- Winning clay, gravel, rock, sand, stone or other materials.
- Laundering, repairing, servicing or washing any article, machinery, or vehicle.
- On site work on a building, works or land.
- Any process of testing or analysis.
- Loading or storing goods used in industrial operations or resulting from i.
- Storing foods on site for service or sale.

Lot developers are to provide the following structural measures to provide barriers between potential pollutants and receiving waters:

- Where possible covering industrial activities to prevent rain coming into contact with chemicals and potential pollutants.
- Where unfeasible to locate within a covered area, areas of industrial activity must be drained to an evaporation basin or sump suitably sized or configured to prevent overtopping during storms.
- Draining internal areas to sewer subject to Hunter Water Corporation's trade waste requirements.
- Bunding liquid chemical storage areas.

Performance Targets and Compliance

Industrial activities are to pose low risk of soil contamination and pollutants entering receiving waters.

5.4 SITE MANAGEMENT

Stormwater pollutants are best managed by preventing their generation through general housekeeping, spill management and effective material handling practices.

Developers shall be obliged to establish a Stormwater Management Plan (SMP) for each site as part of their development application. The SMP must address at a minimum:

- Materials selection and identification:
- Materials handling
- Materials storage
- Cleaning, wash down and maintenance
- Storing and disposing of wastes
- Emergencies and spill response plans
- Staff and contractor training.

Performance Targets

Industrial activities are to pose low risk of soil contamination and pollutants entering receiving waters.

5.5 POTABLE WATER CONSERVATION AND WASTE WATER GENERATION

There is no legislation in NSW governing potable water demand reduction in commercial and industrial sectors. New residential development in eastern NSW is required to meet reductions in potable water demand (compared to baseline conditions), and this is also considered a reasonable target for industry.

The following objectives will apply to the HEZ::

- Reduction in potable water consumption.
- Harvesting rainwater and urban stormwater runoff for use where appropriate.
- Reduction in wastewater discharge.
- To capture, treat and reuse wastewater where appropriate.
- To ensure infrastructure design is complementary to current and future water use.

Performance Targets and Compliance

Industrial lots must meet minimum water conservation ratings as defined by the Water Efficiency Labelling and Standards (WELS) Scheme. Minimum WELS ratings for water fittings in these buildings are 3 star toilets, 3 star showerheads, 4 star taps and 3 star urinals. Water efficient washing machines and dishwashers should also be used wherever possible.

At a minimum, industrial lot occupants shall achieve an average daily rainwater/stormwater reuse rate of 15 kL/d/Ha of site developed. Where this re-use rate cannot be achieved the excess water must be either offset by or supplied to another industrial lot occupant.

5.6 STORMWATER QUALITY

TSS, TP and TN are common pollutants in stormwater, which are all associated with increased loads after urban development.

Receiving water quality objectives are typically specified in terms of desired pollutant concentration. For example, the ANZECC (2000) Guidelines define concentration-based water quality criteria for receiving waters. ANZECC (2000, p.3.3-2) recommends that load based guidelines be developed for nutrients, biodegradable organic matter and suspended particulate matter (TSS). This is in recognition of the importance of the mass (or load) of these pollutants in terms of their impact on aquatic ecosystem health. In particular, loads of TSS, TP and TN influence nuisance aquatic plant growth and TSS impedes light penetration and smothers benthic habitats. Treatment systems designed to remove TSS, TP and TN will also remove significant loads of heavy metals, hydrocarbons, and other important stormwater pollutants.

Therefore best practice load based objectives have been adopted for defining stormwater quality treatment requirements from development at HEZ. Accordingly, the mean annual pollutant loads generated from an un-mitigated development are to be reduced by at least the percentage reduction rates prescribed in the design objectives (see below). This form of design objective for stormwater quality management is consistent with the current load based design objectives adopted in South East Queensland, Victoria and NSW and is consistent with the recommendations of Australian Runoff Quality (Engineers Australia 2006) and ANZECC (2000, p.3.3- 2).

