

Overview

What

This guide explains what you need to do when building a stormwater connection into Sydney Water's natural open channel waterways in the Rouse Hill Development Area (RHDA). We allow stormwater connections that ensure:

- stable transition from a constructed drainage system to the natural waterway
- sustainable water quality management
- restoration of vegetation following construction.

Who

This guide applies to owners and developers proposing to build a stormwater pipe connecting to a waterway owned or managed by Sydney Water in the RHDA. This applies to connection proposals for residential, commercial, industrial and other government agencies (e.g. Roads and Maritime Services) developments.

Why

Construction of stormwater connections to natural waterways affects the waterway and the riparian corridor. This guide ensures that owners and developers design and construct stormwater connections to a safe and sustainable standard by:

- minimising the number of uncontrolled stormwater discharges
- ensuring new stormwater connections cause minimal environmental impact to the waterway and its water quality
- restoring and maintaining disturbed waterfront and riparian vegetation following construction activities.

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1. Introduction

Building a stormwater connection to natural waterways affects both the waterway and riparian corridor. Before construction can commence, you need to design a suitable connection point, considering the:

- type of development
- quality of stormwater discharge
- outlet headwall.

You must renew any existing land and vegetation that may be affected by the work, to restore the integrity of the riparian corridor.

This guide helps ensure that stormwater connections to a Sydney Water natural waterway are designed and constructed to a safe and sustainable standard.

2. Approval requirements

Connecting to any waterway

To construct a stormwater connection to **any natural waterway**, you need approval from the NSW Office of Water, as this is considered a 'controlled activity' under the *Water Management Act 2000*.

To gain approval from NSW Office of Water, you must meet their requirements, including:

- [Guidelines for outlet structures on waterfront land](#)
- [Guidelines for vegetation management plans on waterfront land](#)
- [Guidelines for riparian corridors and waterfront land](#)

Before disturbing any land within 200 metres of **any natural waterway**, you also need to consider Aboriginal heritage matters in accordance with Part 6 of the *National Parks and Wildlife Act 1974*. Additional due diligence assessments and/or permits from the Office of Environment and Heritage may be required. This is required if Aboriginal objects will be or are likely to be harmed by any activity associated with the proposed connection works.

Connecting to a Sydney Water waterway

To construct a stormwater connection to a **Sydney Water owned natural waterway**, you also need approval from Sydney Water. This guide specifically addresses our additional requirements. It supplements NSW Office of Water guidelines by providing more detail for stormwater connections within the Rouse Hill Development Area. It does not replace them.

To gain our approval for your stormwater connection, lodge your application through a Water Servicing Coordinator.

The application must demonstrate that the proposed stormwater connection meets our design requirements (see Section 3). Once we are satisfied with the design, you may start construction. We will issue a Compliance Certificate once construction is complete and the land is appropriately restored (see Section 4).

For submission requirements, please refer to Section 0.

If you need to enter Sydney Water land to inspect or do work, you must get permission from our Land and Waterways team. Make your enquiries to stormwater@sydneywater.com.au.

All costs involved in design, construction and approvals are the responsibility of the person proposing the development, unless otherwise agreed.

3. Stormwater connection design

Point of connection

The owner or developer wanting to connect their stormwater drainage system to the natural waterway must contact the local council and Sydney Water to check if there are existing connection points available. If there is an existing council stormwater connection and the new line can practically connect to it, then you must use the existing connection.

If a stormwater connection does not currently exist or is not available, you must liaise with council and Sydney Water to agree on a connection point. You must prepare a broad catchment plan to identify the most ideal locations to connect to the natural waterway. The plan must consider the:

- land contours
- location of road infrastructure
- intended land use.

The proposed connection must be able to effectively service both the intended development and other future developments within the adjacent and/ or upstream area, and must not hinder overall future land management.

Drainage system

Our requirements for the drainage system vary depending on the type of development it is intended to support.

Requirements for residential subdivisions - single and dual occupancy lots

- You must minimise the number of discharge points in the drainage system, for example a single combined large outlet rather than multiple smaller outlets.
- Pipe dimensions must be between 600 mm and 1,350 mm depending on what is appropriate to the broad catchment plan and land use of surrounding developments.
- You must allow for a future Gross Pollution Trap (GPT) to be installed later, upstream of the pipe outlet to protect the health of the waterway.
 - The GPT must be outside of the riparian vegetation corridor and have safe, low impact access for vehicles.
 - The preferred invert level drop from the inflow pipe to the outlet flow through the GPT is 600 mm (with a minimum of 300 mm).
 - The preferred invert level drop from the outlet pipe to the normal level of the waterway is 450 mm on a 1.0% grade (with a minimum of 200 mm on a 0.5% grade).

Requirements for all other developments

- Stormwater run-off from the site must be of appropriate quality and quantity before it enters the natural waterway. Sites must establish their own stormwater quality improvement device(s) that meets the following specified water quality outcomes:

Pollutant	Pollutant load reduction objective (%) ¹
Gross pollutants (>5 mm)	90
Total suspended solids	85
Total phosphorus	65
Total nitrogen	45

- You must register the private infrastructure and its importance on the land title. This ensures the current or future land owner services the installed stormwater quality improvement device(s) and does not remove, alter or impede its function. We will provide a formal agreement under the *Conveyancing Act 1919*, which sets out the ongoing responsibilities of the land owner.

Outlet headwall

The pipe outlet headwall must meet our requirements to ensure the output flow does not adversely impact the waterway and the headwall is safe and stable (see Section 5 – Design drawings, for more information).

Design and position

- Outlet angle is to be no greater than 30 degrees in the direction of the channel flow.
- Setback of the end of the pipe must be:
 - at least three times the bank height from the toe of the bank on the **same** side of the channel
 - at least 10 times the pipe diameter from the toe of the bank on the **opposite** side of the channel, if there is only one pipe
 - at least 13 times the largest pipe diameter from the toe of the bank on the **opposite** side of the channel, if there are multiple pipes.
- The cover over the pipe must be a minimum of 300 mm.
- A maximum of one metre of the pipe can be exposed.
- Place the headwall so as to avoid vertical drops of over 900 mm.
- For locations where the vertical fall is greater than 900 mm and where rock batters are steeper than 1H:1V, you must install monowills balltube fencing with band and knee rails.

Material composition

- The headwall foundation must sit on a geotextile fabric of Bidim A44 or approved equivalent.
- There must be a 100 mm thick layer of coarse granular material, such as crushed recycled terracotta 10–40 mm Ø (not blue metal) on the geotextile fabric.

¹ Pollutant removal design criteria adopted from *Western Sydney Growth Centres – Stormwater Guidance For Precinct Planning* (Prepared by DEC Nov 2006)

- Stacked rock rip rap is to be a mixture of hard sandstone rocks to fill voids during placement. It should be made up of:
 - 70% large rocks of regular dimension suitable for neat interlocking stacks (typically 200 kg to 500 kg and 0.75–1.2 m x 0.5 m x 0.25–0.45 m)
 - 15% medium rocks (typically the size of a soccer ball)
 - 15% small rocks (typically the size of a closed fist)
 - hand-compacted growing medium for voids less than 200 mm Ø. This should not be over compacted.
- All rock batters steeper than 2H:1V require to be rock armoured.
- All non-rock batters are to be no steeper than 3H:1V.

Asset ownership

Once construction is completed to Sydney Water's specifications, details of ownership and maintenance are as follows:

- The serviced property owner or council is responsible for newly constructed pipelines (including all concrete structures) and stormwater quality improvement devices up until the point of discharge (once the developer has formally handed over the asset).
- Sydney Water will maintain the condition of the rock head wall.
- Sydney Water will maintain the condition of the rock rip rap.
- Sydney Water will maintain headwall fences.

4. Land and vegetation restoration

Sydney Water owns and manages land within the riparian corridor surrounding its natural waterways. Stormwater connections affect this land, so you must rehabilitate the vegetation to restore the integrity of the riparian corridor². There are specific requirements to manage the vegetation.

Soil and earthworks

- You must stockpile excavated soil from works as separate layers to use in site restoration later (refer to Section 5: Soil horizons – Montage):
 - Top soil – about 300 mm
 - Sub-soil – about 700 mm
 - C-horizon (clay/shale/sandstone) – remainder.
- Return the layers of soil, in the same order as you excavated them. There will likely be extra soil, due to the space taken up by the new pipe. Only soil from the C-horizon should be removed from the site.
- Do not import soil into the trunk drainage corridor.
- Top soil must be free of large debris or contaminants. Spread it evenly to match the natural surface level.
- Use coconut matting (or similar products) to stabilise the topsoil.

