1-8-2010

Managing storm water flow in the Neridup Creek catchment

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Department of
Agriculture and **Food**

GOVERNMENT OF
WESTERN AUSTRALIA

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RESOURCE MANAGEMENT TECHNICAL REPORT 365

ISSN 1039–7205

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August 2010

GOVERNMENT OF WESTERN AUSTRALIA

Department of Agriculture and Food

Australian Government

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Contents

Acknowledgements

The authors would like to thank the landholders in the Neridup Creek catchment who gave their time and support for the project.

Thanks to John Simons (Hydrologist, DAFWA) for contributing the groundwater hydrology information and providing constructive feedback on this report.

This project is part of project 04SC1–11f (Implementation of the Lake Warden Catchment Project), funded jointly by the Australian Government and the Government of Western Australia under the National Action Plan for Salinity and Water Quality through South Coast Natural Resource Management Inc. and managed by the Esperance Regional Forum.

Summary

The Department of Agriculture and Food, Western Australia (DAFWA) was commissioned by the Esperance Regional Forum to investigate opportunities for managing storm flow, erosion and sedimentation in large storm events through the Neridup Creek catchment. The investigation involved identifying landscapes for natural detention and orthophoto interpretation of the catchment, surveying the main flow lines, and evaluating the two natural basins for additional detention capability.

The focus of the investigation was in the mid–lower catchment which is principally flat with areas of ill-defined surface water flows in multi-braided channels, which are cleared and farmed for agriculture. Through this part of the catchment a shallow relief drain was built to define a channel for the Neridup Creek and its major tributary which is known as Green's drain.

The main findings from this investigation are:

- Flooding of paddocks is most prevalent where agriculture is practiced in natural flood plain areas.
- The recommended engineering option in paddocks needing drainage are shallow relief drains for moving water on and not levees/banks for holding water back, which would result in widespread flooding over the flat landscape.
- Redirecting water in storm events from the Neridup Creek to the natural basin of Terrells Lake to use it to attenuate peak flow for the catchment (additional to its current use) is not considered to be feasible or economical from preliminary assessment.
- Plowmans Lake is a small natural basin that may be capable of offering some detention of storm water if the discharge drain of the lake is deepened to 1 m. This option needs further investigation to determine its effectiveness in attenuating storm events (that is, will increasing the lake capacity provide sufficient attenuation for the lower catchment in a large storm event to warrant the investment) and the environmental risk (for example, exposing acid sulfate soils which are likely to be present).
- There are opportunities for increasing landscape detention in areas where natural sumps have been drained, for example upper Green's drain catchment, by constructing a small earthen wall with a pipe in the base across some of the existing shallow relief drains to detain water and control its release over a longer time period.
- Reserve 27388 in the upper catchment contains salt lakes that provide natural attenuation by holding back water and evaporating or recharging groundwater which is important for reducing surface water flow into the mid–lower catchment.

1. Introduction

The Department of Agriculture and Food, Western Australia (DAFWA) was commissioned by the Esperance Regional Forum to investigate opportunities for managing storm flow, erosion and sedimentation in large storm events through the Neridup Creek catchment. This report details the findings of the investigation and also provides some recommendations for managing farm-scale drainage issues and catchment water flow.

1.1 Background

In 1989, Esperance and surrounds experienced an above average wet growing season (May–October) after receiving above average rainfall in April. Throughout this season, a number of 5–20 year Average Recurrence Interval (ARI) events occurred which resulted in widespread flooding throughout the Lake Warden catchment, Lake Warden Wetland System and the Esperance townsite.[1] The Neridup Creek catchment, which is a sub-catchment of the Lake Warden catchment, was greatly impacted by erosion and waterlogging. Between 1990 and 1992, DAFWA worked with the Neridup Soil Conservation Group to develop a catchment surface water management plan. Most of this plan was implemented and consequently the catchment withstood the 1999 and 2000 summer rainfall events (10–20 year ARI), 2007 summer event (more than 100 year ARI) and 2009 summer event (5–10 year ARI) with minimal damage, although parts of the drain network sustained damage during these events.[2,3] Because much of the catchment has low slope, these surface drainage works proved to be effective in defining water flow and reducing ponding. The drains have been in place for nearly 20 years.

The Neridup Soil Conservation Group are seeking to build on this previous surface water management planning in order to further improve water management and reduce water erosion potential in the catchment. Landholders in the mid catchment have been implementing surface water management works to alleviate winter waterlogging for some time which has resulted in greater surface water flows and increased erosion and sedimentation in the mid–lower parts of the catchment during peak flow events. These processes are impacting on farm sustainability in the mid–lower catchment. Well-planned surface water management at a catchment scale is seen as a priority for better managing the changed hydrology of the catchment as well as addressing farm sustainability issues and environmental needs.

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1 ARI is a measure of the rarity of a rainfall event (Bureau of Meteorology 2006). The higher the ARI, the lower the chance of the event being equalled or exceeded in any one year.

2 Rainfall data sourced from Patched Point Dataset station 9739, just east of the Neridup Creek catchment, near the corner of Savages and Lanes Roads.

3 A 5–10 year ARI event has about a 20–10% chance of being equalled or exceeded in any one year;
a 10–20 year ARI has a 10–5% chance of being equalled or exceeded in any one year; and
a greater than 100 year ARI has a less than 1% chance of being equalled or exceeded in any one year.

1.2 Project aim

The aim of the project was to investigate surface water management options for attenuating large rainfall events in the Neridup Creek catchment. Specifically DAFWA was asked to:

- determine options available for using natural features and/or engineering solutions to reduce the impacts of large rainfall events, such as erosion and sedimentation, throughout the catchment
- raise landholder awareness of surface water management options and issues
- identify a suitable and cost-effective demonstration site to show an example of the type of surface water management earthworks that could be implemented by landholders to control surface water flow through the mid–lower catchment.

1.3 Project approach

Water management planning for buffering large rainfall events involved liaising with representatives of the Neridup Soil Conservation Group to discuss their primary concerns. These discussions determined that members farming in the mid and lower catchment were aware of the impact of large storm events in the catchment and the need to slow the water flow down to reduce its erosive potential, while at the same time wanting to keep water moving through farmland to reduce ponding and waterlogging. Ideas to control the water flow were based around holding the water back using some sort of detention structure/s and allowing it to release in a controlled measure over a number of days rather than hours.

The main area of concern was identified in the mid–lower catchment, south of Scaddan Road and so this investigation was focussed in this area.

Investigating water management options involved:

- identifying landscapes for natural detention and orthophoto interpretation of the entire catchment
- surveying the Neridup Creek flow line which starts on Property ID 1194330 south of Scaddan Road, and 'Green's drain' which starts on Property ID 1194470 north of Scaddan Road (Figure 1)
- investigating the two natural basins—Terrells and Plowmans Lakes—for additional detention capability.

By following this approach, we were able to determine options for reducing the impacts of large rainfall events, raise landholder awareness of water management options, and identify a potential demonstration site for controlling surface water flow in the mid–lower catchment.

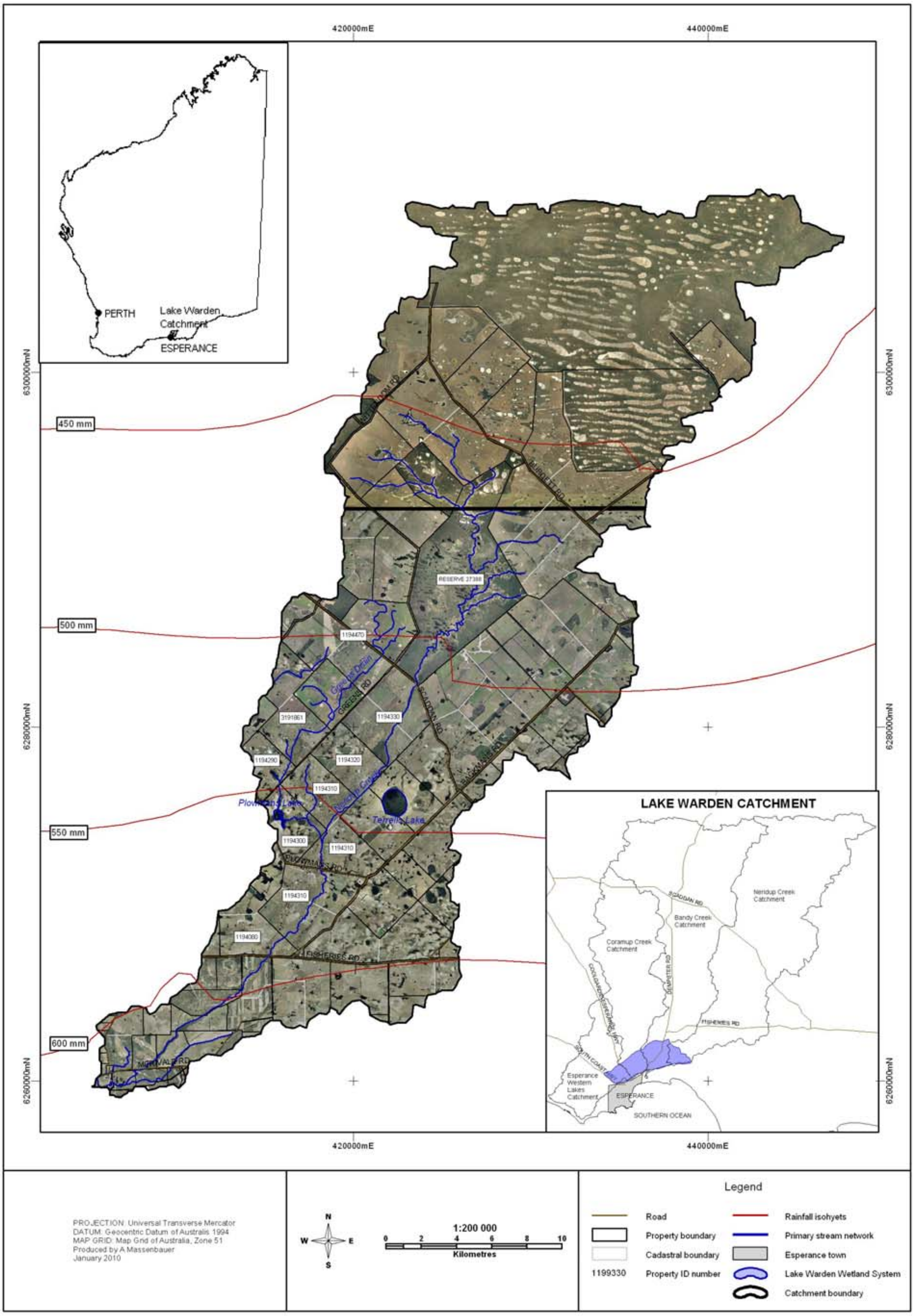

Figure 1 **Neridup Creek catchment**

2. Catchment description

The Neridup Creek catchment is one of four sub-catchments of the Lake Warden catchment which surrounds the town of Esperance on the South Coast of Western Australia (Figure 1). This catchment is a Natural Diversity Recovery Catchment managed by the Department of Environment and Conservation because it drains into the internationally significant, Ramsar-listed Lake Warden Wetland System, which is a high priority public resource that is currently at risk from increased water volume, eutrophication, sedimentation and salinity.

