1289.3.6.1	A.S. Sieve Sizes	Specification Minimum	Percent Passing	Specification Maximum
		75.00 mm		100	
		53.00 mm		100	
		37.50 mm		100	
		26.50 mm		100	
		19.00 mm		100	
		13.2 mm		100	
		9,50 mm		100	
		6.7 mm		100	
		4.75 mm		98	
		2.36 mm		97	
		1:18 mm	The second second	96	
		0.600 mm		95	
		- 0.425 mm		94	
		0.300 mm		92	
		0.150 mm		90	
		0.075 mm		87	

Atterberg Tests	Test Method	Specification Minimum	Result	Specification Maximum
Liquid Limit (%)	AS1289.3.1.2		47	
Plastic Limit (%)	AS1289.3.2.1		17	
Plasticity Index	AS1289.3.3.1		30	
Linear Shrinkage (%)	AS1289.3.4.1		15.0	



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David Steep NATA Accred No:5023 Form Number



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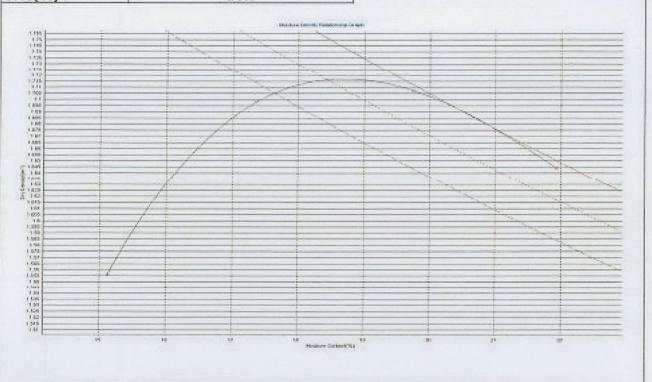
Ph: (03) 5821 7393 Fax: (03) 5831 3042

Moisture Density Relationship Report

Client:	Reeds Consulting	Report Number:	30170 - 3
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000		
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	
Location	NE Shep Growth Area , Shepparton	Test Method :	AS1289.5.1.1
Lab No:	11721	Sample Location	
Date Sampled:	1/04/2011	Bore Hole: 1	
Date Tested:	8/04/2011	Start Depth (mm): 1000	
Sampled By:	David Melrose	End Depth (mm): 1500	
Sample Method:	AS1289.1.2.1	Clay with trace Sa	ind (CI-CH)
Material Source:	Site	ATOMIN AND ATTEME	
For Use As:	Investigation	Lot Number:	
Remarks:		Item Number : -	

Page 1 of 5

Maximum Size (mm) :	19.0	Moisture Content Test Method :	AS1289.2.1.1
Oversize (%):		Oversize Test Method :	
MDD (t/m³):	1.717	Oversize Density (t/m²):	
OMC(%):	18.7		



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Approved Rigeassey Form Number David Sleep

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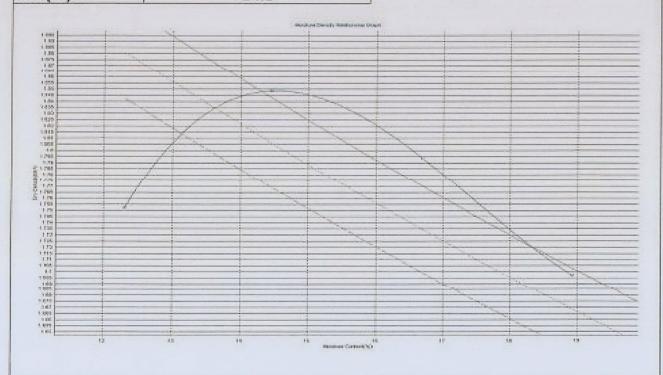
Ph; (80) 5821 7391 Fac: (00) 5001 3042