Pollution control targets proposed at the HEZ have been adopted by the Growth Centres Commission for development in Sydney’s north west and south west growth centres and represent current best practice stormwater management. While these targets are more stringent in the control of sediment and phosphorous, they achieve the same nitrogen reduction which is often the critical nutrient in sizing treatment facilities. It is expected that they will become the new industry benchmark across the state and will be adopted by other authorities including the DECC in the near future. Attainment of the pollution control targets for both private and public areas is likely to be through the use treatment trains which may include:

- Swales and bioretention pods
- Bioretention with pre-treatment from sedimentation areas.

- GPTs and wetlands.

Details on swale, bioretention and wetland treatment elements are presented in Appendix 1.

Performance Targets and Compliance

Treatment trains are to achieve the following stormwater pollutant reductions prior to discharge to receiving waters:

- 85% retention of total suspended solids (TSS) loads from roads and lots.
- 65% retention of total phosphorus (TP) loads from roads and lots.
- 45% retention of total nitrogen (TN) loads from roads and lots
- Retention of litter greater than 50 mm for flows up to the 3-month event
- No hydrocarbons or oils to be visible in flows leaving sites up to the 3 month peak flow

These targets are more stringent in the control of sediment and phosphorous than those commonly adopted across NSW and represent best practice stormwater management targets as specified by the DECC.

Street scale bioretention cells are to be sized at 1.0 % of the road catchment area. An additional 0.5% of the upstream area is to be designated as a grassed swale to assist with concentrate sediment deposition outside of the bioretention system to reduce management requirements.

Site developers must demonstrate that site design incorporates either or a combination of:

- Bioretention areas accounting for 1.5% percent of impervious catchment areas comprising hardstand areas and car parking; and
- Wetlands with sedimentation basins and macrophyte zones accounting for no less than 1.5% and 4% percent of impervious catchment areas respectively.

Allowance for ponding depth can be calculated from sizing curves presented in HEZ Stormwater Quality and Hydrologic Modelling Report (EDAW, 2007).

GPTs are to be used where sites discharge to stormwater pipes below ground, and are to be placed upstream of wetland inlet zones.

Swales are to be used where sites drain via sheet flow or spoon drains, and are to be placed upstream of bioretention or wetland areas.

Oil and grit separators are to be used where large volumes of oil are handled on site and sized to suppliers specifications.

5.7 FLOOD MANAGEMENT

From a floodplain management perspective, the NSW Floodplain Development Manual (DIPNR, 2005) raises the requirement to manage peak flows and flood levels in the 100 year Average Recurrence Interval (ARI) event.

Management 100 year ARI peak flows at the downstream HEZ boundary will be managed by a combination of lot scale On-Site-Detention (OSD) and designated detention basins for existing roads. Future roads will not require detention as lot scale OSD will compensate for road runoff.

OSD structures must be designed to have a 2 stage outlet, achieving Permissible Site Discharges (PSDs) for the 1.5 and 100 year events respectively. Site storage volumes and PSDs have been determined through hydrologic modelling using RAFS software and is further described in the HEZ Stormwater Quality and Hydrologic Modelling Report (EDAW, 2007). More detail on controlling the 1.5 year ARI peak discharge is discussed in Section 5.8.

Performance Targets and Compliance

Site developers must demonstrate that site design incorporates a multiple outlet Onsite Detention Storage area for each site discharge point that achieves:

- A 2-yr Permissible Site Discharge of 40 L/s/ha of impermeable catchment;: and
- A secondary 100-yr Permissible Site Discharge of 115 L/s/ha operational at the peak 2 year detention stage and a total storage volume of 530 m^3/ha of impermeable catchment area:

This storage is to be provided within a bunded area either:

- above a treatment wetland; or
- in a car park or hard stand area that is to pond no deeper than 200 mm in the critical 100-yr event.

Details on OSD configuration is presented in HEZ Stormwater Quality and Hydrologic Modelling Report (EDAW, 2007).