Revegetation

Revegetation must be appropriate to the site's native ecological communities. Native ecological communities within the RHDA include:

- Cumberland Plain Woodlands (CPW)
- River-Flat Eucalyptus Forest on Coastal Floodplains (RFEFCF)
- Shale Sandstone Transitional Forests (SSTF)
- Swamp Oak Floodplain Forest (SWFF)

To determine the ecological communities that are native to your site, email the Land and Waterways team at stormwater@sydneywater.com.au.

Revegetation also depends on where it is within the riparian corridor – toe, middle or upper zones. Please see Section 5 - Appropriate revegetation – plan and section elevation, for more information.

Species selection and the required density of ground, mid-storey and canopy cover is determined using the tables in Section 6 – Prescribed vegetation tables.

To support long-term vegetation growth:

- remove weeds or exotic grass (eg kikuyu or other turf varieties) with appropriate herbicide
- manually remove perennial weeds
- spread clean mulch around the areas of revegetation to reduce weed infestation

² Subject to appropriate approvals / assessments as stated in Section 2

- install plant guards in areas where the new vegetation will be susceptible to weed intrusion
- apply fertilizer and soil conditioning material (eg pellets), considering the topsoil condition and soil fertility.

Bushfire protection measures

The NSW Rural Fire Service (RFS) require building set back distances – Asset Protection Zones (APZ) – wholly within all development properties on bushfire prone land. APZ requirements are outlined in the RFS document [Planning for Bush Fire Protection 2006](#).

If you cannot provide a full APZ because of 'acceptable exceptional circumstances' (detailed in the [Planning for Bush Fire Protection 2006](#)), RFS may require additional protection measures. An APZ is always the responsibility of the landowner.

Sydney Water maintains Hazard Reduction Zones (HRZ) on the adjoining trunk drainage corridor. HRZs reduce bushfire risk to adjoining properties, by creating a buffer zone in a fuel reduced state. An **HRZ is not a substitute to an APZ** requirement from the RFS and does not absolve the developer's responsibility to implement an APZ within their own development boundary.

If there is an HRZ in a Sydney Water trunk drainage corridor, we will advise you how wide it is, as it may vary depending on the site parameters. Revegetation species are restricted within the HRZ – see Section 6 for a table of prescribed species for revegetation.

Maintenance

After landscaping and establishment, you must maintain the works for the next 12 months to ensure native plants survive and grow. This includes watering, if there is inadequate rain, fixing damaged or dead plants and managing weeds.

You will need to contact Sydney Water to gain access to sites.

Inspections and final handover

The developer or its contractor must organise a site inspection with a Sydney Water representative when restoration work is complete, and at the end of the mandatory maintenance period. If we are satisfied with the work, we will issue a Compliance Certificate.

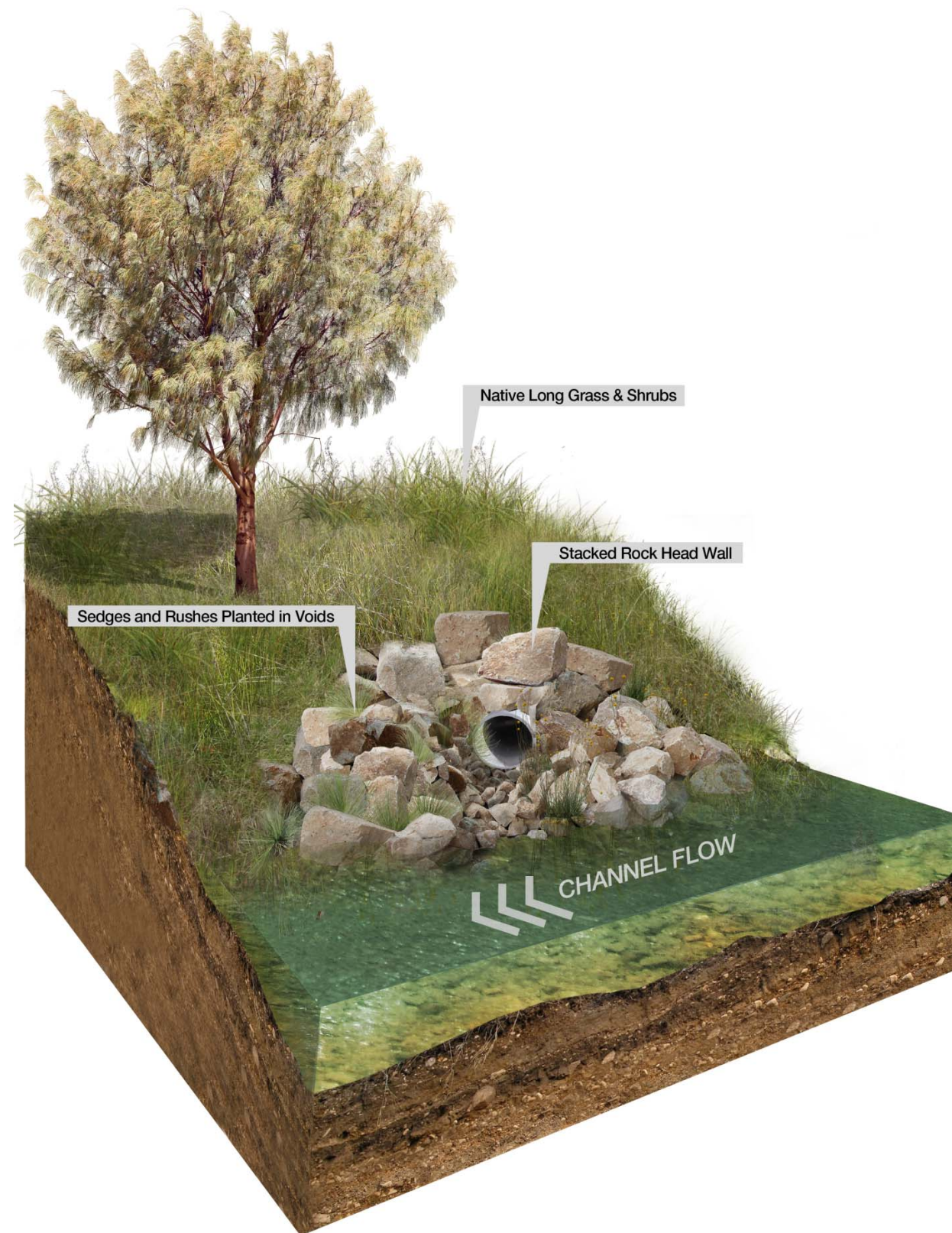
5. Submission requirements

You must submit the following documents.

- **A CAD plan and long-section** clearly showing (as per Section 3):
 - o connection up to the waterway/basin
 - o disturbed area (cross-hatched) and quantified (m²)
 - o compliance with stormwater connection design requirements (pipe dimensions, invert level drops, grades)
 - o compliance with outlet headwall design (e.g. material composition) and positioning (e.g. setback, angle)
- **Vegetation Management Plan** clearly stating (as per Section 4):
 - o how soil works will be conducted – demonstrating understanding of requirements set out in guideline
 - o which plants will be used, at what densities and at what locations (plan required to indicate toe, middle and upper regions)
 - o who will be maintaining the re-vegetated areas for 12 months – providing a quote by a subcontractor for the re-vegetation work and maintenance costs