The Neridup Creek catchment is about 81 000 ha and most of the catchment has been cleared for broadacre agriculture.

2.1 Rainfall

Annual rainfall averages 540 mm and two-thirds of the rain falls during the May–October growing season (Figures 1 and 2) (Patched Point Dataset 2010).[4] Figure 2 also shows the frequency and amount of out of season rainfall, which has often caused problems such as erosion and sedimentation. The driest year since 1976 was 1994, when the area received only half of the average annual rainfall. The highest annual rainfall occurred in 1992 with 260 mm more than average (Table 1). There is a 20 per cent chance (one in five years) that the area will receive annual rainfall above 610 mm (wet year) or below 450 mm (dry year). July is the wettest month averaging 76 mm and the driest month, December, averages only about 20 mm (Figure 3).

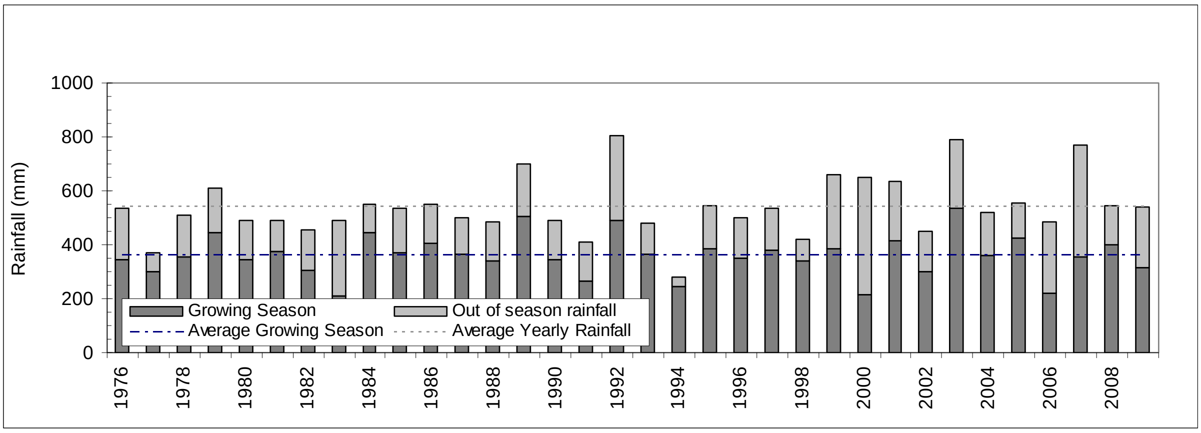

Figure 2 **Average yearly rainfall 1976–2009**

Table 1 **Rainfall statistics 1976–2009**

	mm
Average annual rainfall	540
20% percentile Dry year	450
50% percentile Median	510
80% percentile Wet year	610
Driest year	280 (1994)
Wettest year	800 (1992)

4 Rainfall data sourced from Patched Point Dataset station 9739 just east of the Neridup Creek catchment, near the corner of Savages and Lanes Roads.

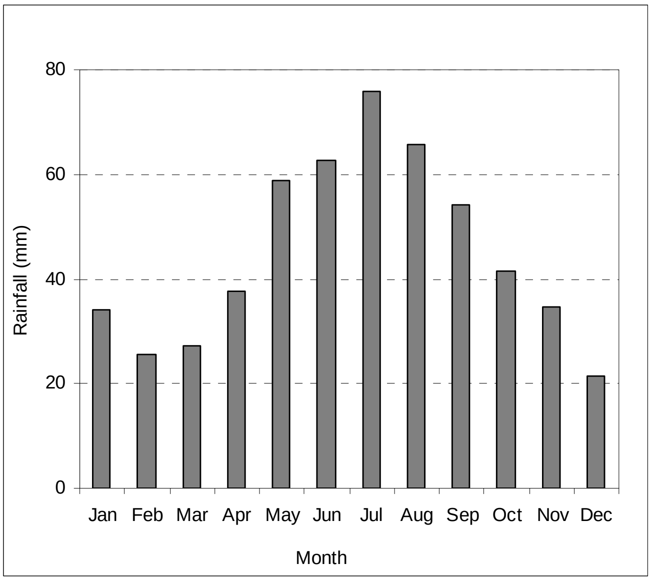

Figure 3 **Average monthly rainfall 1976–2009**

2.2 Landscape description

The landscape north of Burdett Road is internally drained into parallel chains of salt lakes, running predominantly in an east–west direction. The surface water is mostly detained within these salt lakes with aeolian (wind blown) dunes separating the chains of salt lakes. This system contributes minimal surface water flow to the Neridup Creek.

The upper catchment (between Scaddan Road and Burdett Road) has surface water shedding off the granite hills into a series of salt lakes in Reserve 27388, which is nearly 4500 ha, managed by Department of Environment and Conservation. These salt lakes provide natural attenuation of surface water flow by holding back water and evaporating or recharging groundwater which is important for reducing surface water flow into the mid–lower catchment.

The mid–lower catchment (south of Scaddan Road) is principally flat with areas of ill-defined surface water flows in multi-braided channels. Low-lying depressions form collection points for water and the low landscape relief provides limited opportunities for linking shallow relief drainage. In the early 90s, a shallow relief drain was built to define a channel for the Neridup Creek south of Scaddan Road. There is one major tributary, locally known as Green’s drain, which is also a man-made shallow drain built to define water flow across the flat landscape. Green’s drain runs to the west of, and roughly parallel to, the Neridup Creek until it joins the Neridup Creek 300 m south-east of the boundary between Property ID 1194300 and Property ID 1194310. The Neridup Creek drain starts on Property ID 1194330 south of Scaddan Road and Green's drain starts on Property ID 1194470 north of Scaddan Road (Figure 1).

The landscape relief south of Fisheries Road becomes steeper and the Neridup Creek more defined as it enters the eastern suite of the Lake Warden Wetland System which flows to the Bandy Creek boat harbour and the Southern Ocean.

2.2.1 Topography

Nearly half of the catchment has less than 1 per cent slope, which means it is principally flat. These areas have ill-defined flowpaths and are prone to ponding, waterlogging, flooding and increasing groundwater recharge (Table 2, Figure 4). However, the overall proportion of flat landscape in the entire catchment is similar to other sandplain catchments in the Esperance Shire. Figure 4 highlights the high proportion of flat landscape in the mid–lower catchment, as well as the internally draining salt lakes of the northern catchment and the granite hills and high relief of the upper catchment draining into Reserve 27388.

Table 2 **Slope classes**

Slope class	Area (%)
0 – 1%	46
1 – 2%	34
> 2%	20

Figure 5 depicts two metre contour lines across the mid–lower catchment which shows the low gradient of the catchment. From Scaddan Road to Fisheries Road, the landscape through which the Neridup Creek flows averages a slope of only 0.22 per cent and it's slightly lower for Green's drain (Table 3).

Table 3 **Slope characteristics of Neridup Creek**

	Neridup Creek	Green's drain
Scaddan Road	122 m AHD	122 m AHD
Juncture with Neridup Creek	–	101 m AHD
Fisheries Road	82 m AHD	–
Distance (approx)	18.3 km	15.3 km
Average slope	0.22%	0.14%

