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Tiffany Developments Pty Ltd

Report on Oxford Falls

Riparian Areas Assessment

June 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Overview

GHD Pty Ltd (GHD) has been engaged by Tiffany Developments Pty Ltd to undertake a riparian area assessment of watercourses associated with a proposed Seniors Living Development at Oxford Falls. The site in question covers Lots 1110, 1111, 1113 & 1336 DP 752038, Lot 20 DP 842523 and Lot 80 DP 846099 on Oxford Falls and Barnes Road, Oxford Falls, New South Wales (hereby referred to as the subject site) (Figure 1). The report includes assessment of all drainage lines in accordance with the *Water Management Act 2000 (WMA)*. The WMA came into effect in early February 2008 with the *Rivers and Foreshore Improvement Act (RFI) 1948, now* formally repealed.

Information contained in the report will form the basis for developing a concept plan for the development and to support the Part 3A Concept Application. GHD has included regular consultation with the Department of Environment, Climate Change and Water (DECCW) to set the agreed riparian corridor as depicted in this report. Information includes relevant legislative requirements, categorisation of drainage lines in accordance with the WMA (see Figure 1), recommendations for rehabilitation and management of drainage lines and preparation of the 'Preferred Riparian Corridor Network'.

1.2 Assessment Objectives

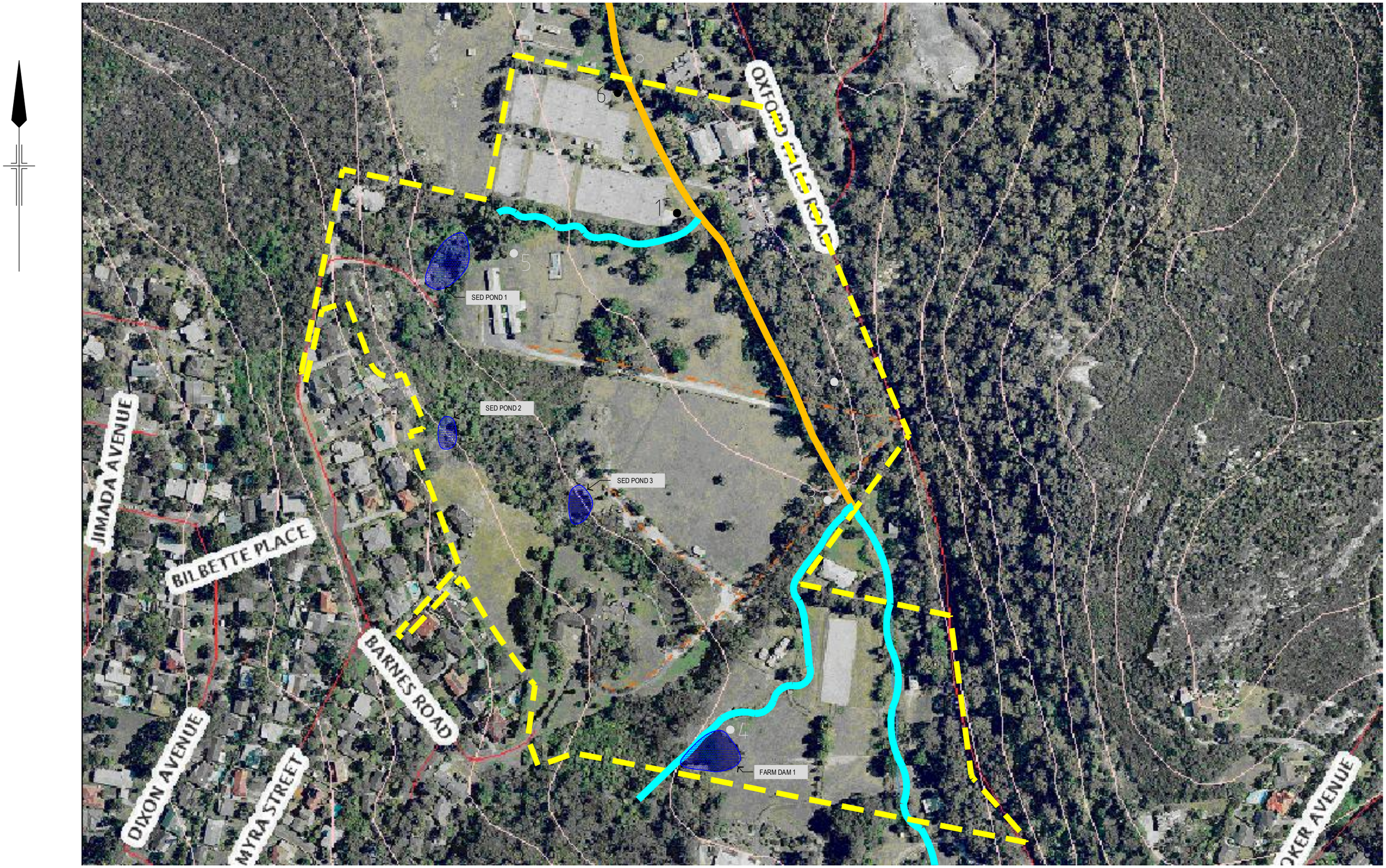
The objectives of the riparian areas assessment were to:

- Confirm the application of legislation and current policy relating to watercourses throughout the site (see Appendix A);
- Identify those watercourses on the site that fit the definition of *'a river' or 'protected waters'* for the purposes of the WMA*;*
- For those watercourses defined as *protected waters*, identify appropriate stream category and corresponding management objectives;
- Identify appropriate riparian zone widths to achieve the management objectives; and
- Develop a constraints plan for reference in developing a concept plan for the site.

1.3 Assessment Method

In order to meet the objectives of this study, the following were undertaken:

1. A desktop review which included examination of site plans, topographic maps, aerial photography and references listed in the final section of this report;
2. A site inspection to classify watercourses according to the procedures set out under the WMA (using the Strahler Classification System). GHD also referred to *Managing Urban Stormwater: Soils and Construction* (Landcom 2004) and the guidelines associated with the RFI, to complete the field assessment; and
3. Preparation of report and figures describing results and recommendations.