Moisture Density Relationship Report

Client: Reeds Consulting Report Number: 30170 - 3 Client Address: Level 6, 440 Elizabeth Street Melbourne VIC 3000 Job Number: 30170 Report Date: 18/04/2011 Geotechnical Investigation Project: Order Number: Location NE Shep Growth Area, Shepparton Test Method: AS1289.5.1.1 Lab No: 11723 Sample Location Date Sampled: 1/04/2011 Bore Hole: 4 Date Tested: 8/04/2011 Start Depth (mm): 200 Sampled By: **David Melrose** End Depth (mm): 2000 Sample Method: AS1289.1.2.1 Silty Clay with Sand (CL-CI) Material Source: Investigation For Use As: Lot Number: Remarks: Item Number :

Page 2 of 5

Maximum Size (mm) :	19.0	Moisture Content Test Method :	AS1289.2.1.1
Oversize (%):		Oversize Test, Method :	-
MDD (t/m3):	1.849	Oversize Density (t/m²):	
OMC(%):	14.5	and the second s	





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David Sleep

NATA Accred No:5023

REP MDR-1-17



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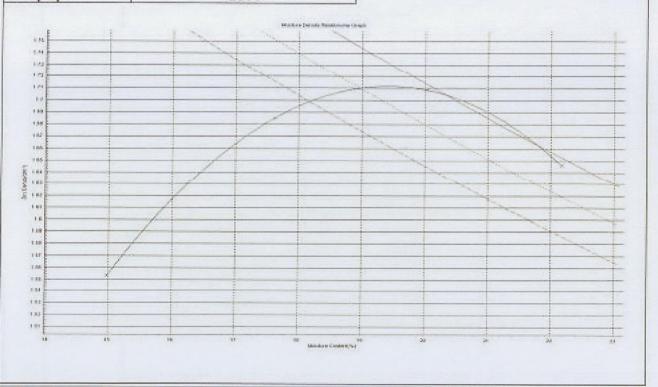
Phc (03) 5821 7393 Fax: (83) 5831 3042

Moisture Density Relationship Report

Client:	Reeds Consulting	Report Number:	30170 - 3
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000	and the role and the	
Job Number:	30170	Report Date:	18/04/2011
Project:	Geotechnical Investigation	Order Number:	
Location	NE Shep Growth Area , Shepparton	Test Method :	AS1289.5.1.1
Lab No:	11724	Sample Location	
Date Sampled:	1/04/2011	Bore Hole : 5	
Date Tested:	8/04/2011	Start Depth (mm)	: 500
Sampled By: David Melrose End Depth (mm): 2000		2000	
Sample Method:	AS1289.1.2.1	Silty Clay with tra	ce Sand (CI)
Material Source:	Site		
For Use As:	Investigation	Lot Number: -	
Remarks:		Item Number : -	

Page 3 of 5

Maximum Size (mm) :	19.0	Moisture Content Test Method :	AS1289.2.1.1
Oversize (%):		Oversize Test Method :	-
MDD (t/m3):	1.712	Oversize Density (t/m³):	
OMC(%):	19.4		





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David Sleep

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Phi (03) 5821 7393 Fee: (03) 5831 3042

Moisture Density Relationship Report

Client: Reeds Consulting Report Number: 30170 - 3 Client Address: Level 6, 440 Elizabeth Street Melbourne VIC 3000 18/04/2011 Job Number: 30170 Report Date: Project: Geotechnical Investigation Order Number: NE Shep Growth Area, Shepparton Location Test Method: AS1289.5.1.1 Lab No: 11725 Sample Location Date Sampled: 1/04/2011 Bore Hole: 8 Date Tested: 8/04/2011 Start Depth (mm): 2000 Sampled By: David Melrose end Depth (mm): 3000 Sample Method: AS1289.1.2.1 Silty Clay with trace Sand (CI) Material Source: For Use As: Investigation Lot Number:

Page 4 of 5

Item Number :