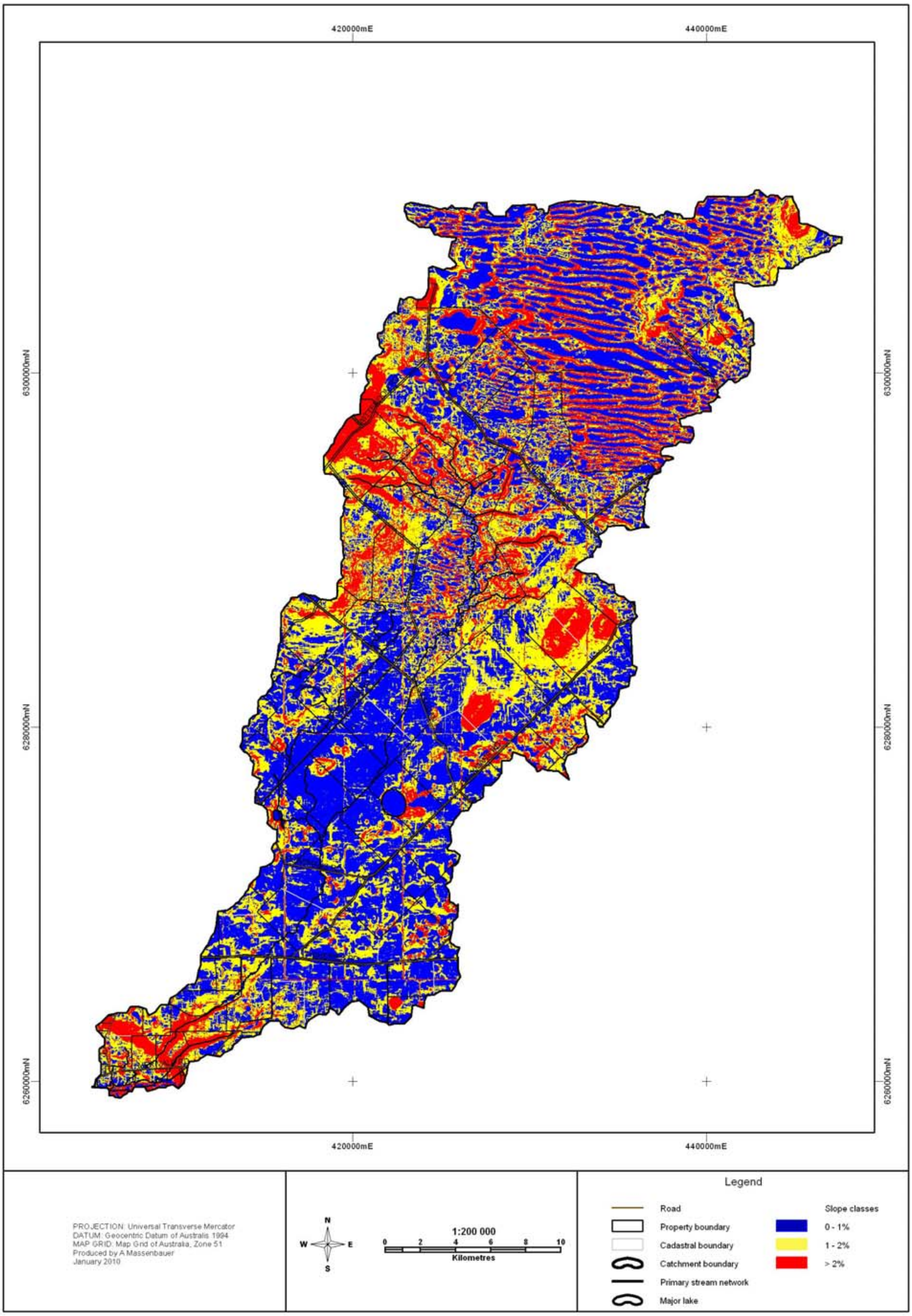

Figure 4 **Slope classes**

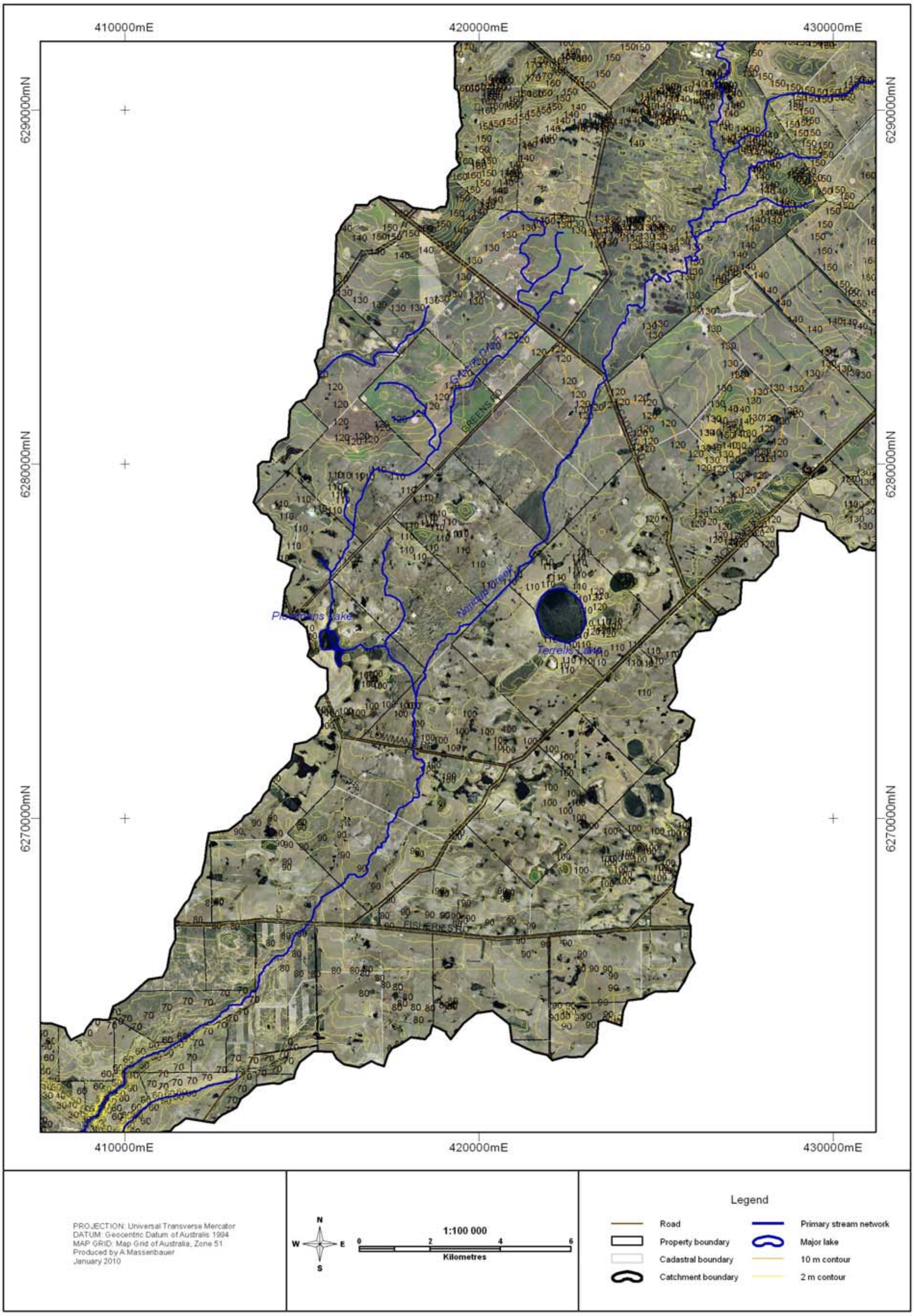

Figure 5 **Contours of the mid–lower catchment**

2.3 Surface water hydrology

2.3.1 Sub-catchments

Only about one-third of the Neridup Catchment actually contributes to the Neridup Creek and its tributary Green's drain. This area can be divided into three main sub-catchments—Neridup central (15 400 ha), Plowmans Lake (7500 ha) and Neridup lower (6700 ha) (Figure 6). A fourth sub-catchment containing Terrells Lake (13 100 ha) lies to the east of Neridup central sub-catchment and is mostly internally drained; that is, it doesn't drain out of the sub-catchment. The remainder of the catchment is also internally drained.

Dunne et al. (2001) mapped low-lying areas which also show the contribution and connectivity of the landscape to the creek.[5] Figure 6 shows the low-lying areas in the catchment if the landscape had 50 cm of water lying on the flowpaths. Flowpaths are areas where water flow accumulation is high (not just creeklines). In wetter years the low-lying areas are at risk of flooding, inundation and waterlogging and, where groundwater levels are rising, indicate areas with a potential to develop shallow watertables. The low-lying areas with shallow watertables may not develop bare saline scalds because of soil and aquifer properties, but crop yields are likely to be reduced.

2.3.2 Neridup Creek

The Neridup Creek, like many other South Coast rivers and creeks, is salty and dries up for significant parts of the year. During an average rainfall year the Neridup Creek provides less than 5 per cent of surface water flow into the Lake Warden Wetland System. It transports large salt loads in storm flow rather than via base flow, and even though high concentrations of nutrients are also transported, the loads are low because of the low surface water flow (Department of Environment and Conservation In press).

2.4 Groundwater hydrology

Since clearing the native vegetation for agricultural land development, the catchment water balance has been significantly altered. Groundwater recharge and surface run-off has increased and plant water use (evapotranspiration) and interception has decreased.

Without perennial vegetation to intercept and use rain where it falls, more rainfall infiltrates the soil and recharges groundwater and more rainfall runs off the land surface (McFarlane et al. 1991). As the soil profile fills (wets up), there is less room to store water and when the profile is saturated, water ponds on the surface or becomes run-off.

In general the Neridup catchment has not yet reached its new hydrological equilibrium (when the groundwater in an area stops rising and the area of groundwater discharge stops expanding) and so surface water flows will continue to increase as the catchment continues to wet up until the new equilibrium is reached. In the Mallee, the time until equilibrium is long term (more than 75 years) while in the Esperance Sandplain, this time is expected to be reached in 30–75 years (Simons and Alderman 2004).

[5] The mapping did not cover the catchment south of Plowmans Road.