IST ORDER STREAM

2ND ORDER STREAM

SITE BOUNDARY

1 PHOTO POINTS

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TIFFANY DEVELOPMENTS PTY LTD
OXFORD FALLS

STRAHLER STREAM ORDER

job no. 22-14500
rev no. B

scale | 1:2500 for A3 date | JUNE 2010

Figure 01

2nd Floor, Belconnen Chambers, 59 Cameron Ave Belconnen ACT 2617 Australia **T** 61 2 6253 1999 **F** 61 2 6253 1911 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Plot Date: 09 June, 2010 - 1:30 PM Cad File No: G:\22\14500\CADD\Drawings\ 22-14500-SK100.dwg

2. Relevant Legislation

2.1 Department of Environment, Climate Change and Water (DECCW) - NSW Office of Water

The *Rivers and Foreshores Improvement Act 1948* has been repealed and the controlled activity provisions in the *Water Management Act 2000 (WMA)* commenced on the 4th February 2008. A Controlled Activity Approval (CAA) under the WMA is required for certain types of developments and activities that are carried out in or near a river, lake or estuary.

Under the WMA, a controlled activity means:

- The erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979 (EP7A Act)); or
- The removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise; or
- The deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise; or
- The carrying out of any other activity that affects the quantity or flow of water in a water source.

A CAA confers a right on its holder to carry out a specified controlled activity at a specified location in, on or under waterfront land.

For the purposes of this report, the key features of the definition of water front land under the WMA are "*The bed of any river, together with any land lying between the bed of a river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of a river*". The prescribed distance is currently 40 m.

In support of the Legislation, the DECCW has issued a number of guidelines. For purposes of this report, the relevant guidelines are:

- *Guidelines for Controlled Activities: Riparian Corridors* NSW Department of Water and Energy (DWE) 2008;;
- *Guidelines for Controlled Activities: In-stream Works.* NSW DWE 2008; and
- *Guidelines for Controlled Activities: Outlet Structures*, NSW DWE 2008.

Although issued as official Departmental guidelines, it is understood that they are advisory only and have no regulatory force.

2.2 Department of Environment, Climate Change and Water (DECCW)

DECCW is responsible for administering the *Threatened Species Conservation Act 1995* (TSC Act). The objectives of the TSC Act are to:

- Conserve biological diversity and promote ecologically sustainable development;
- To prevent the extinction and promote the recovery of threatened species, populations and ecological communities;

- To protect the critical habitat of those threatened species, populations and ecological communities that are endangered;
- To eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities;
- To ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed; and
- To encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

The TSC Act includes schedules that list threatened species, populations and ecological communities and key threatening processes. Three (3) vegetation communities were identified within the subject site through aerial photographic interpretations and extensive ground truthing (Travers Environmental, 2008 and 2010). These were identified as:

- Sandstone Woodland;
- Exotic grassland with Scattered Trees; and
- Aquatic Herbfield.

GHD has considered their conservation 'values' when designing the 'preferred riparian corridor network'.

2.3 Environment Protection and Biodiversity Conservation Act 1999

The purpose of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is to ensure that actions likely to cause a significant impact on 'matters of national environmental significance' (NES) undergo an assessment and approval process. Under the EPBC Act, an action includes a project, undertaking, development or activity. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Commonwealth Minister for the Environment, Water, Heritage and the Arts (DEWHA).

In January 2007 the Commonwealth and NSW governments signed a Bilateral Agreement which allows DEWHA to accredit the assessment regimes under Part 3A, Part 4 and Part 5 of the EP&A Act for assessment purposes under the EPBC Act. The Bilateral Agreement applies only to proposals that the Commonwealth Environment Minister has determined are controlled actions under the EPBC Act, with the exception of nuclear actions (DoP, 2007).

The EPBC Act identifies matters of national environmental significance as:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

The Administrative Guidelines for the EPBC Act (DEH, 2006) set out criteria intended to assist in determining whether an action is controlled and hence requires approval. In particular, the Guidelines contain criteria for determining whether a proposed action is likely to have a 'significant impact' on a matter of NES. Should the proponent deem the proposal likely to have a significant impact on a matter of NES, a referral to the Commonwealth Minister for the Environment would be undertaken to obtain a determination as to whether the proposal is a 'controlled action' requiring Commonwealth approval.

2.4 Other Authorities

Future consultation will also need to consider a range of other interested stakeholders. GHD envisages that consultation with the Department of Primary Industries (DPI), Sydney Water and the Sydney Metropolitan Catchment Management Authority (CMA) will be important in progressing the management strategies outlined in this riparian assessment. Further consultation with relevant stakeholders will be required as we progress through the approval process. Such consultation is outside the scope of GHD's present commission.

3. Relevant Background

3.1 Catchment Characteristics

The subject site is located within the sub catchment of Narrabeen Lagoon with Middle Creek being the main tributary. The Middle Creek tributary runs parallel to Oxford Falls Road across the subject site in a north westerly direction (referred to as drainage line S1a, S1b and T3 in Appendix A). In addition, there are two minor drainage lines within the subject site. Drainage line T1 runs in an easterly direction towards the Middle Creek tributary and is situated along the southern edge of the Australian Tennis Academy. Drainage line T2 extends for approximately 160m in a north-easterly direction towards the Middle Creek tributary. The lower reach of this drainage line runs parallel to the Barnes Road Reserve that connects to Oxford Falls Road (See Figure 2, Appendix A).

The Middle Creek tributary extends for approximately 1.5 kilometres and originates near the intersection of Iris Street and flows in a north-westerly direction parallel to Oxford Falls Road where it flows under the Wakehurst Parkway before joining Middle Creek about 150 m further west. The Middle Creek tributary exhibits variable channel characteristics along its length.

On the basis of the report compiled by Evans and Peck (2008), it appears that the current alignment of Middle Creek tributary has remained substantially the same since the early 1900s. The Middle Creek tributary is depicted on the 1:25,000 scale topographic maps for Hornsby 9130-4S (third edition 2001) and Mona Vale 9130-1S (third edition 2000), but had no tributaries joining it within or upstream of the Site.

Since this time two (2) minor drainage lines have been constructed (referred to as T1 and T2 in Figure 2, Appendix A) on site that would fit the definition of a 'river' as per the WMA. T1 is a small drainage line in the north of the site constructed using concrete culverts to divert surface water around the tennis courts with T2 being a constructed channel using sandstone rocks placed throughout to assist with erosion control. Both these channels will be removed and replaced with reconstructed drainage lines in the locations shown in Figure 2, Appendix A.