AS1289.2.1.1 Maximum Size (mm): 19.0 Maisture Content Test Method : Oversize (%): Oversize Test Method : 1.760 MDD (t/m3): Oversize Density (t/m3) OMC(%): 16.5



Remarks:

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Approved Signatory

David Sleep

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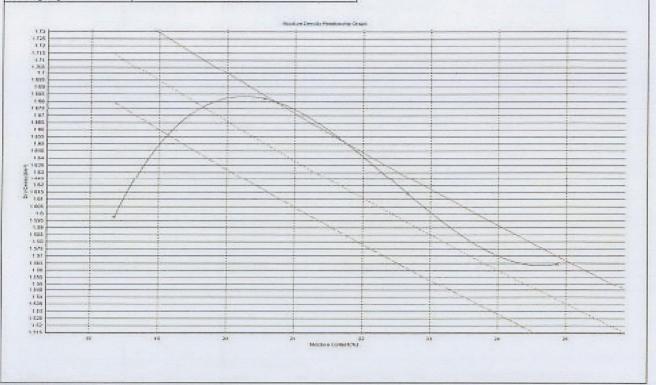
Pic (00) 5821 7090 Fee: (00) 5831 3042

Moisture Density Relationship Report

Client:	Reeds Consulting	Report Number: 30170 - 3
Client Address:	Level 6, 440 Elizabeth Street Melbourne VIC 3000	
Job Number:	30170	Report Date: 18/04/2011
Project:	Geotechnical Investigation	Order Number:
Location	NE Shep Growth Area , Shepparton	Test Method : AS1289.5.1.1
Lab No:	11726	Sample Location
Date Sampled:	1/04/2011	Bore Hole: 10
Date Tested:	8/04/2011	Start Depth (mm): 800
Sampled By:	David Melrose	End Depth (mm): 1500
Sample Method:	AS1289.1.2.1	Clay with trace Sand & Gravel (CI-CH)
Material Source:	Site	
For Use As:	Investigation	Lot Number: -
Remarks:		Item Number: -

Page 5 of 5

Maximum Size (mm) :	19.0	Moisture Content Test Method :	AS1289.2.1.1
Oversize (%) :	-	Oversize Test Method :	
MDD (t/m2):	1.684	Oversize Density (t/m²):	
OMC(%):	20.3		





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David Sleep

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Emerson Class Number Report

Client: Client Address:

Job Number :

Project :

Reeds Consulting

Level 6, 440 Elizabeth Street Melbourne VIC 3000

Report Number: 30170 - 2 Report Date: 18/04/2011

Order Number: Test Method:

Geotechnical Investigation

AS 1289.3.8.1

Location: NE Shep Growth Area, Shepparton

30170

Page 1 of 2 Lab No : 11722 11723 11721 11724 ID No : Lot No: Item No : Sampling Method : AS1289.1.2.1 AS1289.1.2.1 AS1289.1.2.1 AS1289.1.2.1 Date Sampled: 1/4/2011 1/4/2011 1/4/2011 1/4/2011 Date Tested: 13/4/2011 13/4/2011 13/4/2011 13/4/2011 Material Source : Site Site For Use As : investigation Investigation anvestigation Investigation Sample Location: Bore Hole : 1. Bore Hale : 5 Sore Hote : 2 Bore Hole : 4 Start Depth (mm): 1000 Start Depth (mm) : 300 Start Depth (mm) : 200 Start Death (mm) : 500 End Depth (mm): 1500 End Depth (mm) : 1600 End Depth (mm): 2000 End Depth (mm): 2000 Sity Day with trace Sand (CI) Clay with thece Send (CI-CH) Sifty Clay with trace Sand (CI) Sity Clay with Send (CL-CI) TEST 1 Clay with trace Sand (CI-Silty Clay with Sand (CL-Silty Clay with trace Sand Silty Clay with trace Sand Soil Description : CH) (CI) CI) (CI) **Distilled Water** Distilled Water Distilled Water **Distilled Water** Type of Water Used : Temperature of Water (*C): 20.0 20.0 20.0 20.0 Emerson Class Number : Class 4 Class 2 Class 5 Class 5 TEST 2 Clay with trace Sand (CI- Silty Clay with trace Sand Silty Clay with Sand (CL-Silty Clay with trace Sand Soil Description (CI) Tap Water Type of Water Used : Tap Water Tap Water Tap water 20 20 Temperature of Water (°C): 20 20 Emerson Class Number : Class 4 Class 5 Class 6 Class 5 Remarks:

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APPROVED SIGNATORY

David Sleep NATA Accred No: 5023 FORM NUMBER

RP052-7



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P.O. Tors 6577, Shapparton, 3632
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David Battle my treet with consist and
Peter Williams a my real arts consist and
Pr. (17) 5221-733
Pres. (17) 5321-733

Emerson Class Number Report

Csent : Report Number: Reeds Consulting 30170 - 2 Client Address : Level 6, 440 Elizabeth Street Melbourne VIC 3000 Report Date: 18/04/2011 Job Number : Order Number: Project : Test Method: AS 1289.3.8.1 Geotechnical Investigation Location : NE Shep Growth Area , Shepparton

			rage z or z
Lab No :	11725	11726	
ID No :			
Lot No :	2	3-6	
Item No :			
Sampling Method :	AS1289.1.2.1	AS1289.1.2.1	
Date Sampled :	1/4/2011	1/4/2011	
Date Tested :	13/4/2011	13/4/2011	
Material Source :	Site	Site	
For Use As :	Investigation	Investigation	
Sample Location :	Bore Hole: 8 Start Depth (mm) + 2000 End Depth (mm) : 3000 Sity Clay with trace Sand (Ct)	Bore Hote: 10 Start Dopth (mm): 300 End Depth (mm): 1500 Seep managed among watered (see Cm)	
TEST 1			
Soil Description :	Slifty Clay with trace Sand (CI)	Clay with trace Sand & gravel (CI-CH)	
Type of Water Used :	Distilled Water	Distilled Water	
Temperature of Water (°C) :	20.0	20.0	
Emerson Class Number ;	Class 2	Class 6	
TEST 2			
Soil Description :	Silty Clay with trace Sand (CI)	Clay with trace Sand & gravel (CI-CH)	
Type of Water Used :	Tap Water	Tap Water	
Temperature of Water (°C)	20	20	
Emerson Class Number :	Class 4	Class 6	
temarks :			