5.8 WATERWAY EROSION AND STABILITY MANAGEMENT

Post development runoff volumes, runoff frequency and low flow rates must be managed to preserve ephemeral creek and floodplain habitats, ensure waterway stability and to stop ongoing channel erosion. Following development of a catchment, frequent runoff events create the majority of erosion impacts which can be managed through OSD, stormwater harvesting and flow delivery devices.

Stormwater harvesting entails onsite storage and reuse to intercept frequent flows with additional benefits of potable water use reductions. Hydrologic modelling indicates that an optimal combination of stormwater storage volumes and reuse rates can preserve a level of ephemeral hydrology within HEZ waterways. A practical level of stormwater harvesting is proposed that balances habitat protection and infrastructure requirements on site. Details of modelling are presented in HEZ Stormwater Quality and Hydrologic Modelling Report (EDAW, 2007).

Pre-developed peak 1.5 year ARI flow rates are to be maintained to prevent waterway erosion and protect stream stability. Hydrologic modelling of predevelopment and post development flow rates has informed the selection of a 1.5 year PSD and corresponding onsite detention volume to achieve no increase in peak 1.5 year flow rates from each lot. Details of modelling are presented in HEZ Stormwater Quality and Hydrologic Modelling Report (EDAW, 2007).

At the edge of a development, the physical nature of flows into receiving environments needs to be preserved to ensure concentrated or altered flow patterns do not cause scouring or erosion.

Performance Targets and Compliance

Industrial lot occupants shall achieve an average daily rainwater/stormwater reuse rate of 15 kL/d/Ha of site developed. Where this re-use rate cannot be achieved the excess water must be either offset by or supplied to another industrial lot occupant. Alternatively an average annual runoff reduction of 55% to be demonstrated through a water balance.

Site developers must demonstrate that site design incorporates a multiple outlet Onsite Detention Storage area for each discharge point that achieves:

- A 1.5 year PSD of 40 L/s/ha of impermeable catchment and corresponding SSR of 190 m^3/ha of impermeable catchment area: and

Flow spreaders and erosion protection shall be used where stormwater pipes and culverts discharge to waterways.

5.9 GROUNDWATER QUALITY AND RECHARGE

Groundwater recharge will be encouraged through the preservation of vegetated zones around each allotment, through the use of drainage swales within road corridors and infiltration zones provided at suitable locations. There is a likely to be a net reduction in groundwater recharge rates but there is also a reduction in evapotranspiration processes that would reduce the volumes of groundwater generated.

Treated stormwater runoff from lots will be encouraged to infiltrate within drainage swales along road verges. Similarly treated stormwater from road runoff will be encouraged to infiltrate where soils are conducive. Where future stages of development require, large infiltration zones can be provided at a small fraction of the feeding catchment to preserves runoff volumes and balance groundwater infiltration..

Performance Targets and Compliance

Where stormwater reuse rates described in Section 5.8 are not achieved, development must incorporate designated infiltration areas to encourage the recharge of groundwater. All stormwater must be treated to best practice pollutant reduction targets prior to discharge to infiltration zones.

6

6 MANAGED IMPACTS OF HEZ

This section presents results of modelling that give indicative hydrologic and water quality impacts of HEZ under the proposed Water Cycle Management Strategy.

6.1 FREQUENT FLOW CONTROLLS

The frequency of flows from industrial lots will be reduced through stormwater harvesting, encouraging evaporative losses and providing infiltration to use stormwater runoff to recharge groundwater. This strategy is presented in Section 7.

For existing roads, existing lots and for proposed lots that do not adhere to the WCMS presented within this document, little thought has been given to controlling frequent flows. Instead the strategy for these sites has entailed delivering flows with little attenuation of peak flows or runoff volume reduction. For these lots opportunities still exist to harvest stormwater and encourage infiltration to control the frequency of frequent flows within ephemeral creeks.