3.2 Riparian Vegetation

The following vegetation communities were identified within the riparian corridors of the subject site:

- Sandstone Woodland;
- Exotic Grassland with Scattered Trees; and
- Aquatic Herbfield.

3.2.1 Sandstone Woodland

Sandstone Woodland occurs in a number of sections of the subject site, particularly in areas that do not contain arable soil. This community is dominated by Sydney Peppermint (E*ucalyptus piperita*), Sydney Red Gum (*Angophora costata)* and Red Bloodwood (*Corymbia gummifera)* on the subject site (Travers Environmental, 2008 and 2010). .

3.2.2 Exotic Grassland with Scattered Trees

This vegetation community also occurs in areas of the subject site with arable soil. The dominant tree species are Sydney Red Gum *(Angophora costata)*, River Oak (*Casuarina cunninghamiana),* Sydney Peppermint (*Eucalyptus piperita)* and Grey Gum (*Eucalyptus punctata).*

Exotic Grassland with Scattered Trees is highly disturbed and is likely that it was previously Sandstone Woodland (Travers Environmental, 2008 and 2010).

3.2.3 Aquatic Herbfield

Aquatic Herbfield occurs alongside the tributary of Middle Creek and farm dam within Lot 1336. Dominant Native species include *Hydrocotyle peduncularis (Pennywort), Juncus usitatus (Common Rush) and Typha orientalis (Cumbungi).*

This community has a moderate to dense herbfield ranging in height from 1-2 metres, together with occasional exotic shrubs (Travers Environmental, 2008 and 2010).

3.3 Flooding

A preliminary flood study has been prepared for the site (JMD 2008). Delineation of flood extents is important for riparian zone selection and management, particularly 100 year ARI and PMF events. GHD has considered the riparian corridor and open space network to enable the 100 year ARI event to be contained within this open space. Consistency between the riparian objectives and flood risk implications must be ensured. The riparian objectives must be integrated into the setting of flood planning levels.

4. Stream Categories and Riparian Zones

4.1 Categorisation Method

GHD undertook an assessment of the site to determine stream categories and riparian corridors in accordance with the provisions of the WMA using the Strahler classification system. GHD also utilised the method set out by Landcom (2004) to help determine appropriate riparian zones. Each stream was given a label for the purposes of discussion with the results shown in Figure 1. The following characteristics were considered for each defined channel during the assessment:

- Stream geomorphology;
- Definition and size of channel;
- Riparian and in-stream vegetation;
- Flood conveyance; and
- Connectivity with the surrounding landscape.

4.1.1 Riparian Corridor Components

Riparian corridors described in the WMA include the following components and recommended land uses:

- A Core Riparian Zone (CRZ) is the land contained within and adjacent to the channel. The Department will seek to ensure that the CRZ remains, or becomes vegetated, with fully structured native vegetation (including groundcovers, shrubs and trees). The width of the CRZ from the banks of the stream is determined by assessing the importance and riparian functionality of the watercourse, merits of the site and long-term use of the land. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the CRZ.
- A Vegetated Buffer (VB) protects the environmental integrity of the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the VB. The recommended width of the VB is 10 metres.
- An Asset Protection Zone (APZ) is a requirement of the NSW Rural Fire Service and is designed to protect assets (houses, buildings, etc.) from potential bushfire damage. The APZ is measured from the asset to the outer edge of the vegetated buffer (VB). The APZ should contain cleared land that means that it can not be part of the CRZ or VB. The APZ must not result in clearing of vegetation within the CRZ or VB. Infrastructure such as roads, drainage, stormwater structures, services, etc. can be located within APZs.

4.1.2 WMA Stream Categories

The WMA identifies three stream categories, each with minimum objectives for riparian zones and differing management objectives. Widths for riparian zone are to be calculated from 'top of bank'. The following is a description of each category:

- ***1st Order Stream – Bank Stability and Water Quality*** – Riparian zone minimum width of 10m from top of each bank and generally no vegetated buffer is required. Vegetation used in restoration will be of local provenance.

- ***2nd Order Stream – Terrestrial and Aquatic Habitat*** – minimum CRZ of 20 m from the top of each bank, with a further 10m outer riparian zone (ORZ) to counter edge effects. Again, the entire riparian zone is to consist of local provenance native vegetation, with utility services, recreational activities and stormwater treatment facilities located outside the CRZ; and
- ***3rd Order Stream – Environmental Corridor*** – minimum CRZ of 20-40 m from the top of each bank, with a further 10m ORZ to counter edge effects. The entire riparian zone is to consist of local provenance native vegetation, with utility services, bushfire asset protection, recreational activities and stormwater treatment facilities located outside the CRZ.

The site at Oxford Falls contains only one 2nd order stream and 1st order streams.

4.2 Category Management Objectives

Each category of stream presents opportunities and constraints to the proposed development. In determining the final stream category, GHD considered the interaction of the stream to achieve the development's desired objectives. The management objectives that have been adopted under the WMA for 1st and 2nd order streams are listed below.

- ***1st Order Stream***:
  - Stormwater and water quality management; and
  - Bed and bank stability.
- ***2nd Order Stream***:
  - Linking 3rd order steams with pockets of existing vegetation;
  - Improve the connectivity of vegetation and drainage lines throughout the site;
  - Flood management;
  - Stormwater and water quality management; and
  - Watercourse crossings allowing for continuity of habitat.

4.3 Drainage Line Categories

All identified drainage lines, with the corresponding riparian zones and setbacks are shown in Figure 2 in Appendix A. Consultation with DECCW was required to reach agreement on the proposed stream categories and the 'preferred riparian corridor network'.

The main drainage line on the subject site (S1a and S1b) is a 2nd order stream from the confluence of T2 and T3 through to the northern boundary of the site. The remaining drainage lines are all considered 1st order streams. For purposes of this assessment, Middle Creek tributary has been considered as three separate reaches:

1. Upstream of Barnes Road Reserve (T3);

2. Barnes Road to the Australian Tennis Academy (S1a); and

3. The Australian Tennis Academy (S1b).

4.3.1 Upstream of Barnes Road Reserve (drainage line T3)

This reach of the drainage line has been classified as a 1st order stream. The width of the riparian corridor is quite narrow, and is highly degraded due to access from live stock and previous clearing.