6. Design drawings

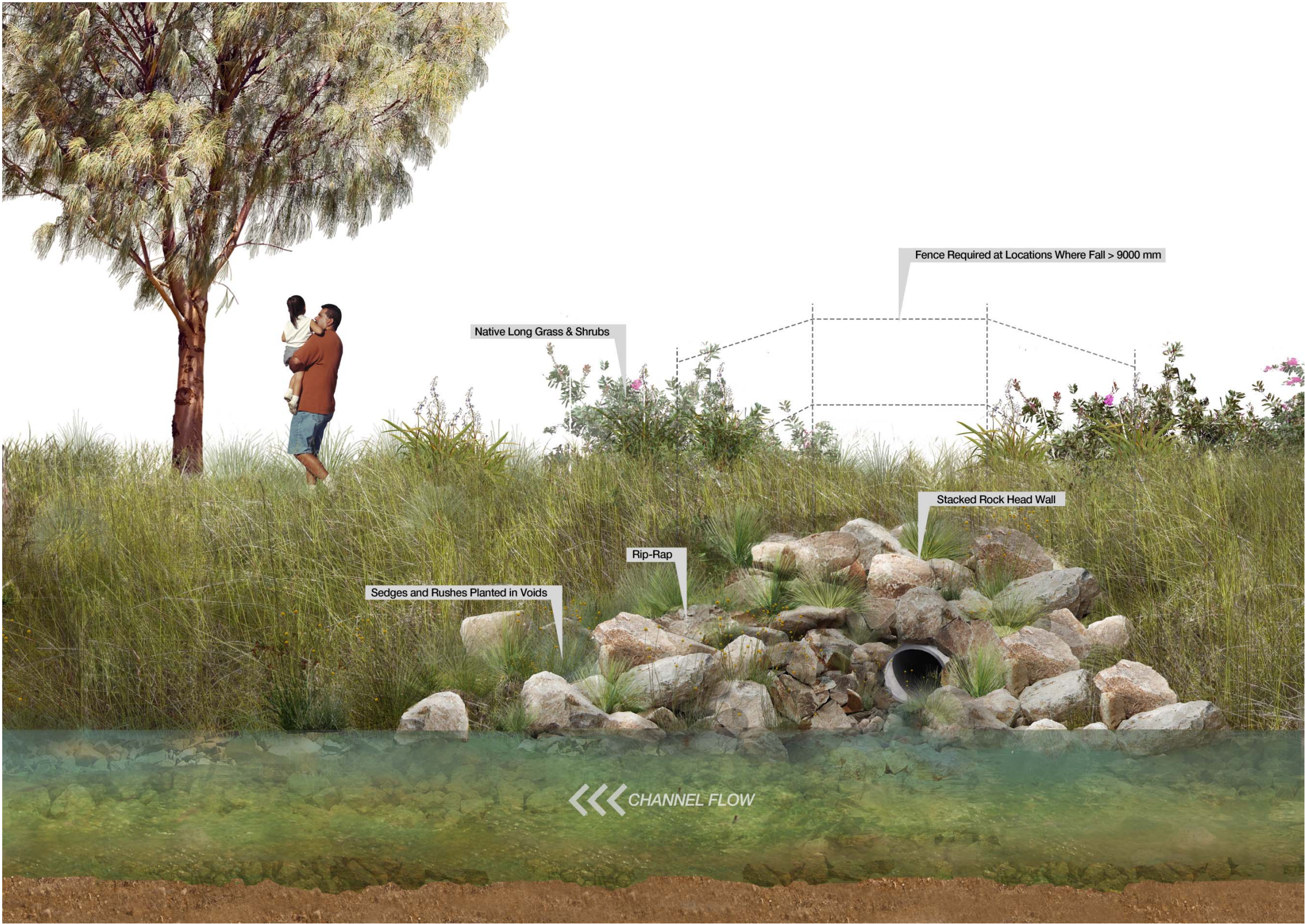
Headwall setback from creek channel – montage



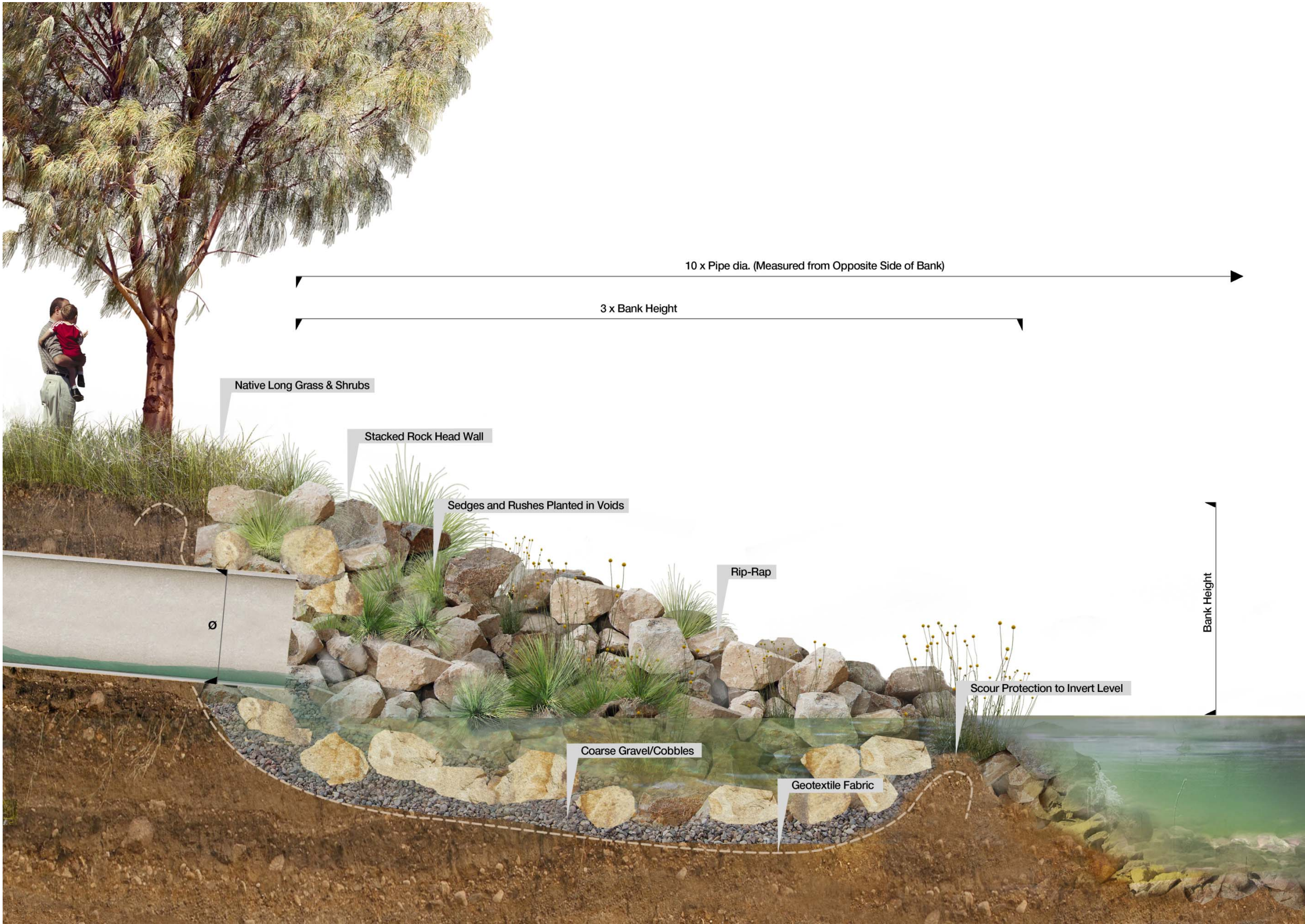
Headwall setback from creek channel – plan