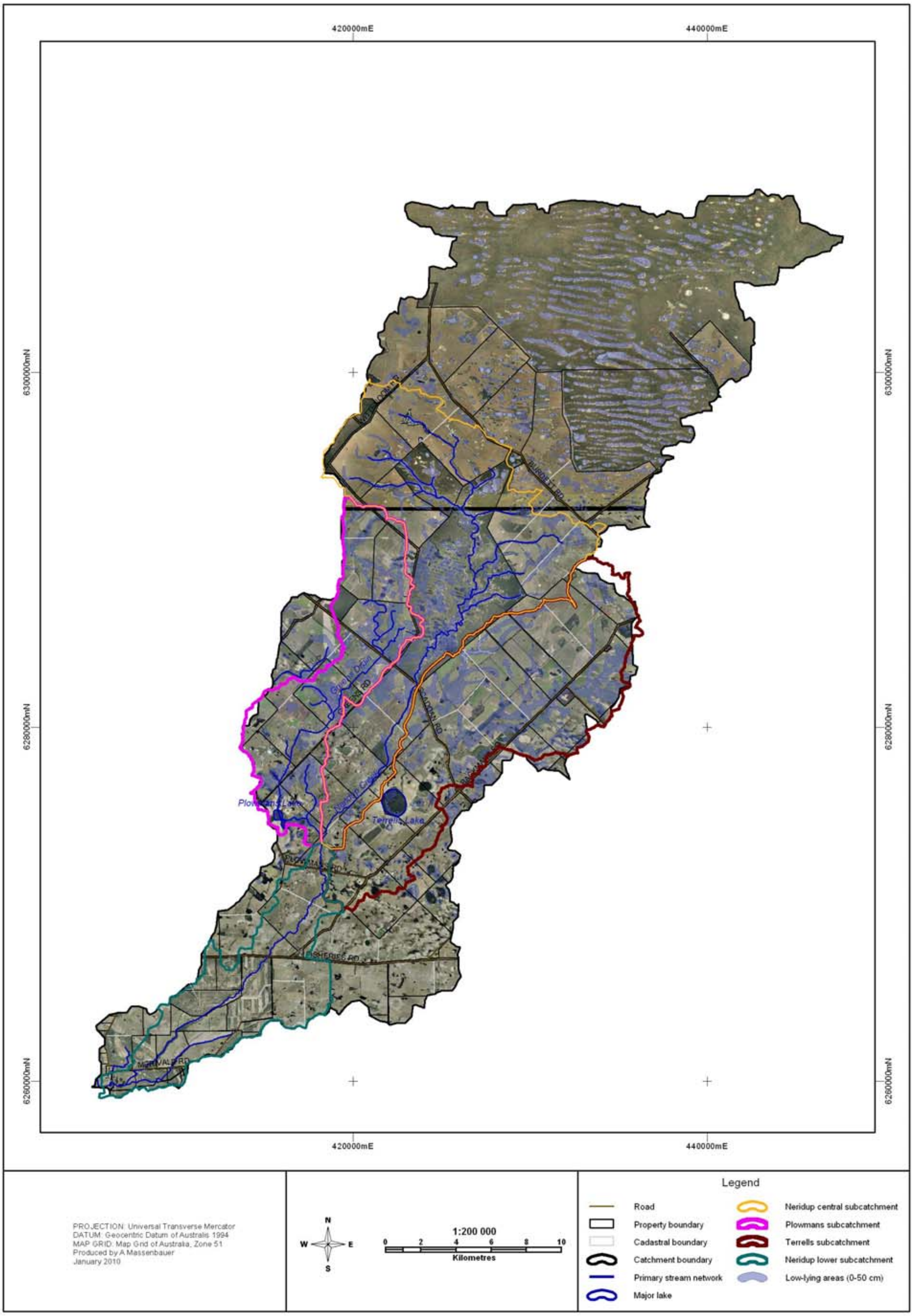

Figure 6 **Sub-catchments contributing to Neridup Creek and low-lying areas**

2.4.1 Groundwater depth, quality and trends

The depth to groundwater ranges from less than 2 m (bore nest AG16) to just deeper than 5 m (bore nest AG2) (Figure 7). The deeper groundwater levels predominantly occur in the south-east, whereas groundwater levels are shallower in the west and north. Groundwater salinity increases with distance away from the coast and ranges from 70 mS/m (milliSiemens per metre), which is fresh, in the perched aquifers, to 10 900 mS/m (highly saline) in the stagnant aquifers in the mallee (Agbores database 2009).

Groundwater levels in the Halbert Soil-landscape System (Figure 8 and Appendix 1) associated with the salt lakes are shallow (less than 2 m) and fluctuate seasonally (bore AG12S). Groundwater levels in the Scaddan System are around 5 m below ground level (bore AG13S) and have risen incrementally because of above average rainfall in the summer of 1999 and 2007 and also the autumn of 2000 and 2003 (Figure 3). Groundwater levels in the Esperance System are either shallow and fluctuate seasonally or where they are deeper (more than 5 m) are rising up to 0.25 m/yr (bore AG2I). In general, across the Neridup Catchment where groundwater levels are too deep for evaporation to have an effect, groundwater levels are rising at rates between 0.03 and 0.25 m/yr.

Those areas where the groundwater is less than 2 m and fluctuating seasonally have probably reached hydrological equilibrium, whereas those areas where groundwater levels are rising are yet to reach it.

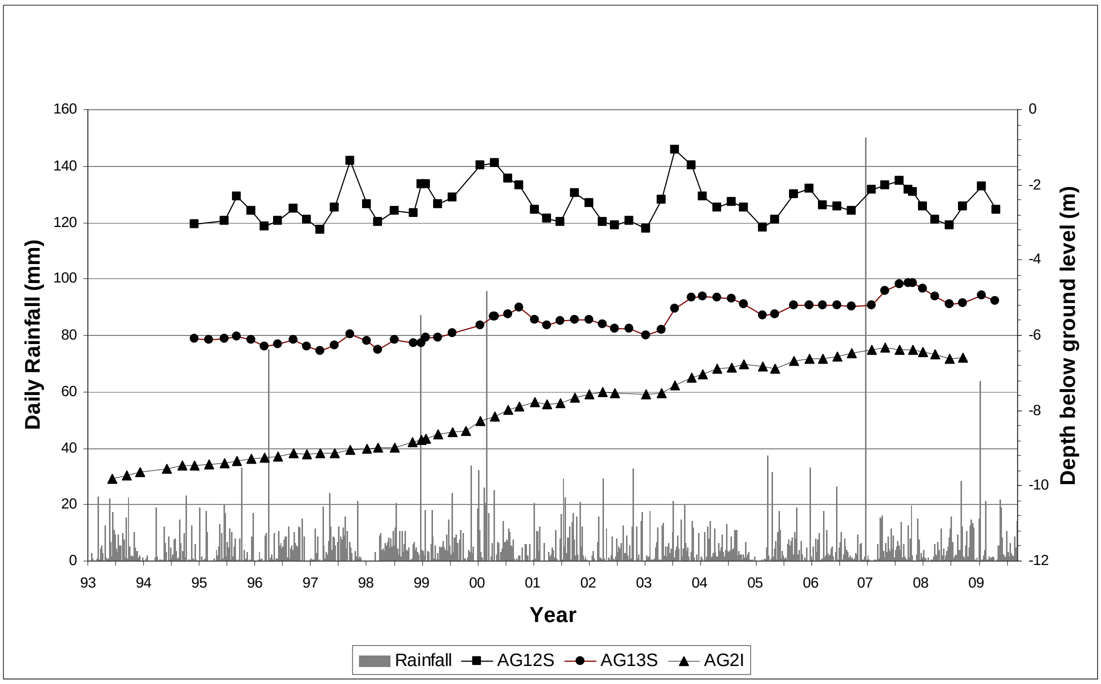

Figure 7 **Representative groundwater hydrographs from bores in the Neridup Catchment**

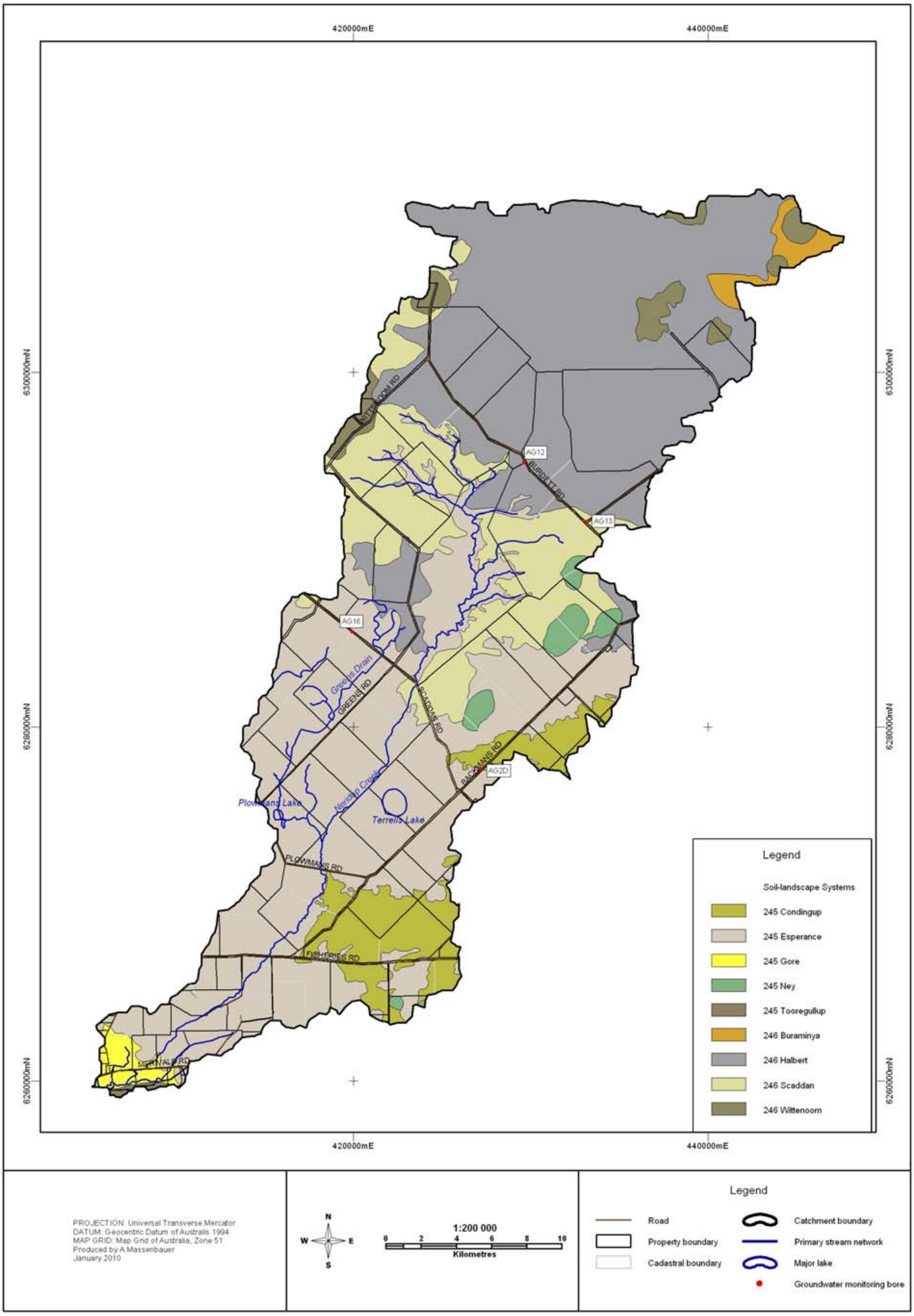

Figure 8 **Soil-landscape Systems and groundwater monitoring bores (description of the systems is contained in Appendix 1)**

3. Catchment assessment

A catchment reconnaissance was conducted using orthophoto interpretation and ground-truthing to identify landscapes for natural detention. The two main flowlines, Neridup Creek and Green's drain, as well as the two main natural basins, Terrells and Plowmans Lakes, were surveyed.