Runoff from existing roads within the HEZ site will be subject to some volume control afforded by evaporative losses within treatment wetlands. There is little opportunity to address the frequency of runoff from these systems and they will contribute to increased runoff frequency and runoff volume, however they represent a small fraction of the overall site and associated impacts are relatively small.

For future lots within Precinct 1 and the greater HEZ site, Section 7.1 presents a lot management strategy where a wetland and open water storage operate in series to treat runoff from car park areas prior to reuse. Stormwater reuse on proposed future developments within Precinct 1 draws water at a rate of 15 kL/day/ha of developed area.

Modelling of this scenario in MUSIC shows that a Mean Annual Runoff Volume reduction of approximately 65%, and a reduction in the frequency of events (compared to no intervention). The effect on flow frequency is presented in Figure 12.

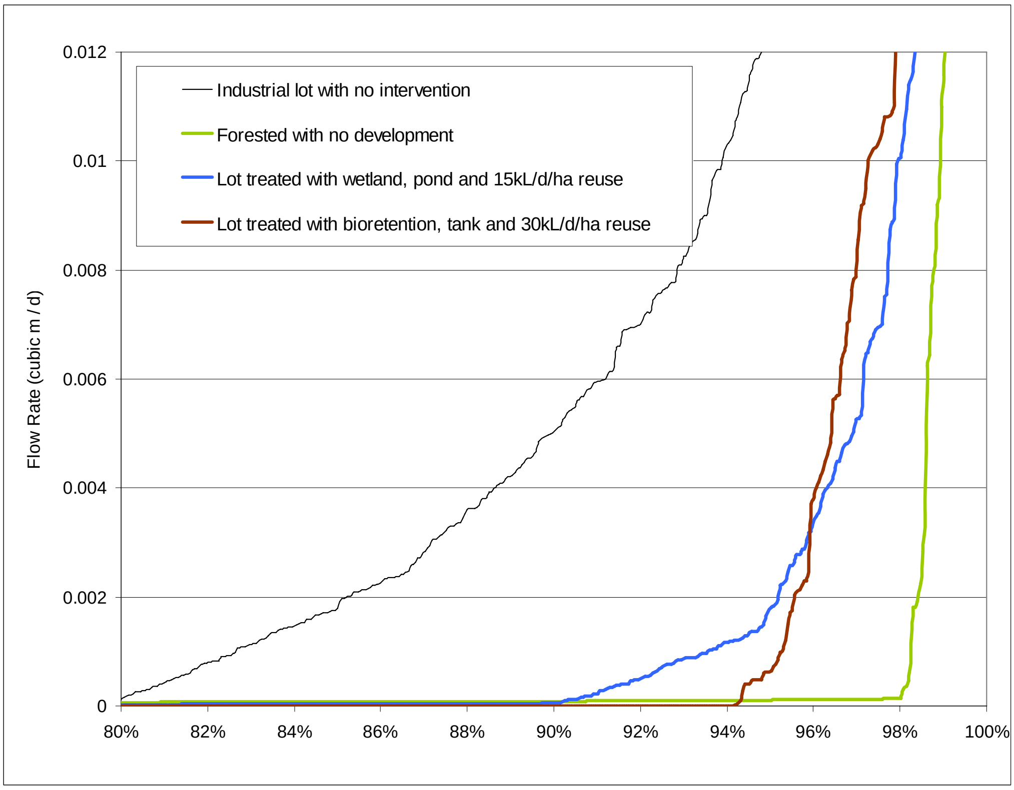


Figure 12 : Effectiveness of proposed stormwater harvesting rates within Precinct 1

This strategy while increasing the frequency of flows by a factor of 5, presents a reasonable balance between environmental outcomes and practical implementation. Furthermore there is the opportunity to introduce infiltration within stormwater conveyance

Section 7.1 presents a lot management strategy where a number of bioretention cells within the car park treats runoff from hardstand areas prior to reuse. Stormwater reuse on site draws water at a rate of 30 kL/day/ha of developed area.