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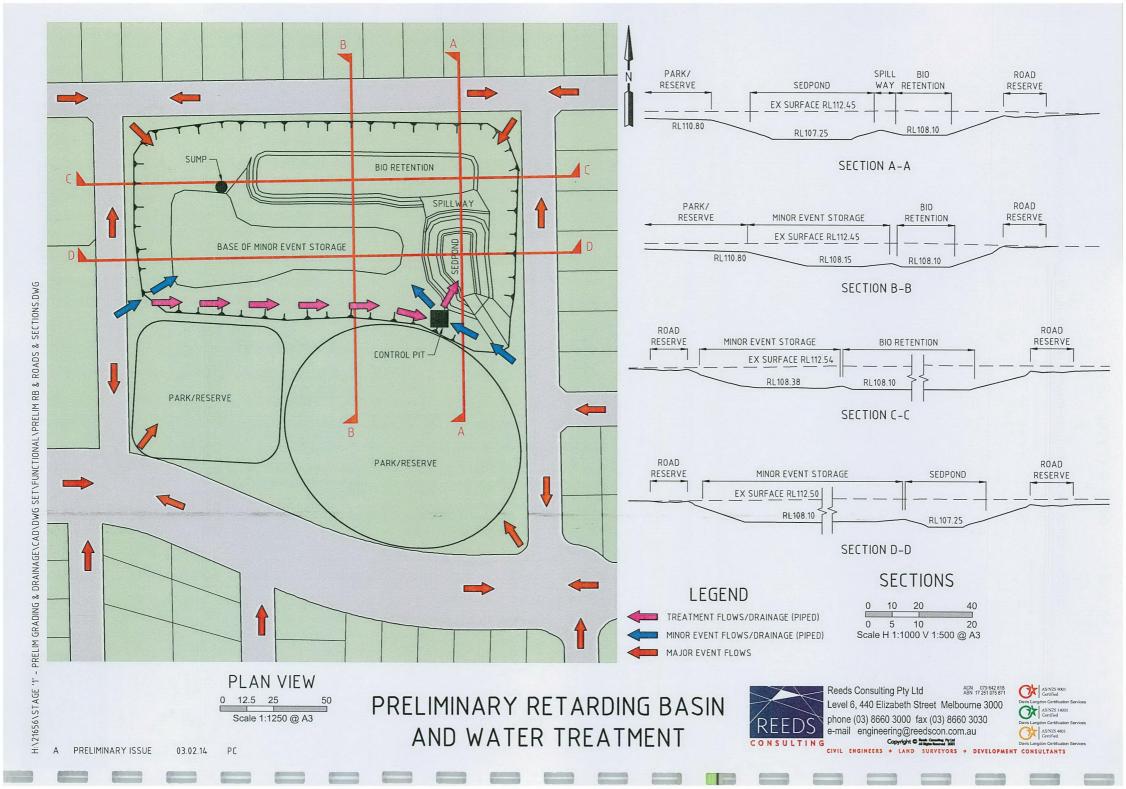
Page 2 of 2

RP052-7



ANNEXURE D

Preliminary Retarding Basin and Water Treatment Plan





ANNEXURE E

Retarding Basin & Reserve Volumes Computation Results

RETARDING BASIN & RESERVE VOLUMES		
RL (m)	FILL / VOLUME (m³)	VOLUME MINUS SEDPOND VOLUMES (m³)
107.9 (BASE)	281.544	0.000
108.0	361.797	18.752
108.2	1124.632	634.007
108.4	2452.996	1779.895
108.6	4021.537	3348.436
108.8	5838.501	5165.400
109.0	7838.016	7164.915
109.2	9982.968	9309.867
109.4	12255.330	11582.229
109.6	14656.888	13983.787
109.8	17189.432	16516,331
110.0	19854.750	19181.649
110.2	22654.631	21981.530
110.4	25590,863	24917.762
110.6	28665.235	27992.134
110.8	31879.535	31206.434
111.0	35494,873	34821.772
111.2	39734.185	39061.084
111.4	44610.017	43936.916
111.6	50189.130	49516.029

SEDPOND VOLUMES		
RL (m)	FILL / VOLUME (m³)	
107.25 (BASE)	0.000	
107.4	51.747	
107.6	130,816	
107.8	226,471	
107.9	281.544	
108.0	343.045	
108.2	490.625	
108.4 (NWL)	673.101	

NOTE Sediment storage to 0.5 below NWL (ie RL 107.9)is 281m³
Requirement for 5 Yr frequency cleanout (at 1.6 m³/Ha/Yr loading) is 256 m³.
The proposal is adequate for 5yr maintenance with max sediment level 0.5m below NWL

Untitled

Routing results:

XXXX

XXXX: 15 min 5 year Design Storm DESIGN run no. 1

DESIGN run no.