The findings are:

- The different types and arrangements of culverts and floodways give an indication of the amount of water and spatial extent of flood flows occurring throughout the catchment.
- Road water crossings in the upper catchment have a single pipe culvert ranging from 250 mm to 375 mm passing under the gravel road. Road crossings for Neridup Creek and Green's drain are listed in Table 4.
- Some of these culverts are partially blocked and require maintenance to improve effectiveness.
- Neridup Creek and Green's drain are shallow relief drains of varying cross-sectional design (Appendix 2).
- Some parts of the Neridup Creek are fully cleared and unfenced, and other parts are fenced and have been revegetated or are contained in remnant vegetation.
- There is an 80 ha block of remnant vegetation on Property ID 1194330 that provides an important attenuation and slow down point for the Neridup Creek. The creek spreads undefined through the vegetation and from our site visits, it appears to withhold or use water as well.
- The floodplain on the west side of the Neridup Creek, between Scaddan and Plowmans Roads, flows through a series of multi-braided channels, spreading up to 1200 m wide from the main channel (Figure 9).
- Because the landscape has limited relief, there are no opportunities to detain water in the mid–lower catchment without causing flooding; for example, a 1 m high bank holding back water may flood back up to 800 m (Figure 9).
- There are two main natural basins in the mid catchment, both on privately owned land—Terrells Lake and Plowmans Lake. Both of these sumps were investigated to determine the possibility of using them to hold and/or store more of the catchment's water in large rainfall events.
- There are some on-farm detention opportunities, and a potential demonstration site, in the upper Green's drain catchment.

The last two findings are further discussed in the following sections.

Table 4 **Culvert size (mm) and number in the mid–lower catchment**

Location	Neridup Creek	Green's drain	Comments
Scaddan Road	2 x 375 mm pipe culverts under a bitumised floodway	1 x 450 mm and 2 x 600 mm pipe culverts under the gravel road	
Greens Road		2, 1200 x 300 mm box culverts under the gravel road	rock gabions supporting the outlet
Plowmans Road	2 x 300 mm pipe culverts about 150 m apart under a bitumised floodway		
Fisheries Road	4, 900 x 450 mm box culverts under bitumen road		rock gabions on the entry and outlet

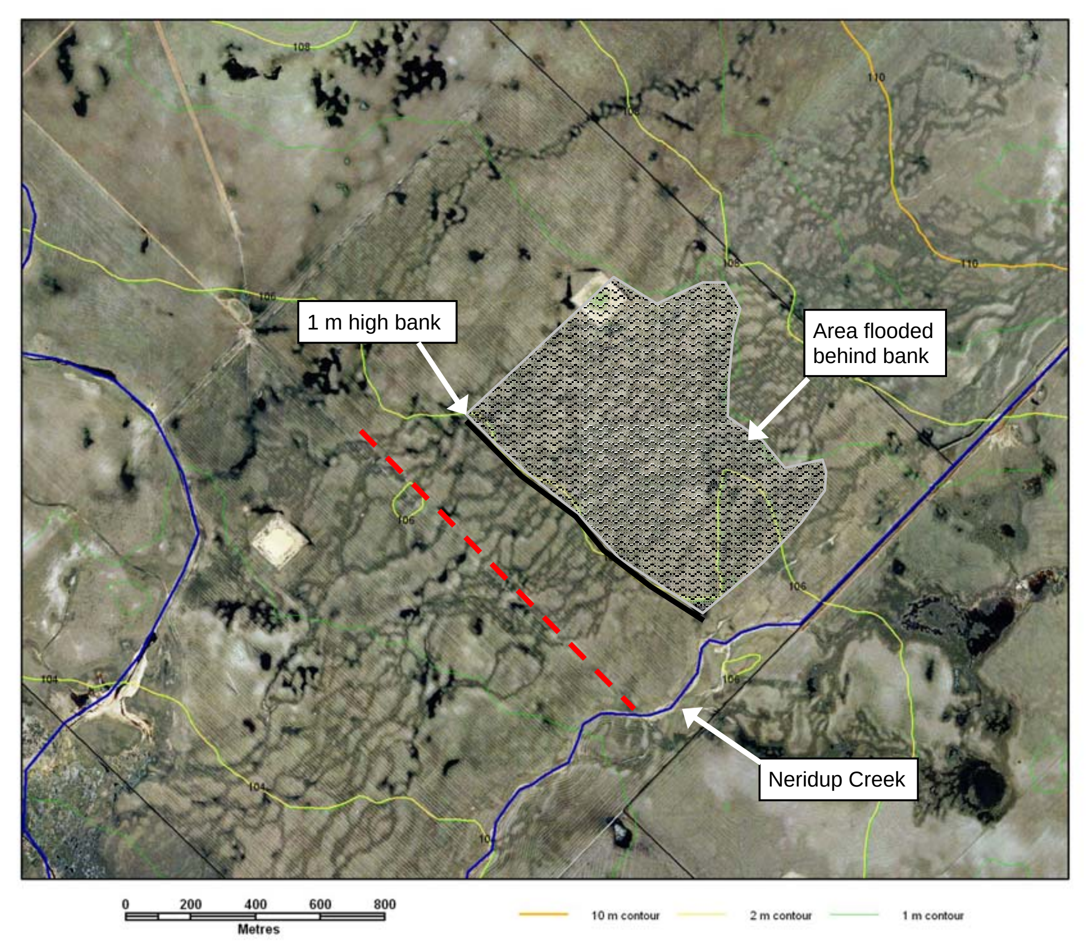

Figure 9 **Multi-braided channels of water flow spanning up to 1200 m from the Neridup Creek (red line). A 1 m high bank (black line) holding back water may flood back up to 800 m (grey shaded area).**

3.1 Terrells Lake

Terrells Lake sits in a catchment of about 13 000 ha and is about 190 ha in area. This basin is not in the through-flow of the main creekline, it can dry up completely and it has not been known to overflow in even the largest storm event. The lake is bound by lunettes ranging from 3 m above the lake level at the lowest point on the south side, to 15 m on the east side.

The Department of Water (2008) characterised and monitored this lake from November 2005 until December 2007 and found that the lake is fed by surface run-off, subsurface flow and via the creekline to the north and contains brackish (340 mS/m) to saline (2100 mS/m) water. Currently there is no groundwater connection, but with the current rate of groundwater rise (0.25 m/yr) in the area, there will be groundwater connectivity within 25 years if the current rate persists or sooner if the rate increases (J. Simons [Hydrologist, DAFWA, Esperance] 2010, pers. comm. 4 May).

For water to be redirected from Neridup Creek into the lake, an inlet channel and an overflow channel are needed. The start of the inlet channel in Neridup Creek can only be positioned one metre in height (107 m AHD) above the lake full level (106 m AHD) otherwise there is no way of limiting flood water from overfilling the lake. For this reason, the inlet channel cannot be located on the north side of the lake.

The theoretical inlet would be a trapezoidal-shaped channel that has a 2 m wide flat bottom, is 1 m deep, has a channel gradient of only 0.04 per cent because of the low landscape relief, and is about 2.5 km long (Figure 10). At full capacity, this drain would only raise the lake level about 130 mm/day while the majority of the storm event will continue along the creek.

The lowest point for the theoretical overflow system is also on the south side. The overflow through the lunette has a smaller capacity than the inlet and would look like:

– flat-bottomed trapezoidal channel 1 m wide (excavator built)
– side slopes of 1:3 (angle of repose for sand)
– maximum top width of 20 m
– maximum depth of 3 m (through the lunette bounding the lake)
– channel gradient 0.03 per cent (1:3000)
– length of channel to return to the Neridup Creek is 3 km.

While the lake has a large capacity (1 m of depth = 1.9 GL), only a small portion of run-off could be redirected from Neridup Creek because of the low relief and large distance between the creek and the lake. Therefore, from preliminary assessment, irrespective of any social or environmental issues, using Terrells Lake as a detention basin for large storm events is not feasible or economical.