Modelling of this scenario in MUSIC shows that a Mean Annual Runoff Volume reduction of approximately 55%, and a significant reduction in the frequency of runoff events (compared to no intervention). The effect on flow frequency is also presented in Figure 12.

The comparison between performance of the two systems illustrates the effectiveness of evaporation as a flow management strategy. The wetland and open water combination requires significantly lower reuse rates to achieve a good environmental outcome. The bioretention system however produces significant volumes of water that could be used in industrial processes providing environmental outcomes for external water catchments.

6.2 STORMWATER QUALITY IMPACTS

Stormwater quality management has been incorporated into all existing development and is proposed for all future development within the HEZ site.

Indicative stormwater quality loads from the HEZ under 4 scenarios is presented in Table impacts on downstream waterways are presented in Table 5.

Table 5: Water quality reductions under the proposed strategy

Runoff and Pollutant Loads	Pre-developed forest	HEZ With No Treatment	HEZ With Treatment	HEZ With Treatment and Harvesting	HEZ Pollutant Reductions
Flow (ML/yr)	1122	4,755	4,755	1,860	61%
Total Suspended Solids (kg/yr)	141,810	1,489,962	223,494	192,618	87%*
Total Phosphorus (kg/yr)	84	1673.3058	586	318	81%*
Total Nitrogen (kg/yr)	939	13,759	7,568	3,814	72%*
Gross Pollutants (kg/yr)	10	136,418	2	2	100%*

* Exceeds DECC pollutant reduction targets for Western Sydney

It should be noted that the model results for the Pre developed forest are not calibrated to existing data and they do not reflect the poor water quality recorded around the site and within downstream waterways. There are several potential reasons for the surface water quality which are discussed in Section 3.4. The values presented above represent those from a forest in reasonable condition without the influence of other factors included the presence of coal waste or upstream irrigation with effluent.

Combined stormwater treatment and harvesting reduces stormwater nutrient loads even further than recommended by best practice guidelines adopted across the state. There is still a net increase in pollutant loads generated from the development, however these loads are associated with storm events when increased flushing potential will exist. During storm events, nutrient concentrations entering creeks will exceed Default Low Risk Trigger Values established by ANZECC. An indication of the frequency and concentration of TN and TP within stormwater discharged from sites within Precinct 1 is presented in Figure 13 which was generated from MUSIC modelling results This assumes that stormwater harvesting and stormwater quality treatment is implemented on site. MUSIC modelling shows that concentrations of TP and TN in stormwater runoff from the developed site will be in the same magnitude as concentrations found in Swamp Creek at the HEZ catchment outlet. It is recognised that these concentrations are higher than the recorded water quality in Hebburn Dam, however it is unlikely that there will be a significant worsening of water quality downstream of HEZ as events will be short lived and pollutant contributions from the proposed development will not contribute to prevailing low flow conditions that are associated with long term poor water quality.