Parameters: kc = 1.25 m = 0.80

Initial loss (mm) Runoff coeff. Loss parameters 10.00 0.60

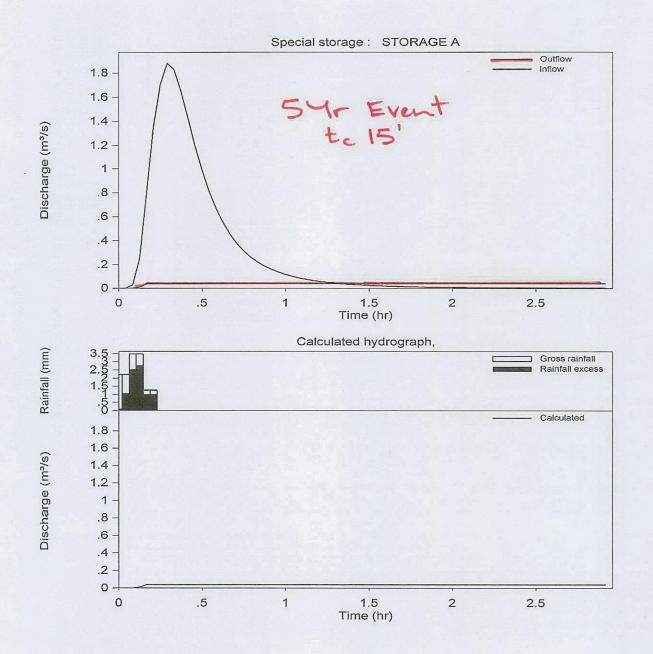
Results of routing through special storage STORAGE A Peak elevation= 108.49 m Peak outflow = $0.04 \text{ m}^3/\text{s}$ Peak storage = $2.51\text{E}+03 \text{ m}^3$

*** Special storage : STORAGE A

Hydrograph Outflow Inflow 0.040 Peak discharge, m³/s 1.880 Time to peak,h Volume,m³ 1.29 0.29 4.03E+02 2.73E+03 1.54 0.46 1.40 0.33 1.16 0.16 Time to centroid,h
Lag (c.m. to c.m.),h
Lag to peak,h 1.16 0.16

*** Calculated hydrograph,

Hydrograph calc. Peak discharge, m³/s 0.04000 Time to peak, h' 1.29 4.03E+02 Time to centroid,h
Lag (c.m. to c.m.),h
Lag to peak,h 1.54 1.40 1.16



Untitled

Routing results:

XXXX

XXXX: 24 hour 100 year Design Storm DESIGN run no. 1

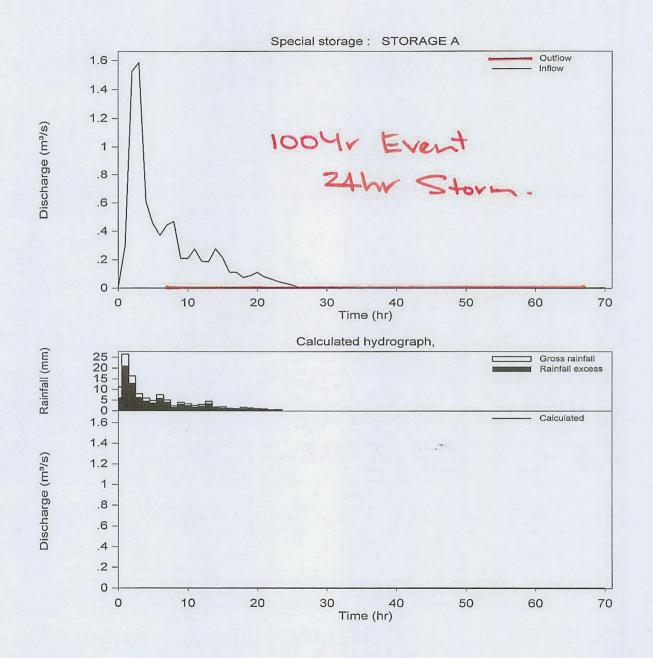
Parameters: kc = 1.25 m = 0.80

Loss parameters Initial loss (mm) Runoff coeff. 10.00 0.60

Results of routing through special storage STORAGE A
Peak elevation= 110.65 m
Peak outflow = 0.00 m³/s
Peak storage = 2.88E+04 m³