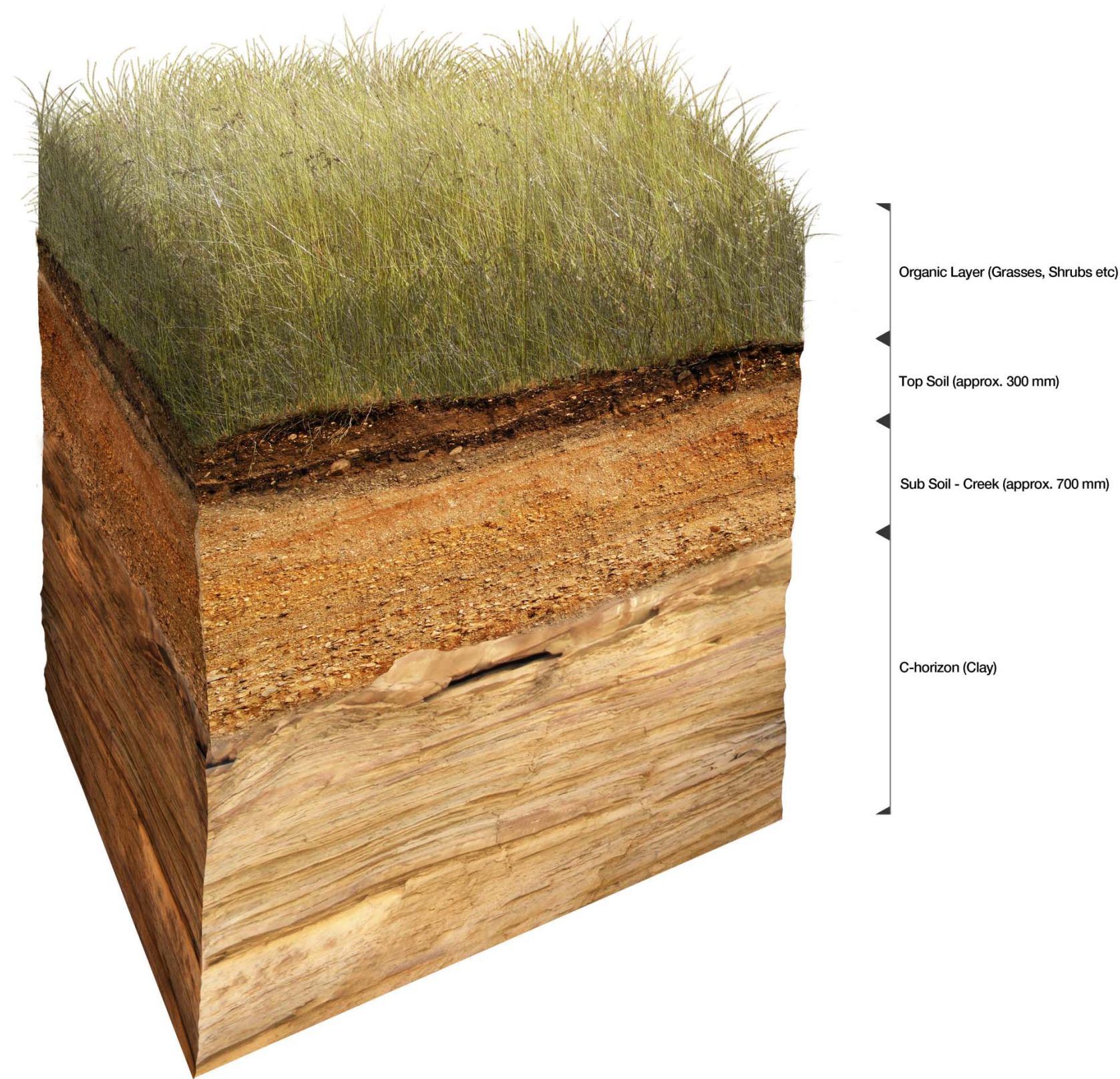
Headwall setback from creek channel – elevation



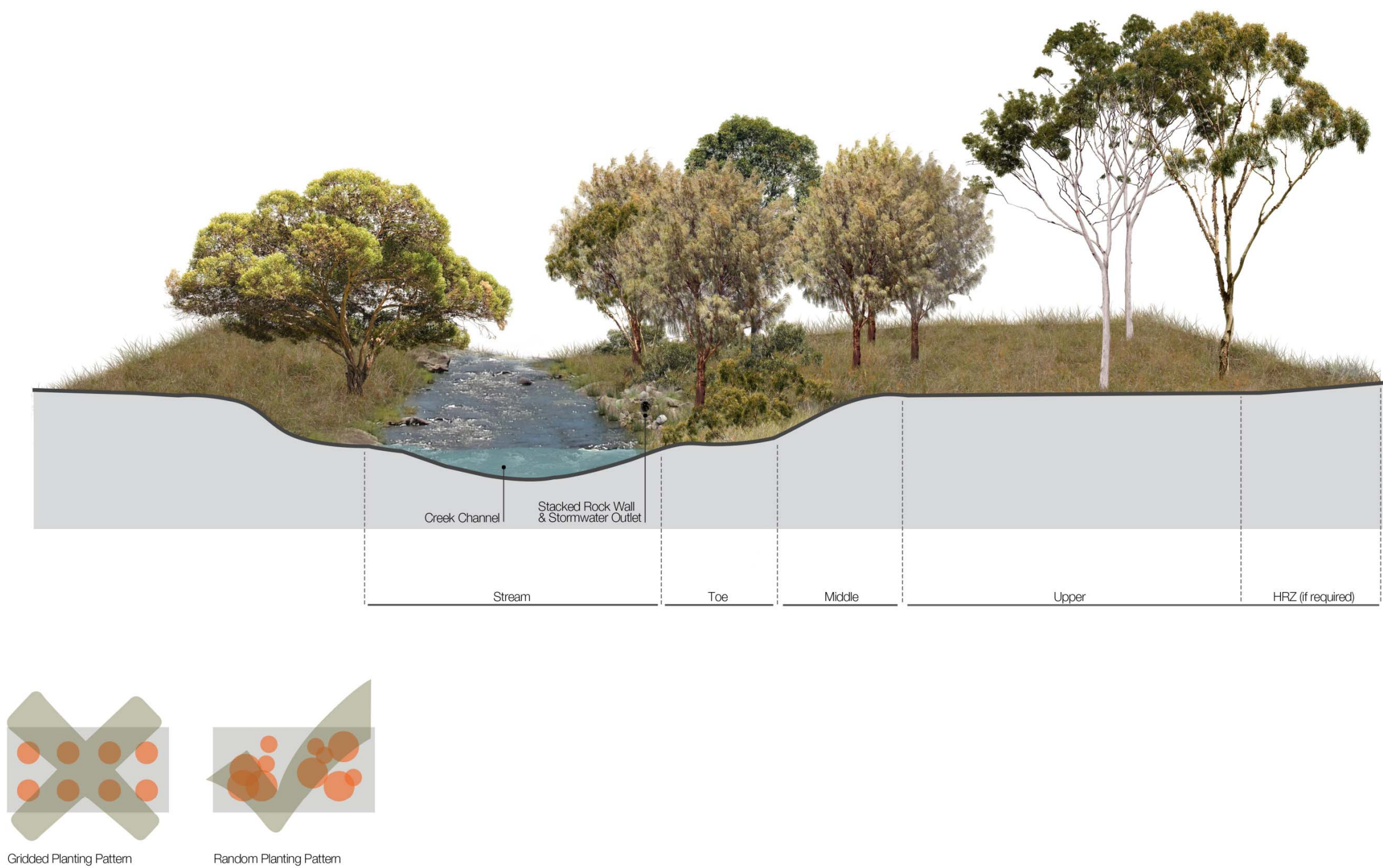
Headwall setback from creek channel – section



Soil horizons – montage



Appropriate revegetation – plan and section elevation



7. Prescribed vegetation tables

Cumberland Plain Woodland (CPW)