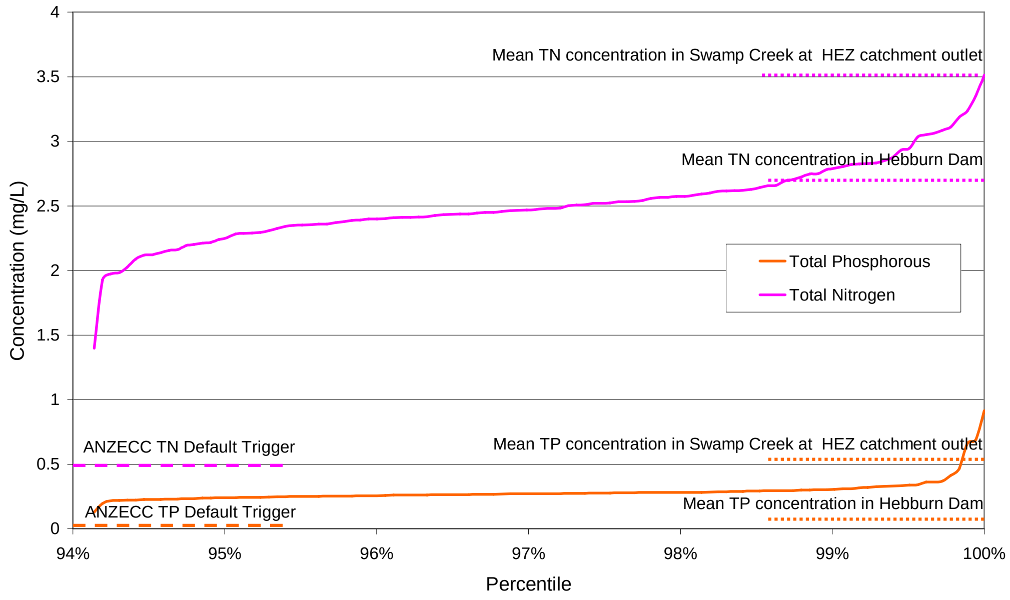


Figure 13 : Concentration of TN and TP in Treated Stormwater runoff

6.3 FLOOD DETENTION PERFORMANCE

Flood detention basins have been incorporated into all existing development and are proposed for all future development within the HEZ site.

Onsite flood detention volumes will control the discharge of stormwater at downstream boundaries of the site to ensure no increase in the 100 year ARI discharges. Flood hydrographs and flow rates are presented in the HEZ Stormwater Quality and Hydrologic Modelling Report (EDAW, 2007).

6.4 GROUNDWATER IMPACTS

The increased impervious areas associated with the proposed development will reduce the areas of forest and natural infiltration across the site. The preservation of 30 m buffer zones along lot fronts, vegetated road reserves and all substantial drainage channels will maintain a level of groundwater recharge across the site. Furthermore the use of drainage swales, bioretention and infiltration zones throughout the proposed HEZ precinct will also allow the infiltration of runoff.

Localised groundwater across the site is located at depths of 10 to 20 m, and is expected to play a small role at creek base flows at this depth. Similarly the fluctuation of the water level in the Hebburn Dam is constant with rainfall and temperature and it is unlikely to be an expression of the localised groundwater table. In regard to this, ecological communities across the site are not considered to be dependent on groundwater and any localised changes to infiltration rates within the site will not affect ecosystem health onsite.

Infiltration rates within the site are likely to be a very small fraction of groundwater recharge within the Wallis and Swamp Creek watersheds. Changes to infiltration rates within the site are therefore likely to have a minimal impact on the groundwater table within downstream wetlands and the Wentworth Swamps.

The water quality of stormwater runoff and infiltration will be managed to ensure that pollutants are removed to best practice management targets. Groundwater processes are a likely culprit of the high nutrient, turbidity and salinity levels of receiving waterways downstream. In light of any changes to the quality of stormwater infiltration within the site is considered to be negligible in the context of the entire Swamp and Wallis Creek catchments. Furthermore, these Nutrient levels are likely

7

7 LOT AND ROAD WSUD IMPLEMENTATION AND MANAGEMENT

This section illustrates typical examples of how the Water Cycle Management Strategy can be implemented at the lot and street scale.

7.1 LOT SCALE IMPLEMENTATION

Key features of the lot scale Water Cycle Management Strategy are the stormwater harvesting system, on site detention area and stormwater pollutant control device. Two examples are presented utilising wetlands and bioretention respectively.

Bioretention systems can achieve target pollutant reductions with a smaller footprint than wetlands. Wetlands on the other hand offer evaporation losses that can be counted in MARV reduction calculations. Ultimately, the topography of the site may dictate which system is utilised.