*** Special storage : STORAGE A

Hydrograph
Outflow Inflow
Peak discharge,m³/s
Time to peak,h
Volume,m³
6.58E+02 2.90E+04
Time to centroid,h
Lag (c.m. to c.m.),h
Lag to peak,h
Outflow Inflow
1.585
26.0
3.0
6.58E+02 2.90E+04
38.3
6.8
Lag (c.m. to c.m.),h
32.3
0.9
Lag to peak,h



Untitled

Routing results:

XXXX

XXXX: 24 hour 500 year Design Storm DESIGN run no. 1

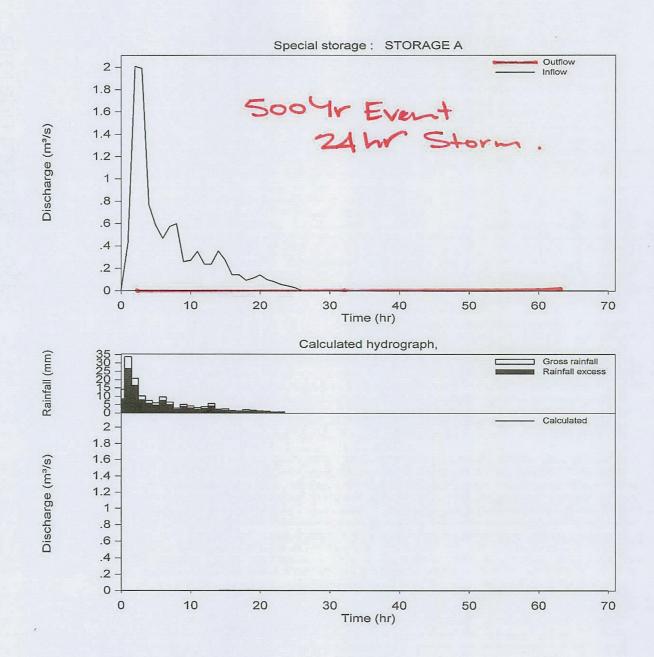
 $1.25 \quad m = 0.80$ Parameters: kc =

Loss parameters Initial loss (mm) Runoff coeff. 10.00 0.60

Results of routing through special storage STORAGE A
Peak elevation= 111.10 m
Peak outflow = 0.00 m³/s 3.70E+04 m3 Peak storage =

*** Special storage : STORAGE A

Hydrograph Outflow Inflow 0.004 2.007 Peak discharge, m³/s 26.0 2.0 8.44E+02 3.72E+04 38.3 6.8 32.3 0.8 Time to peak,h'
Volume,m3 Time to centroid,h
Lag (c.m. to c.m.),h
Lag to peak,h 20.0 -4.0





ANNEXURE F

Preliminary Retarding Basin Storage Extents – 5yr

e-mail engineering@reedscon.com.au

CIVIL ENGINEERS . LAND SURVEYORS . DEVELOPMENT CONSULTANTS

H:\21656\STAGE '1' - PRELIM GRADING & DRAINAGE\CAD\DWG SET\FUNCTIONAL\PRELIM RB & ROADS & SECTIONS.DWG

PRELIMINARY ISSUE

03.02.14



ANNEXURE G

Preliminary Retarding Basin Storage Extents – 100yr H-\21656\STAGE '1' - PRELIM GRADING & DRAINAGE\CAD\DWG SET\FUNCTIONAL\PRELIM RB & ROADS & SECTIONS.DWG

03.02.14



ANNEXURE H

Preliminary Retarding Basin Storage Extents – 500yr

e-mail engineering@reedscon.com.au

CIVIL ENGINEERS + LAND SURVEYORS + DEVELOPMENT CONSULTANTS

H:\21656\STAGE'1' - PRELIM GRADING & DRAINAGE\CAD\DWG SET\FUNCTIONAL\PRELIM RB & ROADS & SECTIONS.DWG

03.02.14

PRELIMINARY ISSUE



ANNEXURE I

MUSIC Model Output Data