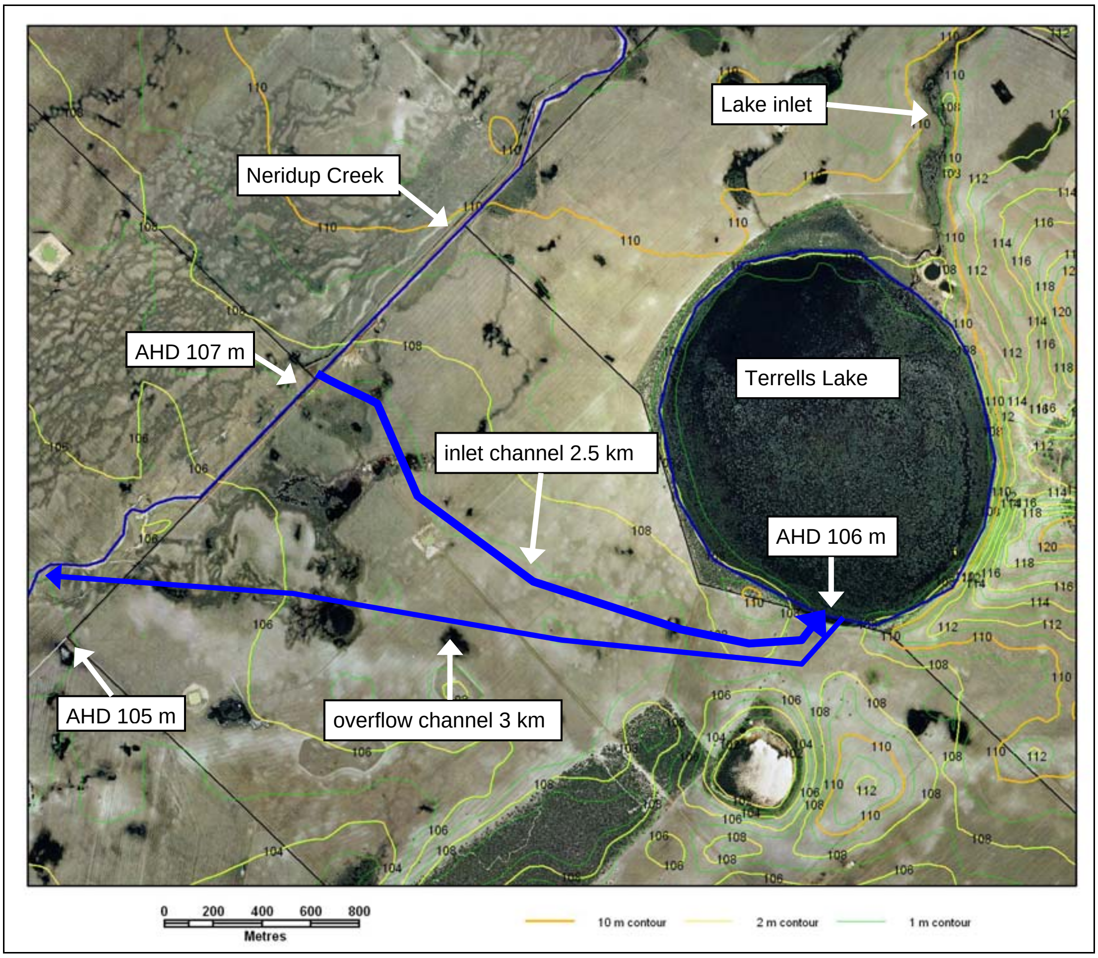

Figure 10 **Theoretical layout of drains entering and exiting Terrells Lake. Inlet channel starts at 107 m AHD and enters the lake at 106 m. The overflow starts at 106 m and re-enters the creek at 105 m.**

3.2 Plowmans Lake

Plowmans Lake is the major basin in series of interconnected low-lying sumps that are in the through-flow of a creekline. It sits in a catchment of about 7500 ha and the lake has an area of about 30 ha (calculated using the 2007 orthophoto). Plowmans Lake is saline and has a maximum depth of about 3.6 m when full. According to John Wallace (property lessee) in recent years the lake has remained at its high water level all year round. Water enters Plowmans Lake from Green's drain. When the lake fills to capacity it slowly flows along a shallow relief drain, through a sump zone and then continues along the drain until it meets up with the Neridup Creek. The drain has up to 100 mm of silt on the channel floor through the sump zone, has a very low gradient of less than 0.1 per cent and is about 3 km long (Figure 11).

In order to reduce the impact of floodwaters moving quickly through the lower catchment, a possible option exists to increase the buffering capacity of this lake in large rainfall events by deepening the existing overflow drain to 1 m. This option would allow the lake to detain up to 1 m of water across the lake area which is estimated to be equivalent to a volume of about 300 000 m^3 or 75 x 4000 m^3 farm dams. The stored water would then be slowly released along the drain over time. The drain would be about 1 m deep along most of its length before it could be returned to near ground level because of the low landscape relief.

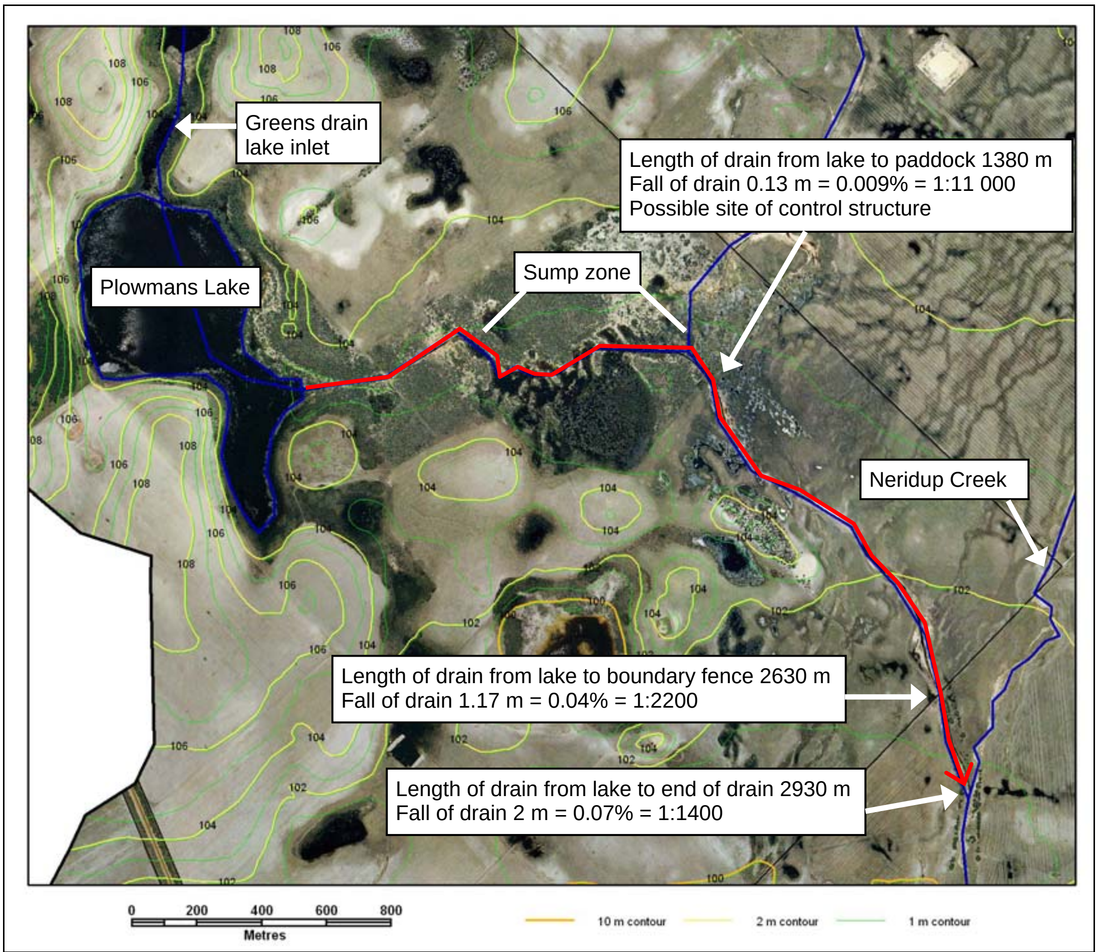

Figure 11 **Details of Plowmans Lake overflow channel**

Two possible designs that may be suitable for the deepening of the overflow drain:

- A 2 m wide base, 1 m deep channel with flattened side slopes built by a scraper (Figure 12a). Preliminary calculations show this channel's peak discharge to be 2.19 m^3/s or 7880 m^3/hour which would release 1 m from the lake over 38 hours if running full.
- A 1 m wide base, 1 m deep channel with steeper side slopes built by an excavator (Figure 12b). Preliminary calculations show this channel's peak discharge to be 0.8 m^3/s or 2880 m^3/hour which would release 1 m from the lake over 4 days if running full.

It should be noted that as run-off starts lifting the lake level, discharge will occur at low flow rates and will increase as lake level and therefore channel depth increases. The opposite will also occur as the lake level recedes to its nominated lake full level. No attempt has been made to calculate this discharge period; however, it is expected to be higher than the calculated discharge times noted above, that is, it will take more than 4 days to release 1 m of water from the lake along the drain in Figure 12b.

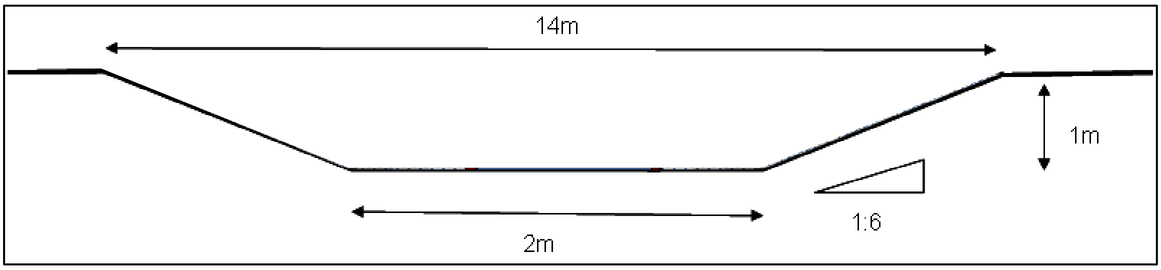

Figure 12a **Cross-section of a scraper built drain**

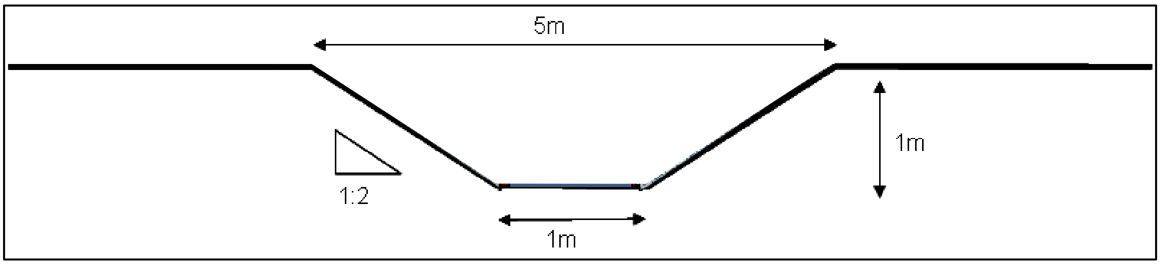

Figure 12b **Cross-section of an excavator built drain**

The cross-sectional area of the drain in Figure 12a may be too large to detain enough water to be effective, so a control structure may need to be installed to slow the release of floodwater from the lake and sump zone over a longer period of time. The control structure would need to be calculated; however, provisional estimates indicate it could be a 1 m x 400 mm box culvert installed in the base of the overflow drain.