CPW	Toe		Middle		Upper		HRZ	
Type of cover	Species	Density	Species	Density	Species	Density	Species	Density
Canopy	Nil	N/A	Eucalyptus crebra Eucalyptus eugenoides Eucalyptus tereticornis Eucalyptus punctata Acacia implexa	1 per 50 m ²	Eucalyptus crebra Eucalyptus eugenoides Eucalyptus tereticornis Eucalyptus punctata Acacia implexa	1 per 10 m ²	Eucalyptus crebra Eucalyptus eugenoides Eucalyptus tereticornis Eucalyptus punctata Acacia implexa	1 per 100 m ²
Mid-storey	Acacia implexa Bursaria spinulosa Indigofera australis	1 per 10 m ²	Acacia implexa Bursaria spinulosa Daviesia ulicifolia Dillwynia sieberi Indigofera australis Exocarpus cupressiformis Pultenaea microphylla	1 per 10 m ²	Acacia implexa Bursaria spinulosa Daviesia ulicifolia Dillwynia sieberi Indigofera australis Exocarpus cupressiformis Pultenaea microphylla	1 per 10 m ²	Daviesia ulicifolia Dillwynia sieberi Indigofera australis Pultenaea microphylla	1 per 10 m ²
Low & ground	Ajuga australis Aristida ramosa Arthropodium milleflorum Asperula conferta Austrodanthonia tenuior Bossiaea prostrata Brachycome multifida Carex inversa Centella asiatica Chorizema parviflorum Chrysocephalum apiculatum Commelina cyanea Cymbopogon refractus Dianella longifolia Dichondra repens Dodonia viscosa subsp. cuneata Einadia hastata Geranium solanderi var. solanderi Glycine clandestina Goodenia hederacea subsp. hederacea Hardenbergia violacea Hypericum gramineum Juncus usitatus Lomandra filiformis subsp. filiformis Microlaena stipoides var. stipoides Plectranthus parviflorus Poa labillardieri var. labillardieri Ranunculus lappaceus Stackhousia viminea Themeda australis Wahlenbergia gracilis	5 per m ²	Ajuga australis Aristida ramosa Arthropodium milleflorum Asperula conferta Austrodanthonia tenuior Bossiaea prostrata Brachycome multifida Carex inversa Centella asiatica Chrysocephalum apiculatum Clematis glycinoides var. glycinoides Commelina cyanea Cymbopogon refractus Dianella longifolia Dichondra repens Dodonia viscosa subsp. cuneata Einadia hastata Geranium solanderi var. solanderi Glycine clandestina Goodenia hederacea subsp. hederacea Hardenbergia violacea Hypericum gramineum Juncus usitatus Lomandra filiformis subsp. filiformis Microlaena stipoides var. stipoides Plectranthus parviflorus Poa labillardieri var. labillardieri Ranunculus lappaceus Stackhousia viminea Themeda australis Wahlenbergia gracilis	4 per m ²	Ajuga australis Aristida ramosa Arthropodium milleflorum Asperula conferta Austrodanthonia tenuior Bossiaea prostrata Brachycome multifida Carex inversa Centella asiatica Chrysocephalum apiculatum Clematis glycinoides var. glycinoides Commelina cyanea Cymbopogon refractus Dianella longifolia Dichondra repens Dodonia viscosa subsp. cuneata Einadia hastata Geranium solanderi var. solanderi Glycine clandestina Goodenia hederacea subsp. hederacea Hardenbergia violacea Hypericum gramineum Juncus usitatus Lomandra filiformis subsp. filiformis Microlaena stipoides var. stipoides Plectranthus parviflorus Poa labillardieri var. labillardieri Ranunculus lappaceus Stackhousia viminea Themeda australis Wahlenbergia gracilis	3 per m ²	Ajuga australis Aristida ramosa Arthropodium milleflorum Asperula conferta Austrodanthonia tenuior Bossiaea prostrata Brachycome multifida Carex inversa Centella asiatica Chrysocephalum apiculatum Clematis glycinoides var. glycinoides Commelina cyanea Cymbopogon refractus Dianella longifolia Dichondra repens Dodonia viscosa subsp. cuneata Einadia hastata Geranium solanderi var. solanderi Glycine clandestina Goodenia hederacea subsp. hederacea Hardenbergia violacea Hypericum gramineum Juncus usitatus Lomandra filiformis subsp. filiformis Microlaena stipoides var. stipoides Plectranthus parviflorus Poa labillardieri var. labillardieri Ranunculus lappaceus Stackhousia viminea Themeda australis Wahlenbergia gracilis	3 per m ²

River-Flat Eucalyptus Forest on Coastal Floodplains (RFEFCF)

RFEFCF	Toe		Middle		Upper		HRZ	
Type of cover	Species	Density	Species	Density	Species	Density	Species	Density
Canopy	Nil	N/A	Angophora floribunda Angophora subvelutina Eucalyptus amplifolia Eucalyptus baueriana Eucalyptus botryoides Eucalyptus moluccana Eucalyptus tereticornis Acmena smithii Casuarina cunninghamiana subsp. cunninghamiana Casuarina glauca Melaleuca decora Melaleuca styphelioides Tristaniopsis laurina	1 per 50 m ²	Angophora floribunda Angophora subvelutina Eucalyptus amplifolia Eucalyptus baueriana Eucalyptus botryoides Eucalyptus moluccana Eucalyptus tereticornis Acmena smithii Casuarina cunninghamiana subsp. cunninghamiana Casuarina glauca Melaleuca decora Melaleuca styphelioides Tristaniopsis laurina	1 per 10 m ²	Angophora floribunda Angophora subvelutina Eucalyptus amplifolia Eucalyptus baueriana Eucalyptus botryoides Eucalyptus moluccana Eucalyptus tereticornis Acmena smithii Casuarina cunninghamiana subsp. cunninghamiana Casuarina glauca Melaleuca decora Melaleuca styphelioides Tristaniopsis laurina	1 per 100 m ²
Mid-storey	Nil	N/A	Acacia floribunda Acacia parramattensis Backhousia myrtifolia Breynia oblongifolia Bursaria spinosa Melaleuca linariifolia Ozothamnus diosmifolius	1 per 10 m ²	Acacia floribunda Acacia parramattensis Backhousia myrtifolia Breynia oblongifolia Bursaria spinosa Melaleuca linariifolia Ozothamnus diosmifolius	1 per 10 m ²	Breynia oblongifolia Melaleuca linariifolia Ozothamnus diosmifolius	1 per 10 m ²
Low & Ground	Adiantum aethiopicum Alisma plantago-aquatica Aristida vagans Bolboschoenus caldwellii Centella asiatica Centipeda cunninghamii Commelina cyanea Cymbopogon refractus Cyperus trinervis Dichelachne micrantha Dichondra repens Doodia aspera Einadia hastata Geranium solanderi Hardenbergia violacea Helichrysum diosmifolius Hydrocotyle peduncularis Imperata cylindrica var. major Lomandra filiformis Lomandra longifolia Lomandra multiflora subsp. multiflora Microlaena stipoides var. stipoides Pandorea pandorana Pteridium esculentum Viola hederacea Wahlenbergia gracilis	5 per m ²	Aristida vagans Centella asiatica Centipeda cunninghamii Clematis aristata Commelina cyanea Cymbopogon refractus Dichelachne micrantha Dichondra repens Digitaria parviflora Doodia aspera Einadia hastata Geranium solanderi Glycine clandestina Hardenbergia violacea Helichrysum diosmifolius Hydrocotyle peduncularis Imperata cylindrica var. major Lomandra filiformis Lomandra longifolia Lomandra multiflora subsp. multiflora Microlaena stipoides var. stipoides Pandorea pandorana Themeda australis Viola hederacea Wahlenbergia gracilis	4 per m ²	Aristida vagans Centella asiatica Centipeda cunninghamii Clematis aristata Commelina cyanea Cymbopogon refractus Dichelachne micrantha Dichondra repens Digitaria parviflora Doodia aspera Einadia hastata Geranium solanderi Glycine clandestina Hardenbergia violacea Helichrysum diosmifolius Hydrocotyle peduncularis Imperata cylindrica var. major Lomandra filiformis Lomandra longifolia Lomandra multiflora subsp. multiflora Microlaena stipoides var. stipoides Pandorea pandorana Themeda australis Viola hederacea Wahlenbergia gracilis	3 per m ²	Aristida vagans Centella asiatica Centipeda cunninghamii Clematis aristata Commelina cyanea Cymbopogon refractus Dichelachne micrantha Dichondra repens Digitaria parviflora Doodia aspera Einadia hastata Geranium solanderi Glycine clandestina Hardenbergia violacea Helichrysum diosmifolius Hydrocotyle peduncularis Imperata cylindrica var. major Lomandra filiformis Lomandra longifolia Lomandra multiflora subsp. multiflora Microlaena stipoides var. stipoides Pandorea pandorana Themeda australis Viola hederacea Wahlenbergia gracilis	3 per m ²

Shale-Sandstone Transition Forest (SSTF)