4.3.2 Barnes Road to the Australian Tennis Academy (reach S1a)

This reach of the drainage line has been classified as a 2nd order stream from the confluence of T3 and T2. This reach is different from other reaches on the site in that it has a band of intact vegetation on the eastern side extending as far as Oxford Falls Road, a distance that varies from about 55 m to 65 m.

On the western bank, there is currently a narrow band of weed infested vegetation (particularly lantana and privet) which gives way to open grazed paddocks.

4.3.3 The Australian Tennis Academy (reach S1b)

This reach has also been categorised as a 2nd order stream. The channel form is highly modified for a distance of approximately 150 m. This section of creek has no existing riparian vegetation or habitat and includes a concrete culvert as the 'low flow' channel.

4.3.4 Drainage line T1

This drainage line has been constructed using concrete culverts to divert surface water around the existing tennis courts and is considered a 1st order stream. The riparian zone consists of exotic species and mown grasses through to some native tree species and weedy understorey as we move upstream towards sediment basin 1.

4.3.5 Drainage line T2

This is a constructed drainage line connecting an 'on line' dam through to the Middle Creek tributary and is also considered a 1st order stream. The drainage line is of earth construction with sand stone rocks used to provide erosion control. This drainage line has no exiting riparian zone and limited macrophyte/aquatic species.

5. Preferred Riparian Corridor Network

The following information describes the recommendations, agreed to by DECCW, regarding drainage lines to determine the 'preferred riparian corridor network' (PRCN) for the site. The PRCN allows for the site's environmental aspects to be *'maintained and enhanced*', manages flooding requirements and provides for suitable mixed development.

5.1 Recommendations

The following recommendations have been made to determine the PRCN and inform potential development footprint:

5.1.1 Middle Creek Tributary

- Re-align and reconstruct the Middle Creek tributary upstream of Barnes Road (shown as reach T3 on Fig 2) to 'mimic', as best as possible, an endemic stream and appropriately protect and link riparian vegetation;
- Realign and reconstruct the Middle Creek tributary downstream of the proposed access (shown as reach S1b on Figure 2) to 'mimic', as best as possible, an endemic stream and appropriately protect and link riparian vegetation;
- Revegetate and rehabilitate the riparian vegetation along the length of the Middle Creek tributary and provide a minimum CRZ of 15 m and a VB of 10 m;
- Conserve and rehabilitate the Biodiversity Zones, on the eastern side of the creek (shown in green hatching in Figure 2);
- Include an APZ of 45m (outside the CRZ) on the western side of this tributary that includes canopy and ground cover species endemic to the location plantings.

5.1.2 Drainage Line T1

- Drainage line T1 will be removed and redirected towards the northern boundary of the site;
- The channel will be reconstructed and incorporated as a Water Sensitive Urban Design (WSUD) feature. The channel will be rehabilitated with native species (canopy and groundcovers/macrophytes only) within the parameters of the APZ.

5.1.3 Drainage line T2

- Drainage line T2 will be removed and redirected towards the southern boundary of the site;
- The channel will be reconstructed and incorporated as a WSUD feature. The channel will be rehabilitated with native species (canopy and groundcovers/macrophytes only) within the parameters of the APZ.

Note: All drainage line rehabilitation works will seek to 'mimic', as best as possible, naturally occurring streams in the area.

5.1.4 Riparian Vegetation

- Retention of all remnant vegetation within the PRCN, including the Biodiversity Zones;
- Investment in condition improvement of all remnant vegetation within the PRCN; and
- Revegetation of all areas of the PRCN not covered with existing vegetation.

5.2 Justification

The proposed riparian corridor network protects and enhances the key ecological features of the site. The corridors are deliverable and can be justified as follows:

- They consider the surrounding landscape and 'build' on existing biodiversity features;
- They provide fauna/flora movements throughout the site and to the surrounding landscape;
- They protect and enhance 'high value' vegetation;
- They provide a significant increase in vegetation cover and, through time, habitat values, across the site;
- They improve environmental function, including water quality and connectivity of riparian corridors;
- They rehabilitate drainage lines constructed as 'concrete channels' to mimic naturally occurring streams;
- They allow for suitable development outcomes to be realised; and
- They provide visual amenity for the development.

6. Restoration Oxford Falls Drainage Lines – Summary Activity Descriptions

The following information summarises the proposed rehabilitation and management activities for the PRCN at Oxford Falls.

6.1 Drainage line Treatments

The development at Oxford Falls will include drainage line rehabilitation works that can be divided into two distinct treatment categories. These being:

- Total reconstruction of drainage lines (usually associated with channels that have previously been modified for drainage); and
- Rehabilitation of 'natural' channels and riparian zones containing existing vegetation.

6.2 Reconstructed Channel

6.2.1 Preparation of DTM

A digital terrain model will be prepared for each of the drainage lines being reconstructed and be included in the detailed VMP to be prepared at the Project Application stage.

6.2.2 Site Protection

To ensure the success of the restoration program it will be necessary to control access into those areas of the riparian zones being protected.

Fencing will be limited to temporary fencing to delineate construction zone for earthworks until completed.

6.2.3 Litter Removal

Small litter items need to be removed by hand prior to any restoration activities. Larger litter items will need to be assessed to ensure they do not provide a valuable source of habitat and then carefully removed with a small bobcat thereby minimising damage to existing vegetation.

6.2.4 Erosion control and Earthworks

Earth works will be required to construct the proposed channel surface as per the relevant DTM. Earth works program will also include erosion control measures as required and described below.

Hydro-mulching

Areas of exposed or re-spread topsoil will be sprayed with an appropriate hydro mulch medium. The "mixture" will include a sterile cover crop, jute fibre and a mixture of native seed. Experience has shown that using a mixture of native peas and Acacias in the hydro mulch is an inexpensive way to establish native vegetation in difficult sites. Similarly, native macrophytes can be included in hydro-mulch 'mixers' when stabilising channels.

Bed Stabilisation

The 'bed' of reconstructed channels will be stabilised using a topsoil and rock aggregate 'mix' with rock being approximately 100 mm in diameter (as an average) and associated larger rock pavements. These areas will then be hydro-mulched using a mix of native macrophytes as a sterile cover crop.