There are some issues that need to be investigated and/or solved before constructing this overflow:

- Will increasing the capacity of the lake make any difference to the downstream catchment in large rainfall events? Further investigation is needed to determine whether 300 000 m^3 is sufficient to make an impact worthy of the cost of implementation. This issue needs modelling which can be done by a consulting engineer.
- The safe (non-erosive) entry of water into the excavated channel from the adjacent sump zone along the length of the proposed deepened channel.
- The risk of exposing acid sulfate soils (ASS). ASS are likely to be found around Plowmans Lake because it is a saline melaleuca swamp that has the required conditions to make ASS likely—sulfate source (from the salinity), waterlogged conditions and

organic matter. To verify whether ASS are present, preliminary field soil tests can be conducted. If sulfides are found, more detailed testing of the soil and water will be required to determine its buffering capacity and the likely impact of exposing the ASS (A. Lillicrap [Hydrologist, DAFWA, Albany] 2009, pers. comm. 19 November).

3.3 Green's drain engineering option

The northern parcel of Property ID 1194470 (north side of Scaddan Road) is predominantly flat with numerous shallow, saline sumps, most of which are not suitable for cropping. Many of these sumps have shallow relief drains connecting them and draining water across the paddocks into the primary drain, Green's drain, which continues south of Scaddan Road, through all of the properties until it flows through Plowmans Lake and joins the Neridup Creek (Figures 1 and 13).

Some of these sumps avail themselves to having a small earthen wall with a pipe in its base constructed across the connecting relief drain channel to detain water in the sump while allowing the controlled release of water over an extended period (Figure 14). Not all sumps are suitable for this type of structure. The sumps most suitable are those that have only small catchments, such as those sumps that are at or near the beginning of a drainage line. Sumps that are in the through-flow of a drainage line (there is more than one sump draining into it) may have too much catchment feeding them and a detention structure in these areas would be ineffective and the risk of degradation too high.

There are opportunities to pilot different wall construction materials and techniques, such as different pipe sizes, varying porosity of earth versus gravel or aggregate walls to allow detained water to drain through the wall at a controlled rate.

The earthen wall will be the size of the existing relief drain channel which is 450–500 mm deep and about 3 m wide. The wall should be slightly parabolic across its top to ensure the lowest overflow point remains in the drain. The crest of the wall should be no less than 0.3 m wide and may vary according to its use; for example, a wall may be constructed and used as a farm crossing and therefore may be 3–5 m wide. The side slope of the upstream side of the wall should be 1:2 while the slope of the downstream side should be 1:3 or flatter to allow steady flow of water over the wall. Ideally, a geotextile would be used in the wall to prevent soil erosion from water moving through or under the wall, as well as preventing sediments from reducing the porosity of the gravel/stones that make up the wall. After the wall and geotextile have been 'keyed' into the ground, the geotextile can be easily cut to insert the pipe and the wall built up (Figure 15).

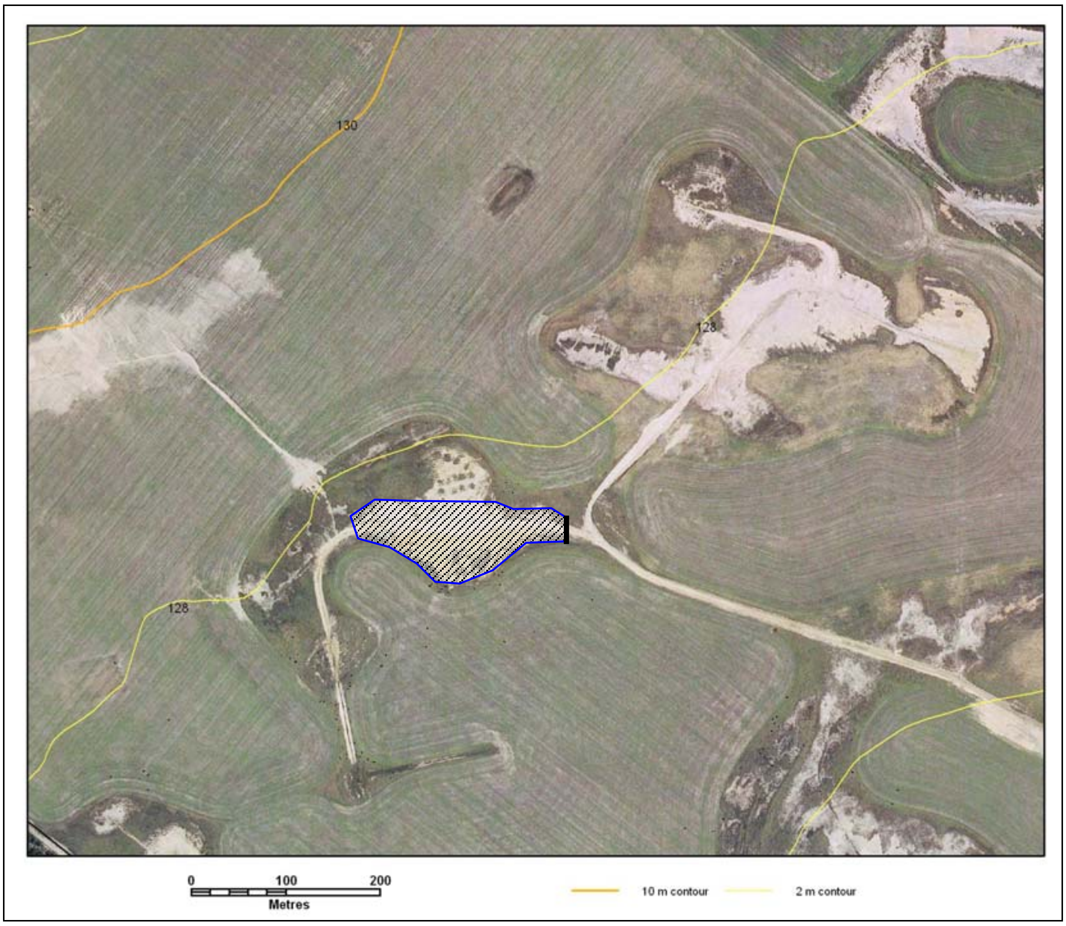

Figure 13 **Aerial view of the location of a possible sump detention wall (thick black line) and the extent of water detained behind the wall when full (blue hashed area)**

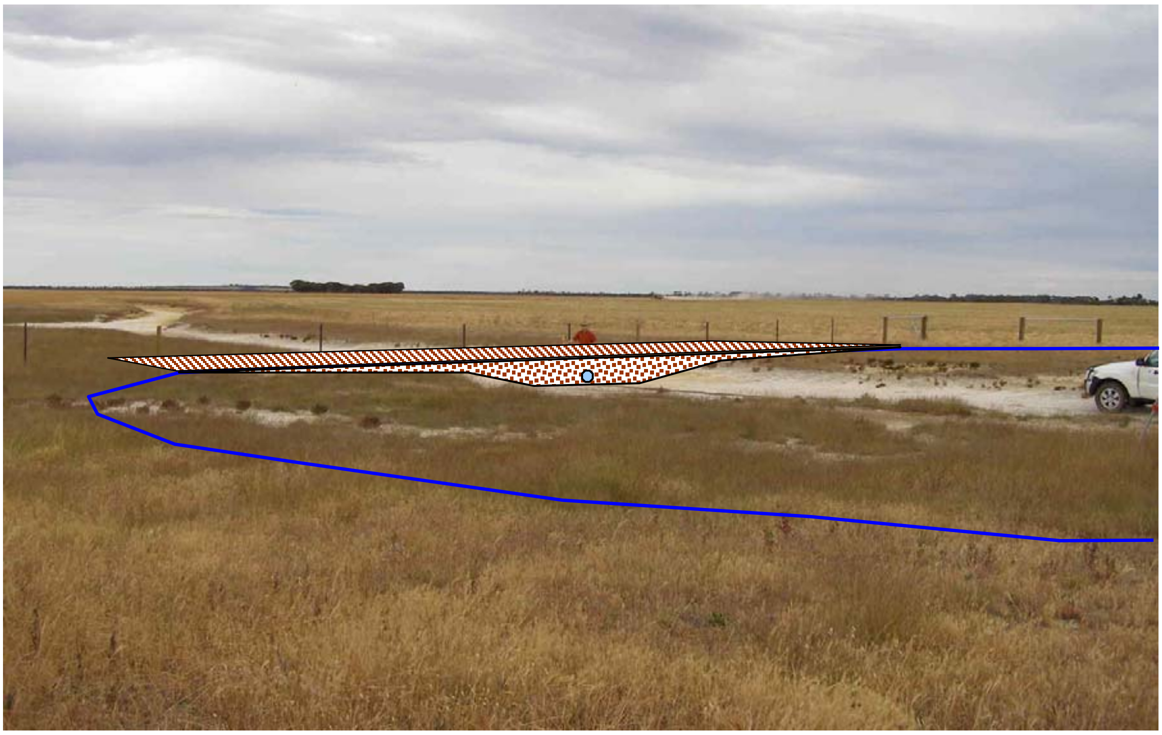

Figure 14 **Possible detention area for controlling water flow. The hatched area represents the wall constructed across the drain with a pipe in the base; the blue line represents the extent of water detained behind the wall when full.**

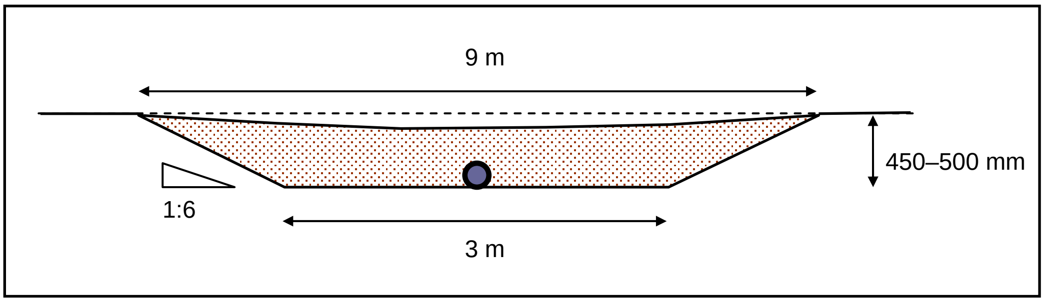

Figure 15a **Cross-section of slightly parabolic wall across drain channel with a suitably sized pipe in the base of the wall**