SSTF	Toe		Middle		Upper		HRZ	
Type of cover	Species	Density	Species	Density	Species	Density	Species	Density
Canopy	Nil	N/A	Acacia implexa Allocasuarina littoralis Allocasuarina torulosa Angophora bakeri Angophora costata Angophora floribunda Corymbia gummifera Eucalyptus crebra Eucalyptus eugenioides Eucalyptus fibrosa	1 per 50 m ²	Acacia implexa Allocasuarina littoralis Allocasuarina torulosa Angophora bakeri Angophora costata Angophora floribunda Corymbia gummifera Eucalyptus crebra Eucalyptus eugenioides Eucalyptus fibrosa	1 per 10 m ²	Acacia implexa Allocasuarina littoralis Allocasuarina torulosa Angophora bakeri Angophora costata Angophora floribunda Corymbia gummifera Eucalyptus crebra Eucalyptus eugenioides Eucalyptus fibrosa	1 per 100 m ²
Mid-storey	Nil	N/A	Acacia falcata Banksia spinulosa Bossiaea obcordata Breynia oblongifolia Bursaria spinosa Calytrix tetragona Daviesia ulicifolia Exocarpos cupressiformis Grevillea mucronulata Hakea sericea Hibbertia obtusifolia Indigofera australis Kunzea ambigua Leptospermum trinervium Melaleuca thymifolia Ozothamnus diosmifolius Persoonia linearis Pimelea linifolia Pultenaea flexilis	1 per 10 m ²	Acacia falcata Banksia spinulosa Bossiaea obcordata Breynia oblongifolia Bursaria spinosa Calytrix tetragona Daviesia ulicifolia Dodonaea triquetra Exocarpos cupressiformis Grevillea mucronulata Hakea sericea Hibbertia obtusifolia Indigofera australis Kunzea ambigua Melaleuca thymifolia Ozothamnus diosmifolius Persoonia linearis Pimelea linifolia Pultenaea flexilis	1 per 10 m ²	Baeckea virgata Bossiaea obcordata Breynia oblongifolia Calytrix tetragona Daviesia ulicifolia Dillwynia phyllicoides Dodonaea triquetra Grevillea mucronulata Hibbertia obtusifolia Indigofera australis Leucopogon lanceolatus Melaleuca thymifolia Ozothamnus diosmifolius Persoonia linearis Pimelea linifolia Pultenaea flexilis Pultenaea villosa	1 per 10 m ²
Low & Ground	Aristida vagans Bossiaea prostrata Brunoniella australis Cymbopogon refractus Dianella revoluta var. revoluta Dichondra repens Echinopogon caespitosus var. caespitosus Einadia hastata Gompholobium grandiflorum Lepidosperma laterale Lomandra longifolia Lomandra multiflora subsp. multiflora Microlaena stipoides Poa labillardieri Poa sieberiana Pomax umbellata Scaevola aemula Themeda australis	5 per m ²	Aristida vagans Bossiaea prostrata Brunoniella australis Cymbopogon refractus Dianella revoluta var. revoluta Dichondra repens Echinopogon caespitosus var. caespitosus Einadia hastata Gompholobium grandiflorum Hardenbergia violacea Lepidosperma laterale Lomandra longifolia Microlaena stipoides Poa labillardieri Poa sieberiana Pomax umbellata Scaevola aemula Themeda australis	4 per m ²	Aristida vagans Bossiaea prostrata Brunoniella australis Cymbopogon refractus Dianella revoluta var. revoluta Dichondra repens Echinopogon caespitosus var. caespitosus Einadia hastata Gompholobium grandiflorum Hardenbergia violacea Lepidosperma laterale Lomandra longifolia Microlaena stipoides Poa labillardieri Poa sieberiana Pomax umbellata Scaevola aemula Themeda australis	3 per m ²	Aristida vagans Bossiaea prostrata Brunoniella australis Cymbopogon refractus Dianella revoluta var. revoluta Dichondra repens Echinopogon caespitosus var. caespitosus Einadia hastata Gompholobium grandiflorum Hardenbergia violacea Lepidosperma laterale Lomandra longifolia Microlaena stipoides Poa labillardieri Poa sieberiana Pomax umbellata Scaevola aemula Themeda australis	3 per m ²

Sydney Turpentine Ironbark Forest (STIF)

STIF	Toe		Middle		Upper		HRZ	
Type of cover	Species	Density	Species	Density	Species	Density	Species	Density
Canopy	Nil	N/A	Angophora costata Angophora floribunda Corymbia gummifera Eucalyptus globoidea Eucalyptus resinifera Eucalyptus paniculata Syncarpia glomulifer	1 per 50 m ²	Angophora costata Angophora floribunda Corymbia gummifera Eucalyptus globoidea Eucalyptus resinifera Eucalyptus paniculata Syncarpia glomulifer	1 per 10 m ²	Angophora costata Angophora floribunda Corymbia gummifera Eucalyptus globoidea Eucalyptus resinifera Eucalyptus paniculata Syncarpia glomulifer	1 per 100 m ²
Mid-storey	Nil	N/A	Acacia longifolia Acacia parramattensis Allocasuarina torulosa Breynia oblongifolia Bursaria spinosa Daviesia ulicifolia Elaeocarpus reticulatus Exocarpos cupressiformis Indigofera australis Kunzea ambigua Leucopogon juniperinus Ozothamnus diosmifolius Polyscias sambucifolius Rapanea variabilis Zieria smithii	1 per 10 m ²	Acacia longifolia Acacia parramattensis Allocasuarina torulosa Breynia oblongifolia Bursaria spinosa Daviesia ulicifolia Elaeocarpus reticulatus Exocarpos cupressiformis Indigofera australis Kunzea ambigua Leucopogon juniperinus Ozothamnus diosmifolius Polyscias sambucifolius Rapanea variabilis Zieria smithii	1 per 10 m ²	Breynia oblongifolia Daviesia ulicifolia Dodonaea triquetra Indigofera australis Leucopogon juniperinus Ozothamnus diosmifolius Polyscias sambucifolius Rapanea variabilis Zieria smithii	1 per 10 m ²
Low & Ground	Aristida vagans Arthropodium milleflorum Centella asiatica Commelina cyanea Dianella caerulea Dianella longifolia Dichondra repens Echinopogon caespitosus Glycine clandestina Imperata cylindrica Lepidosperma laterale Lomandra longifolia Lomandra multiflora subsp. multiflora Microlaena stipoides Panicum simile Poa affinis	5 per m ²	Aristida vagans Arthropodium milleflorum Billardiera scandens Clematis aristata Commelina cyanea Dianella caerulea Dichondra repens Echinopogon caespitosus Glycine clandestina Hardenbergia violacea Hibbertia dentata Imperata cylindrica Kennedia rubicunda Lepidosperma laterale Lomandra longifolia Microlaena stipoides Pandorea pandorana Poa affinis Pomax umbellata Smilax glycyphylla Themeda australis	4 per m ²	Aristida vagans Arthropodium milleflorum Billardiera scandens Clematis aristata Commelina cyanea Dianella caerulea Dichondra repens Echinopogon caespitosus Glycine clandestina Hardenbergia violacea Hibbertia dentata Imperata cylindrica Kennedia rubicunda Lepidosperma laterale Lomandra longifolia Microlaena stipoides Pandorea pandorana Poa affinis Pomax umbellata Smilax glycyphylla Themeda australis	3 per m ²	Aristida vagans Arthropodium milleflorum Billardiera scandens Clematis aristata Commelina cyanea Dianella caerulea Dichondra repens Echinopogon caespitosus Glycine clandestina Hardenbergia violacea Hibbertia dentata Imperata cylindrica Kennedia rubicunda Lepidosperma laterale Lomandra longifolia Microlaena stipoides Pandorea pandorana Poa affinis Pomax umbellata Smilax glycyphylla Themeda australis	3 per m ²

Swamp-Oak Floodplain Forest (SOFF)

SOFF	Toe		Middle		Upper		HRZ	
Type of cover	Species	Density	Species	Density	Species	Density	Species	Density
Canopy	Nil	N/A	Casuarina glauca Acmena smithii Alphitonia excelsa Callistemon salignus Melaleuca styphelioides	1 per 50 m ²	Casuarina glauca Acmena smithii Alphitonia excelsa Callistemon salignus Melaleuca styphelioides	1 per 10 m ²	Acmena smithii Alphitonia excelsa	1 per 100 m ²
Mid-storey	Nil	N/A	Glochidion ferdinandi Melaleuca ericifolia Melaleuca quinquenervia Melaleuca styphelioides Myoporum acuminatum	1 per 10 m ²	Glochidion ferdinandi Melaleuca ericifolia Melaleuca quinquenervia Melaleuca styphelioides Myoporum acuminatum	1 per 10 m ²	Glochidion ferdinandi Melaleuca ericifolia Melaleuca quinquenervia Melaleuca styphelioides Myoporum acuminatum	1 per 10 m ²
Low & Ground	Alternanthera denticulata Baumea juncea Blechnum indicum Carex appressa Centella asiatica Commelina cyanea Dianella caerulea Entolasia marginata Gahnia clarkei Hypolepis muelleri Imperata cylindrica Isolepis inundata Juncus planifolius Juncus usitatus Lobelia alata Lomandra longifolia Oplismenus imbecillis Persicaria decipiens Persicaria strigosa Viola banksii	5 per m ²	Blechnum indicum Carex appressa Centella asiatica Commelina cyanea Dianella caerulea Entolasia marginata Gahnia clarkei Hypolepis muelleri Imperata cylindrica Juncus planifolius Juncus usitatus Lobelia alata Lomandra longifolia Oplismenus imbecillis Parsonsia straminea Smilax australis Stephania japonica Viola banksii	4 per m ²	Blechnum indicum Carex appressa Centella asiatica Commelina cyanea Dianella caerulea Entolasia marginata Gahnia clarkei Hypolepis muelleri Imperata cylindrica Juncus planifolius Juncus usitatus Lobelia alata Lomandra longifolia Oplismenus imbecillis Parsonsia straminea Smilax australis Stephania japonica Viola banksii	3 per m ²	Blechnum indicum Carex appressa Centella asiatica Commelina cyanea Dianella caerulea Entolasia marginata Gahnia clarkei Hypolepis muelleri Imperata cylindrica Juncus planifolius Juncus usitatus Lobelia alata Oplismenus imbecillis Parsonsia straminea Smilax australis Stephania japonica Viola banksii	3 per m ²

References

NSW National Parks and Wildlife Services, 2002. *The Native Vegetation of the Cumberland Plain*. NSW National Parks and Wildlife Service, Hurstville.