6.2.5 Revegetation Program

To rehabilitate functioning riparian vegetation on reconstructed channels, the following revegetation activities are required.

Seed Collection

Experienced and qualified seed collection staff will perform seed collection activities. All seed collection, management, cleaning and storage will be in accordance with *Florabank Seed Collection Guidelines* (prepared by Greening Australia and now accepted as industry best practice). A copy can be provided if required.

All plant material to be used throughout the project will be of local provenance, collected from within a 5 km radius of the site.

Plant Propagation

Plant propagation refers to the germinating of collected seed and the 'growing on' of plants in enviro cells, hiko cells or forestry tubes. All plants will be produced from local provenance seed. This activity should be managed by a suitably qualified and experienced native plant production nursery.

Installation of Native Tube stock

The vegetation to be restored on site will consist of appropriate mixes of canopy, mid-storey and groundcover species from the endemic vegetation community.

Most plants will be planted as hiko or enviro cells. All tree and shrub species will be suitably guarded to prevent herbivory and weed competition, and to encourage optimum growing conditions. Guards will comprise a plastic tree guard and three bamboo stakes.

In general, autumn is the best season for planting as summer temperatures can be too high for young plants to establish and frosts in winter impede survival rates. Planting in early spring can be effective as long as a suitable watering regime is implemented. All plants will be installed either by hand or by mechanical planter if site conditions permit.

Mechanical Installation

GHD recommends the use of the 'Treeliner ®' for mechanical installation. This planter does not utilise deep ripping techniques and as such causes minimal soil disturbance during the planting operation. It simply cuts a knife line through the soil, spreads the cut wide enough to insert the plant and then utilises press wheels to compact the soil around the plant. The operator on the planter also places the mats and bags along side each plant.

Suitably qualified and experienced bush regenerators will then trail behind the planter. The first member will complete the "pressing in" of the plant and place stakes at the plant. The remainder of the team co-ordinate activities to complete the bagging and staking of the plants.

Each plant will have a recycled paper disc and/or mulch around its base and then bagged using a plastic tree guard, stabilised by three bamboo stakes.

Hand Installation

Hand installation requires the planting hole to be a minimum of 25% larger than the planting container and its edges will be suitably 'roughed' prior to plant installation. The planting hole will then be backfilled with soil and firmly tamped down by hand and foot.

6.2.6 Native Seed Dispersal Techniques

Hydro-mulching

Areas of exposed or re-spread topsoil will be sprayed with an appropriate hydro-mulch medium. The "mixture" will include a sterile cover crop, jute fibre and a mixture of native seed. Experience has shown that using a mixture of native peas and Acacias in the hydro mulch is a very inexpensive way to establish native vegetation in difficult sites. Similarly, native macrophytes can be included in hydro-mulch 'mixers' when stabilising channels.

Hand Broadcasting of Native Seed

To supplement the establishment of native trees, shrubs and lower storey species, GHD recommends native grass seed is hand broadcast throughout the maintenance period of the restoration program. This will add further diversity to the site, particularly ground covers, and assist in achieving DECCW targets for planting densities in part 3A permit works when required.

6.2.7 Maintenance Program

The completion of the revegetation (planting works) and target weed control activities will be considered the date of 'Practical Completion' for the restoration works and will signal the commencement of the five year plant maintenance program. The completion of the five year maintenance program will be considered as 'Final Completion' for the revegetation works. Maintenance activities will include such things as watering, herbicide spraying and general maintenance.

Four general maintenance visits have been scheduled throughout each of the first two years of the maintenance period. During the final three years of the maintenance period, three visits per year have been scheduled.

General Maintenance

General maintenance activities will include repairing damaged tree guards, monitoring survival rates, installing replacement plants where required, weeding inside the tree guards and continued follow-up spot spraying.

Watering

All plants will be 'watered in' on installation, with each plant receiving a minimum five litres. All plantings will then receive a further three applications of water during the first 8 weeks, if required, to assist plant establishment. Should weather conditions remain dry for an extended period of time follow-up watering may be required. If so, discussion between client and contractor may be necessary to cover the cost of additional watering.

Maintenance Spraying

To ensure the success of the revegetation activities it is essential to control weed infestation. Weeds compete with the newly installed plants for nutrients and water, thereby limiting their survival and growth rates.

Areas where revegetation activities are dominated by hand-planting, spraying of Round-up® and Biactive herbicides will occur using 'back packs'. Suitably qualified contractors will carry out all spraying.

6.3 For Natural channels

Natural channel will have earthworks limited to removal of concrete debris or minor 'barriers to flow' only. The majority of works will utilise natural regeneration techniques to improve condition and distribution of native vegetation as described below.

6.3.1 Bush Regeneration and Weed Control

GHD recommends noxious weeds are treated in a targeted weed control program prior to any revegetation work and that all remaining weeds be included in the bush regeneration program. All weed control and bush regeneration activities are to be completed by a suitably qualified contractor.

6.3.2 Target Weed Control

This component of the restoration program refers to the control of listed noxious and environmental weeds such as Green Cestrum, Small-leaved Privet, Large-leaved Privet and Bridal Creeper. This program requires specialised equipment and chemicals and will be managed by appropriately trained and experienced staff. Control of these plants usually requires several treatments and is most effective during summer.

Noxious Weeds

The *Noxious Weeds Act 1993* provides for the declaration of noxious weeds in local government areas. Landowners and occupiers must control noxious weeds according to the control category specified in the Act. Appropriate treatment of noxious weeds will include Target Weed Control activities.

6.4 Monitoring and Reporting

In order to accurately evaluate the success of the restoration works, an appropriate monitoring program will be required. This program will be in accordance with DECCW guidelines associated with the WMA. Monitoring will include:

The monitoring and evaluation program should address the following issues:

- Plant growth, percentage cover and survival rates;
- Plant losses through herbivory, disease, vandalism, storm damage or other factors;
- Weed regrowth and control measures;
- Plant replacement;
- Guard repair and weeding inside guards; and
- Maintenance watering regime.