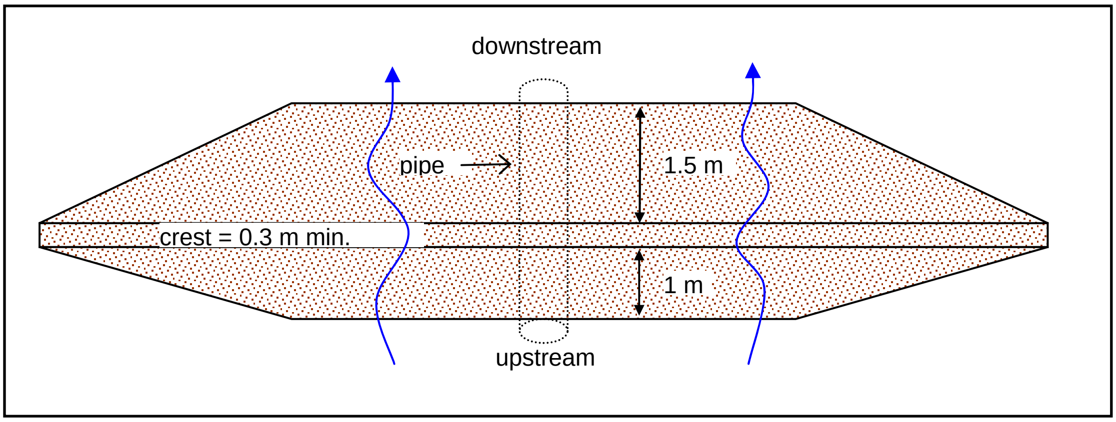

Figure 15b **Aerial view of wall**

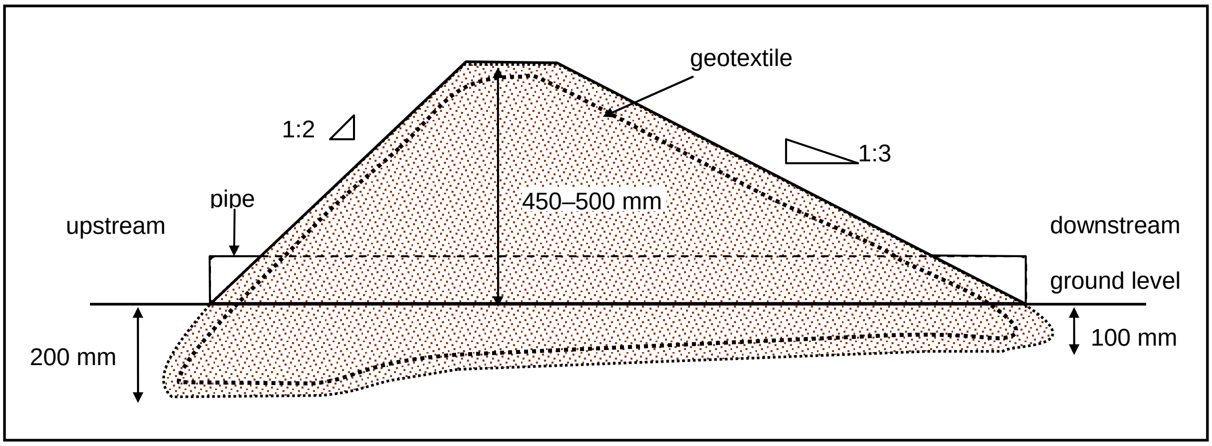

Figure 15c **Cross-section of earthen wall**

4. Recommendations and findings

- Flooding of paddocks is most prevalent where agriculture is practiced in natural flood plain areas.
- Recommended engineering options and design in paddocks needing drainage:
  - use only shallow relief drains for moving water on
    - ❖ the drain should be scraper built to move the soil off-site, for example, to infill depressions in the paddock
    - ❖ channel width of 2.4–3 m (width of scraper)
    - ❖ shallow depth to a maximum 250 mm (10 inches)
    - ❖ low channel gradient to a maximum of 0.2 per cent (1 in 500) to control speed of water flow
    - ❖ if channel depth is more than 250 mm, the gradient must be lowered to prevent water speed increasing as the depth increases
  - no levees/banks for holding water up because this will result in widespread flooding over a flat landscape.
- Redirecting water in storm events from the Neridup Creek to the natural basin of Terrells Lake to use it to attenuate peak flow for the catchment (additional to its current use) is considered to be not feasible or economical from preliminary assessment.
- Plowmans Lake is a small natural basin that may be capable of offering some detention of storm water if the overflow drain of the lake is deepened to 1 m. This option needs further investigation to determine the effectiveness of the option in buffering storm events (that is, will the amount of detention capability provide sufficient buffer for the lower catchment in a large storm event to warrant the cost of implementation) and the environmental risk (for example, exposing acid sulfate soils which are likely to be present).
- There are some opportunities for increasing landscape detention in areas where natural sumps have been drained, such as in the upper Green's drain catchment. Some of these sumps avail themselves to having a small earthen wall with a pipe in its base constructed across the connecting relief drain channel to detain water in the sump while allowing the controlled release of water over an extended period. Not all sumps would be suitable for this type of structure. The sumps most suitable are those that have only small catchments feeding into them, such as those sumps that are at or near the beginning of a drainage line that doesn't have more than one sump draining into it.
- Reserve 27388 in the upper catchment contains salt lakes that provide natural buffering by holding back water and evaporating or recharging groundwater. Maintaining this reserve is important for buffering surface water flow into the mid–lower catchment.

5. References

AgBores database, Department of Agriculture and Food, Data extracted October, 2009, biannual updating.

Bureau of Meteorology 2006, Hydrometeorological Advisory Service. Bureau of Meteorology, Melbourne, viewed April 2010, <http://www.bom.gov.au>.

Department of Environment and Conservation In press, *Lake Warden Natural Diversity Recovery Catchment Recovery Plan 2005 – 2030 Preliminary Draft*, Department of Environment and Conservation, Western Australia.

Department of Water 2008, *Terrells Lake*, South Coast wetland monitoring project, Department of Water, Albany.

Dunne R, Caccetta P and Beetson B 2001, *Prediction of areas of shallow watertable and salinity risk: Ravensthorpe (109–083) and Esperance (108–083) Landsat TM Scenes,* CMIS Report No. 01/**, CSIRO Mathematical and Information Sciences, Perth.

McFarlane DJ, George RJ and Farrington P 1991, 'Changes in the hydrologic cycle', in Hobbs JR and Saunders DA (eds), *Reintegrating fragmented landscapes,* New York, Springer-Verlag, pp 146–86.

Patched point dataset, Department of Agriculture and Food 2010, Data extracted April 2010 <http://agweb/Business/cris/interfaces_climate.htm>.

Simons J and Alderman A 2004, *Groundwater trends in the Esperance Sandplain and Mallee regions*, Miscellaneous Publication 10/04, Department of Agriculture, Perth.

Appendix 1: Descriptions of Soil-landscape Systems

System	Description
245 Condingup	Gently undulating plain of sand sheets and linear dunefields. Soils are Pale deep sands and Grey deep sandy duplex soils (sometimes gravelly).
245 Esperance	Level to gently undulating plain with poor external drainage. Incised by river valleys. Soils are Grey deep sandy duplexes (gravelly) and Pale deep sands.
245 Gore	Poorly drained coastal plain with numerous dunes and lakes. Soils are Wet soils, Grey deep sandy duplexes and Pale deep sands.
245 Ney	Low hills and hills on Archaean granite and gneiss with slopes of colluvium. In places aeolian sand may be present on apron slopes. Soils are Grey deep sandy duplexes, Pale deep sands and Bare rock.
245 Tooregullup	Coastal dunes. Soils are Calcareous deep sands and Calcareous shallow sands.
246 Buraminya	Level to very gently undulating plain on Tertiary sediments with aeolian accessions fringing the north-eastern part of the mallee zone. Soils are Calcareous loams, Grey non-cracking clays and Alkaline grey shallow sandy duplex soils.
246 Halbert	Level to gently undulating plain with numerous salt lakes within a palaeo-valley on Tertiary marine sediments (Plantagenet and Werillup formations). Soils are Alkaline grey shallow sandy duplex soils and Salt lake soils.
246 Scaddan	Level to gently undulating plain with numerous clay pans and salt lakes. Soils are Alkaline grey shallow sandy duplexes and Calcareous loamy earths.
246 Wittenoom	Scattered low hills and hills on Archaean granite and gneiss with slopes of mixed colluvium. Soils are Alkaline grey shallow sandy and loamy duplexes.

Appendix 2: Photographs of Neridup Creek and Green's drain

Plate 1 **Neridup Creek flowing from Scaddan Road and entering Property ID 1194330 (taken 29/07/2009)**

Plate 2 **Neridup Creek below Scaddan Road on Property ID 1194330 (taken 31/07/2009)**

Plate 3 **Neridup Creek spreading through remnant vegetation on Property ID 1194330 and entering a relief drain on the adjoining property (ID 1194320) to continue its way south (taken 31/07/2009)**

Plate 4 **Neridup Creek on Property ID 1194320 (taken 13/08/2009)**

Plate 5 **Neridup Creek on Property ID 1194310 (taken 12/08/2009)**

Plate 6 **Green's drain north of Scaddan Road on Property ID 1194470 (taken 05/11/2009)**

Plate 7 **Fencing and revegetation of Green's drain on Property ID 3191861 (taken 12/08/2009)**

Plate 8 **Green's drain just before Greens Road on Property ID 1194290 (taken 08/10/2009)**

Plate 9 **Green's drain exiting Plowmans Lake before entering the sump zone on Property ID 1194300 (taken 25/08/2009)**

Plate 10 **Green's drain on Property ID 1194300 (taken 12/08/2009)**

Plate 11 **Green's drain 300 m before joining the Neridup Creek on Property ID 1194310 (taken 27/08/2009)**

Plate 12 **Neridup Creek passing Plowmans Road and continuing along Property ID 1194310 (taken 29/07/2009)**

Plate 13 **Neridup Creek north of Fisheries Road on Property ID 1194080 (taken 12/08/2009)**

Plate 14 **Neridup Creek flowing through box culverts under Fisheries Road (taken 29/07/2009)**