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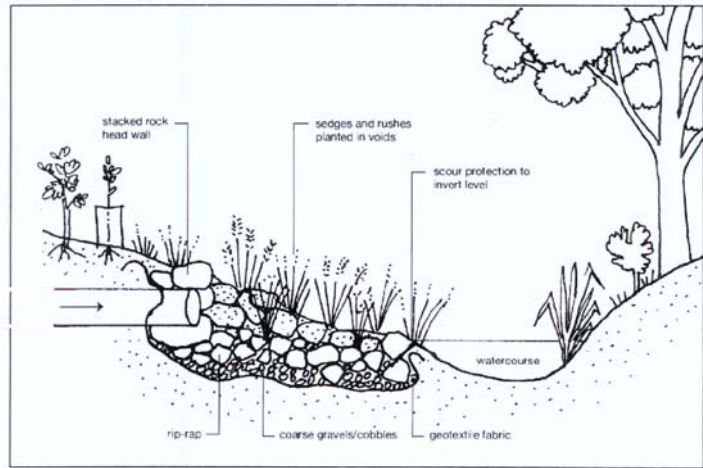
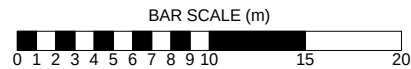
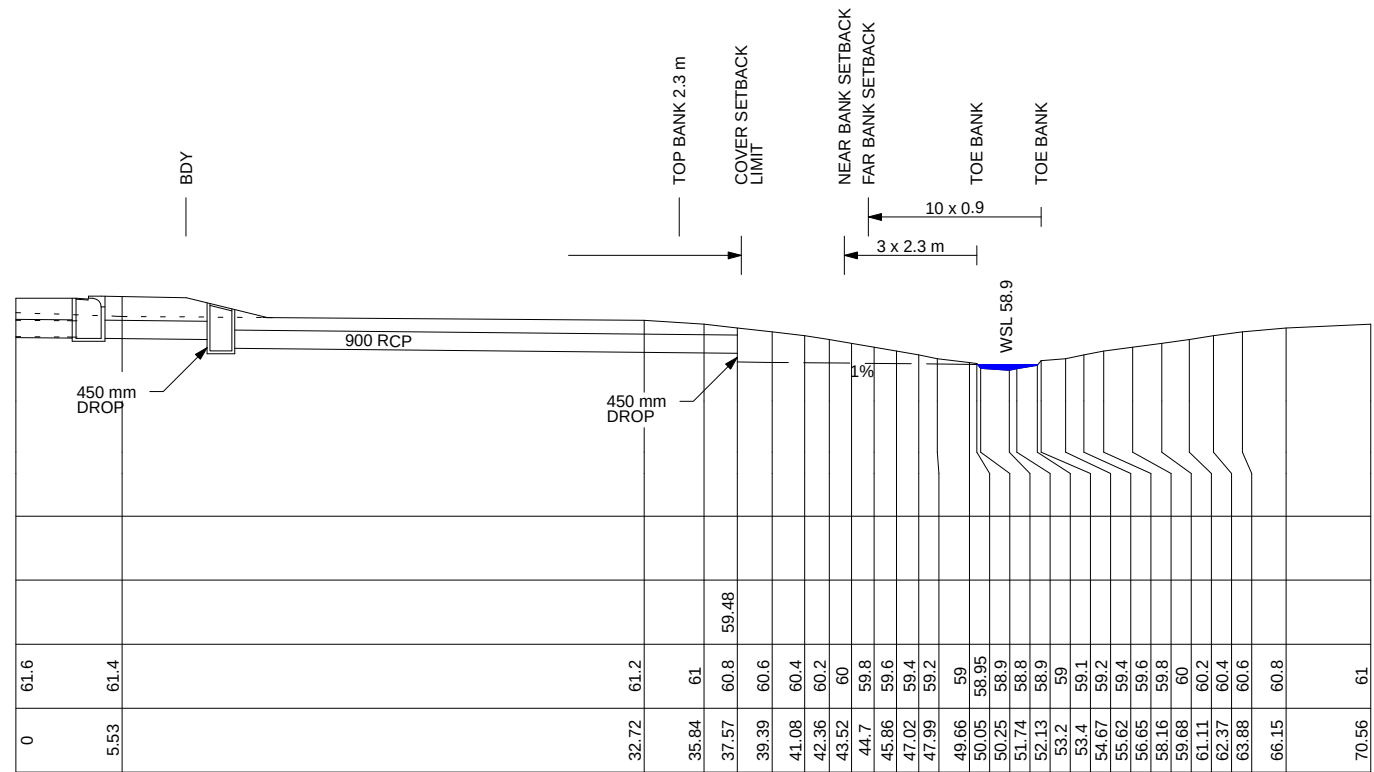
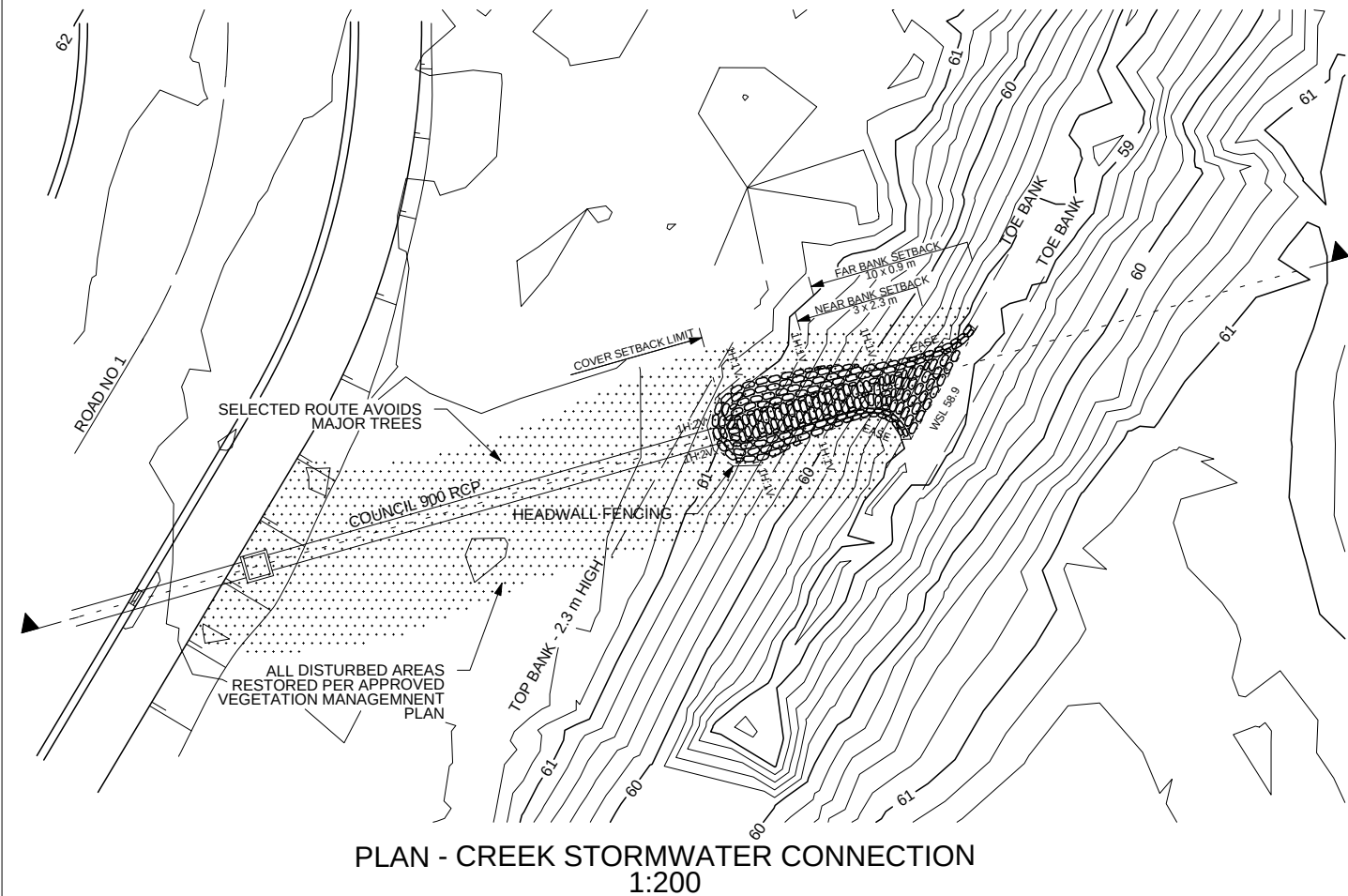
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Natural Asset Operation Manager list assembled from site visits and contractors monthly reports.