GHD recommends that the above issues be monitored and evaluated through the set-up of one representative quadrat in each of the relevant reaches being rehabilitated. It is also essential to keep an accurate photo-record of the progress of the restoration works by setting up an appropriate number of representative fixed photo-points across all restoration zones. Photos should be taken by digital camera and recorded in the project file by date and discrete photo-point number. Photo-point locations should be clearly marked on site and mapped by a surveyor or by GPS.

The monitoring reports should also contain recommendations by the restoration contractor to the client in regard to issues affecting the ongoing success, or otherwise, of the restoration works, and the possible need for additional activities that may be required outside the normal maintenance program.

7. Summary

The Oxford Falls Riparian Assessment has categorised streams (in accordance with WMA) as shown in Figure 1. The site contains two different categories of stream, 1st order and 2nd order. This information has been used to assist in determining a PRCN for the site as shown in Figure 2, Appendix A. Consultation has been undertaken with relevant staff from DECCW to agree to the PRCN and proposed rehabilitation and management program.

In summary the PRCN:

- Consider the surrounding landscape and 'build' on existing biodiversity features;
- Protects and enhances 'high value' biodiversity on site;
- Will improve, through time, environmental function across the site, particularly water quality; and
- Allows for suitable development outcomes to be realised.

8. References and Recommended Reading

ANZECC / ARMCANZ (2000), *Australian and New Zealand guidelines for fresh and marine water quality*, Department of Environment and Heritage, Canberra.

Department of Environment and Conservation (2006), *Local planning for healthy waterways using NSW Water Quality Objectives,* NSW Government, Sydney.

Department of Environment Climate Change and Water (February 2008), Guidelines for Controlled Activities under the Water Management Act 2000

Department of Planning (2005), *Metropolitan Strategy,* NSW Government, Sydney.

Evans and Peck, (October 2008), *Status of Drainage Lines – Oxford Falls*

JMD, (September 2008), *Stormwater Concept Plan – Oxford Falls*

Landcom (2004), *Managing Urban Stormwater: Soils and Construction*, 4th Edition, NSW.

NSW Government (1999), *Environmental objectives for* water *quality and river flow,* Sydney.

NSW Government (2006), *Metropolitan Water Plan*, Sydney.

Price, P., Lovett, S. & Lovett, J. (2004), *Managing riparian widths*, Fact Sheet 13, Land & Water Australia, Canberra.

Travers, J & Coombs, E. (October 2008), *Flora and Fauna Assessment – Oxford Falls*

Travers, J & Holmes, L & Mead, C. (June 2010), *Ecological Assessment – Oxford Falls Seniors Living Resort*

Appendix A

Preferred Riparian Corridor Strategy

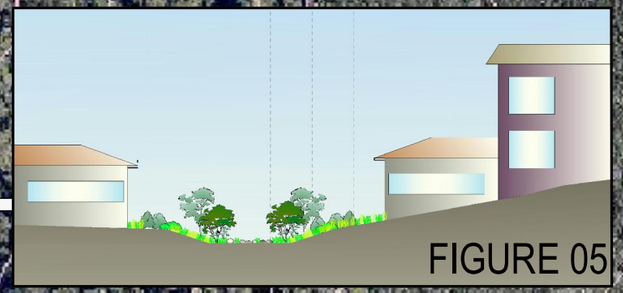
20m APZ from CRZ

EXISTING CONCRETE CHANNEL TO BE RECONSTRUCTED

Precautionary setback 5m from vegetated buffer

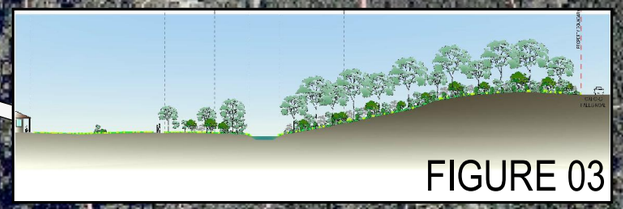
T_1

S_{1b}



SED POND 1

45m APZ from CRZ



SED POND 2

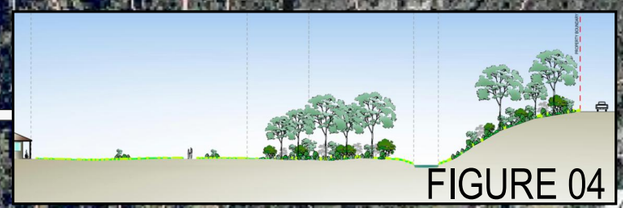
SED POND 3

16m APZ to narrow corridor of vegetation

S_{1a}

Managed Vegetation

38m APZ from CRZ



T_3

T_2

As per discussions during the site visit, the final location of T2 is yet to be determined

5m Wide precautionary setback

BILBETTE PLACE

BARNES ROAD

DIXON AVENUE

MYRA STREET

MANAGED VEGETATED BUFFER

CORE RIPARIAN ZONE. VARIABLE WIDTH

BIODIVERSITY ZONE (SUPPLEMENTARY TO CORE RIPARIAN ZONE)

RECONSTRUCTED "EPHEMERAL" STREAM

T_1 TRIBUTARY

S_1 STREAM

SITE BOUNDARY

PREFERRED CROSSING LOCATION

GHD CLIENTS | PEOPLE | PERFORMANCE

TIFFANY DEVELOPMENTS PTY LTD
OXFORD FALLS
PREFERRED RIPARIAN CORRIDOR STRATEGY

scale | 1:2500 for A3 date | JUNE 2010

job no. | 22-14500
rev no. | B

Figure 02

2nd Floor, Belconnen Chambers, 59 Cameron Ave Belconnen ACT 2617 Australia **T** 61 2 6253 1999 **F** 61 2 6253 1911 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Plot Date: 09 June, 2010 - 1:32 PM Cad File No: G:\22\14500\CADD\Drawings\ 22-14500-SK200.dwg

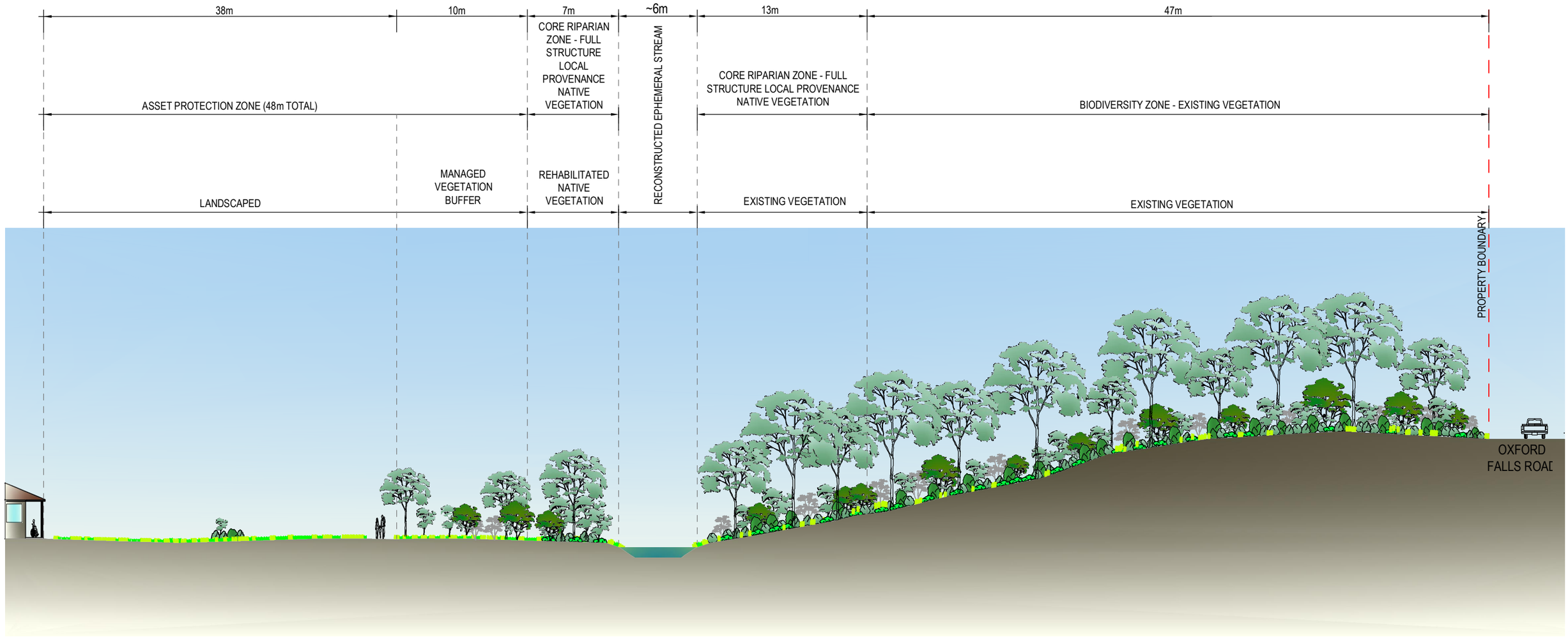
Appendix B

Indicative Cross Sections

Figure 3

Figure 4

Figure 5



PRELIMINARY

GHD CLIENTS | PEOPLE | PERFORMANCE

TIFFANY DEVELOPMENTS PTY LTD
OXFORD FALLS
SECTION A

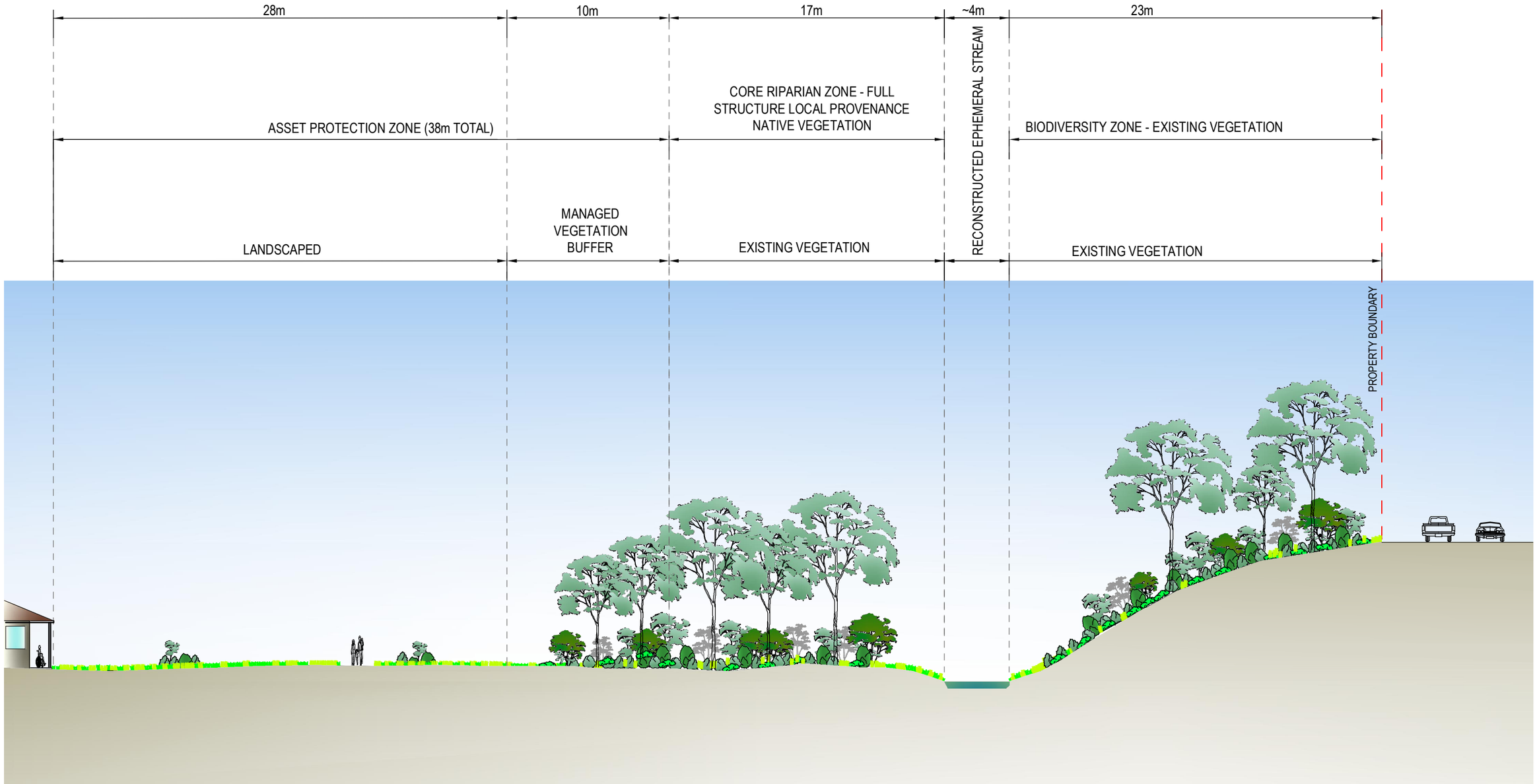
job no. | 22-14500
rev no. | B

scale | 1:300 for A3 date | JUNE 2010

Figure 03

2nd Floor, Belconnen Chambers, 59 Cameron Ave Belconnen ACT 2617 Australia **T** 61 2 6253 1999 **F** 61 2 6253 1911 **E** cbrmail@ghd.com.au **W** www.ghd.com.au