8. Definitions

Term	Definition
Broad catchment plan	Mapping of the area showing various land features that will affect direction of run-off – this will determine the most ideal location for connection
Controlled activities	Developments and activities that are carried out in or near a river, lake or estuary (as defined by the Water Management Act 2000)
Natural waterway	A course of water carrying the flow of a river, lake or estuary
Riparian corridor	The transition zone between the land and waterway (as defined by NSW Office of Water)
Trunk drainage corridor	The boundary of Sydney Water ownership for the natural waterway



LONGSECTION - CREEK STORMWATER CONNECTION
NOT TO SCALE

DESIGN	CONSIDERATION	CRITERIA
HEADWALL LOCATION	LOCATE THE HEADWALL CLOSE TO THE CREEK BUT NOT TOO CLOSE	COVER OVER PIPE 450 mm DESIRABLE MINIMUM 300 mm CONSTRAINED MINIMUM
	TO KEEP THE DISTURBANCE TO THE RIPARIAN CORRIDOR VEGETATION AND ROCK COVERAGE FOOTPRINT AS SMALL AS POSSIBLE	SETBACK FROM CREEK NEAR BANK 3x THE BANK HEIGHT
	TO MAKE SMOOTH BATTER TRANSITIONS TO THE EXISTING GROUND AND BANK LEVELS	SETBACK FROM FAR BANK 10x PIPE DIAMETER (SINGLE PIPE) 13x PIPE DIAMETER (LARGEST OF MULTIPLE)
	TO REDUCE FLOW TURBULENCE AGAINST THE OPPOSING CREEK BANK	
INVERT LEVEL	THE PIPE INVERT LEVEL IS ABOVE THE WATER LEVEL IN THE CREEK	VERTICAL DROP FROM PIPE INVERT TO WATER LEVEL 1.0% GRADE PLUS 450 mm DESIRABLE 0.5% GRADE PLUS 200 mm MINIMUM
	TO MAKE IT LESS LIKELY FOR THE PIPE TO BECOME BLOCKED WITH SILT OVER TIME - ESPECIALLY FOR SMALLER PIPES LESS THAN 600 mm DIAMETER	VERTICAL DROP AT LOCATION OF FUTURE GPT 600 mm DESIRABLE 300 mm MINIMUM
ENTRY ANGLE	THE PIPELINE POINTS DOWNSTREAM	30 DEGREES PREFERRED ANGLE 45 DEGREES ACCEPTABLE ANGLE
	TO ASSIST THE FLOW ENTRY AND REDUCE TURBULENCE AGAINST THE BANKS	CONSIDER ADDITIONAL ROCK ARMOURING OF OPPOSITE BANK FOR HIGHER ANGLES APPROACHING 90 DEGREES
INSPECTION	CONSIDERATION	CRITERIA
GEOFABRIC	PLACE HEAVY DUTY GEOFABRIC OVER EXCAVATED EARTH FACES	BIDIM A44 OR APPROVED EQUIVALENT OVER ALL CUT EARTH FACES UNDER THE ROCKS
	TO PROTECT THE EARTH FROM FLOWING WATER	
COARSE GRAVEL	PLACE A LAYER OF COARSE GRANULAR MATERIAL OVER THE GEOFABRIC	PLACE 100 mm THICK LAYER OF COARSE GRANULAR MATERIAL OVER THE GEOFABRIC
	TO PROTECT THE GEOFABRIC FROM TEARING AND TWISTING DURING THE PLACEMENT OF LARGE ROCKS AND HOLD THE GEOFABRIC EVENLY AGAINST THE EARTH FACE	USE INERT 'LOW ENVIRONMENTAL IMPACT' MATERIAL SUCH AS CRUSHED RECYCLED TERRA COTTA (10 mm – 40 mm) DO NOT USE NATURAL RIVER STONE, BLUE METAL OR SIMILAR
ROCK FOR HEADWALL	INSTALL A NEAT INTERLOCKING HEADWALL MATRIX OF HARD SANDSTONE ROCKS	PROVIDE MIXTURE HARD SANDSTONE ROCK SIZES – BY VOLUME - APPROXIMATELY 70% LARGE - GENERALLY TOO BIG FOR TWO STRONG PEOPLE TO LIFT TYPICALLY 200 kg – 500 kg - REGULAR SHAPE ABOUT 1.20 m - 0.75 m x 0.50 m x 0.45 m - 0.25 m - APPROXIMATELY 15% MEDIUM - ABOUT 'SOCCER BALL' SIZE - APPROXIMATELY 15% SMALL - ABOUT 'CLOSED FIST' SIZE
	TO HOLD DOWN THE END PIPE SECURELY AND RETAIN THE EARTH ABOUT THE PIPE	ROCK BATTERS UP TO 1H:2V STEEP ACCEPTABLE A MAXIMUM OF 1 m OF THE TOP OF THE PIPE CAN BE EXPOSED
ROCK FOR BED AND SIDE BATTERS	INSTALL A NEAT INTERLOCKING MATRIX OF HARD SANDSTONE ROCKS OVER THE CHANNEL BATTERS AND BASE SMOOTHLY BETWEEN THE PIPE INVERT TO THE WATER LEVEL IN THE CREEK	PROVIDE MIXTURE HARD SANDSTONE ROCK SIZES A HIGHER PROPORTION OF MEDIUM AND SMALL SIZED ROCKS ACCEPTABLE
	TO SPREAD WATER FLOWS ENTERING THE CREEK AND SUPPORT AND PROTECT THE CHANNEL SIDE BATTERS	MINIMUM 50% LARGE ROCKS REQUIRED ALL BATTERS STEEPER THAN 2H:1V TO BE ROCK ARMoured ALL NON ROCK BATTERS TO BE NO STEEPER THAN 3H:1V AND REVEGETATED
ROCKS CONNECT WITH THE WATER IN CREEK	THE ROCK CHANNEL EXTENDS INTO THE LOW WATER IN THE CREEK	ROCK TO EXTEND TO A MINIMUM 200 mm BELOW THE CREEK (LOW) WATER LEVEL
	TO CUSHION WATER ENTERING THE CREEK AND REDUCE EROSION	
SOIL AND VEGETATION	PLACE SOIL INTO THE ROCK MATRIX	USE STOCKPILED LOCAL SOIL STRIPPED DURING THE PIPELINE CONSTRUCTION
	TO SUPPORT VEGETATION PLANTINGS	IF ADDITIONAL SOIL REQUIRED TO BE IMPORTED MUST COMPLY WITH AS 4419 FILL ROCK VOIDS WITH TOPSOIL FOR PLANTINGS INSTALL TOPSOIL ON ALL EARTH BATTERS FOR PLANTING AND PROTECT WITH JUTE MATTING REFER SEPARATE APPROVED VEGETATION MANAGEMENT PLAN FOR PLANTING AND REHABILITATION REQUIREMENTS
FENCING	INSTALL FENCING TO STEEP BATTER AREAS	INSTALL MONOWILLS BALLTUBE FENCING WITH HAND AND KNEE RAILS OR APPROVED EQUIVALENT
	TO REDUCE FALL HAZARD	ALONG ROCK BATTERS STEEPER THAN 1 H:1V

REVISION	REVISION DESCRIPTION	DATE
1	ORIGINAL ISSUE	JULY 2014

Sydney
WATER

SYDNEY WATER CORPORATION

STANDARD DRAWINGS FOR
STORMWATER CONNECTIONS

STORMWATER CONNECTIONS TO
NATURAL WATERWAYS

SCALE AS SHOWN

STW-1108