Plot Date: 09 June, 2010 - 1:34 PM Cad File No: G:\22\14500\CADD\Drawings\22-14500-SK400_SECTION_A.dwg



0 2.5 5.0 7.5m
SCALE 1:250 AT ORIGINAL SIZE

PRELIMINARY

GHD CLIENTS | PEOPLE | PERFORMANCE

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TIFFANY DEVELOPMENTS PTY LTD
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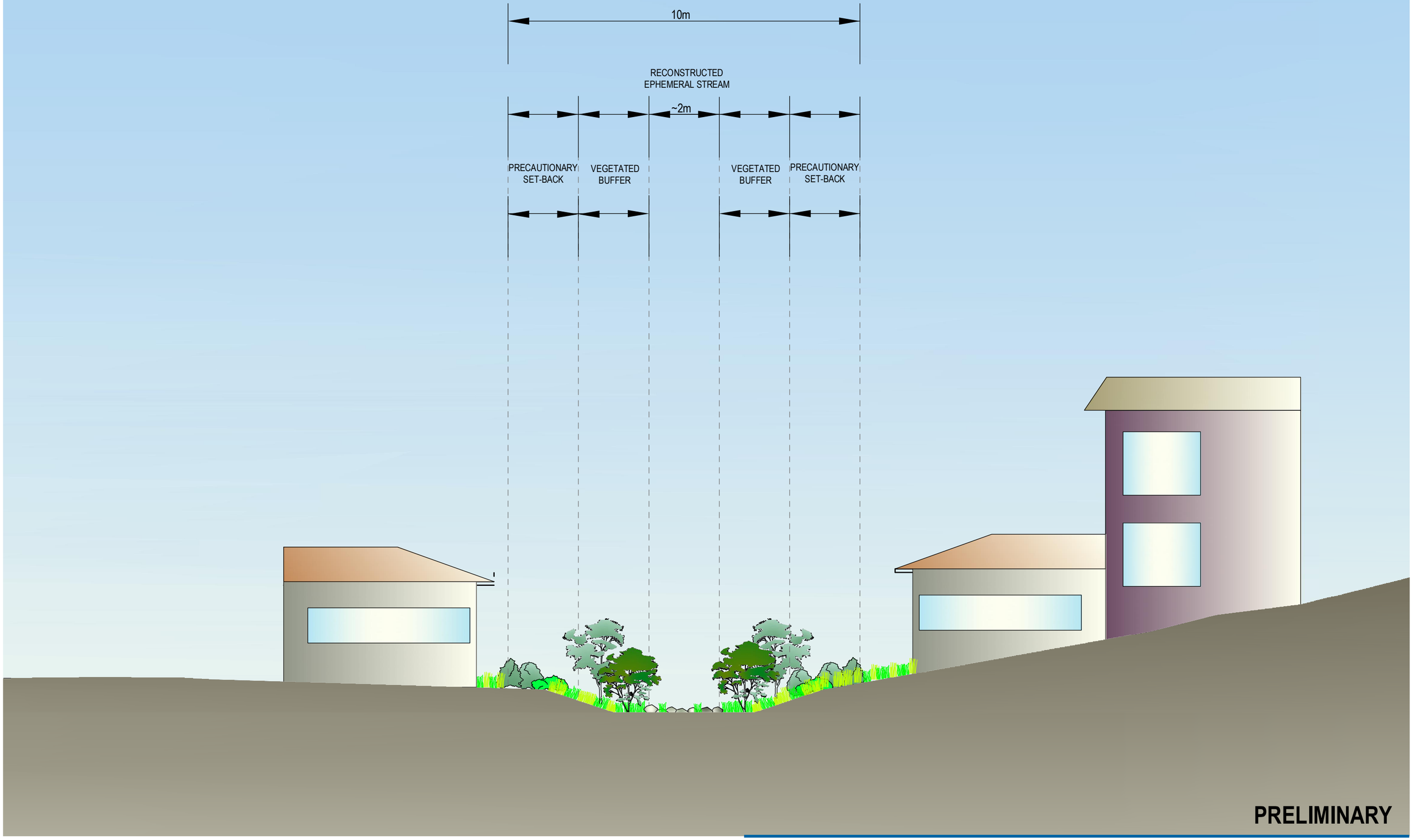
scale | 1:250 for A3 date | JUNE 2010

Figure 04

Plot Date: 09 June, 2010 - 1:36 PM Cad File No: G:\22\14500\CADD\Drawings\ 22-14500-SK300_SECTION_B.dwg



PRELIMINARY

0 1 2 3m
SCALE 1:100 AT ORIGINAL SIZE

GHD CLIENTS | PEOPLE | PERFORMANCE

TIFFANY DEVELOPMENTS PTY LTD
OXFORD FALLS
SECTION C

job no. | 22-14500
rev no. | B

scale | 1:100 for A3 date | JUNE 2010

Figure 05

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Plot Date: 09 June, 2010 - 1:39 PM Cad File No: G:\22\14500\CADD\Drawings\22-14500-SK500_SECTION_C.dwg

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PO Box 2875 Port Macquarie NSW 2444
T: (02) 6586 8700 F: (02) 6586 8701 E: pqqmail@ghd.com.au

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Document Status

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		Name	Signature	Name	Signature	Date
A	L Gallagher	D Williams	*D Williams*	P Parker	*P Parker*	07/04/2010
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