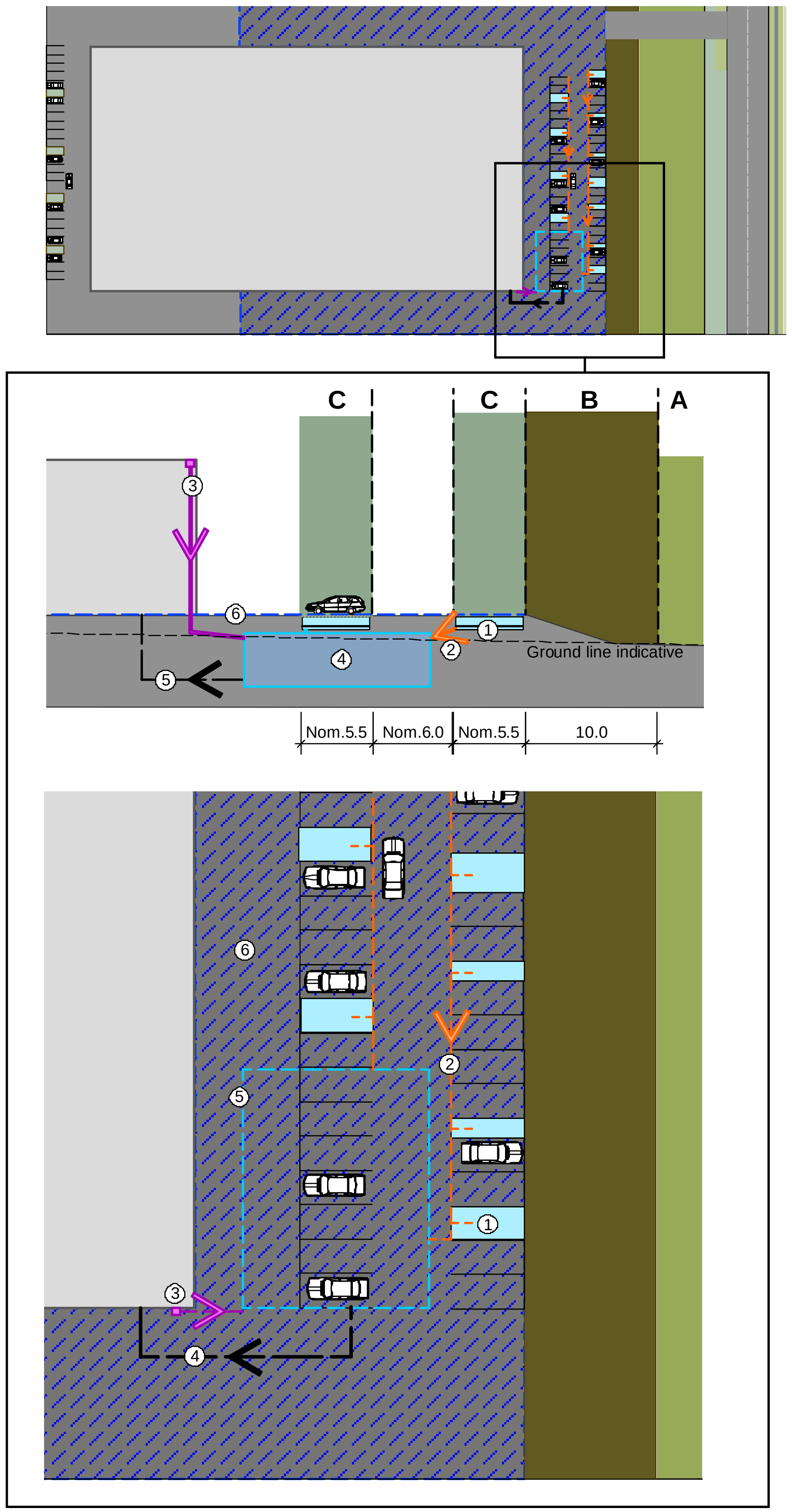
The topography of the existing site is typified by grades of 3% that will be reduced with earthworks to create suitable sites for industry. Benching will create level differences between the finished site and the discharge point in the adjacent swale. This level change will determine the suitability of wetlands or bioretention in stormwater pollution control.

Figure 14 shows a site with significant level change that allows for bioretention which typically discharges 800 to 1000 mm below surface level. This system is suited to level differences of 1 m or greater between discharge point and finished lot surface.

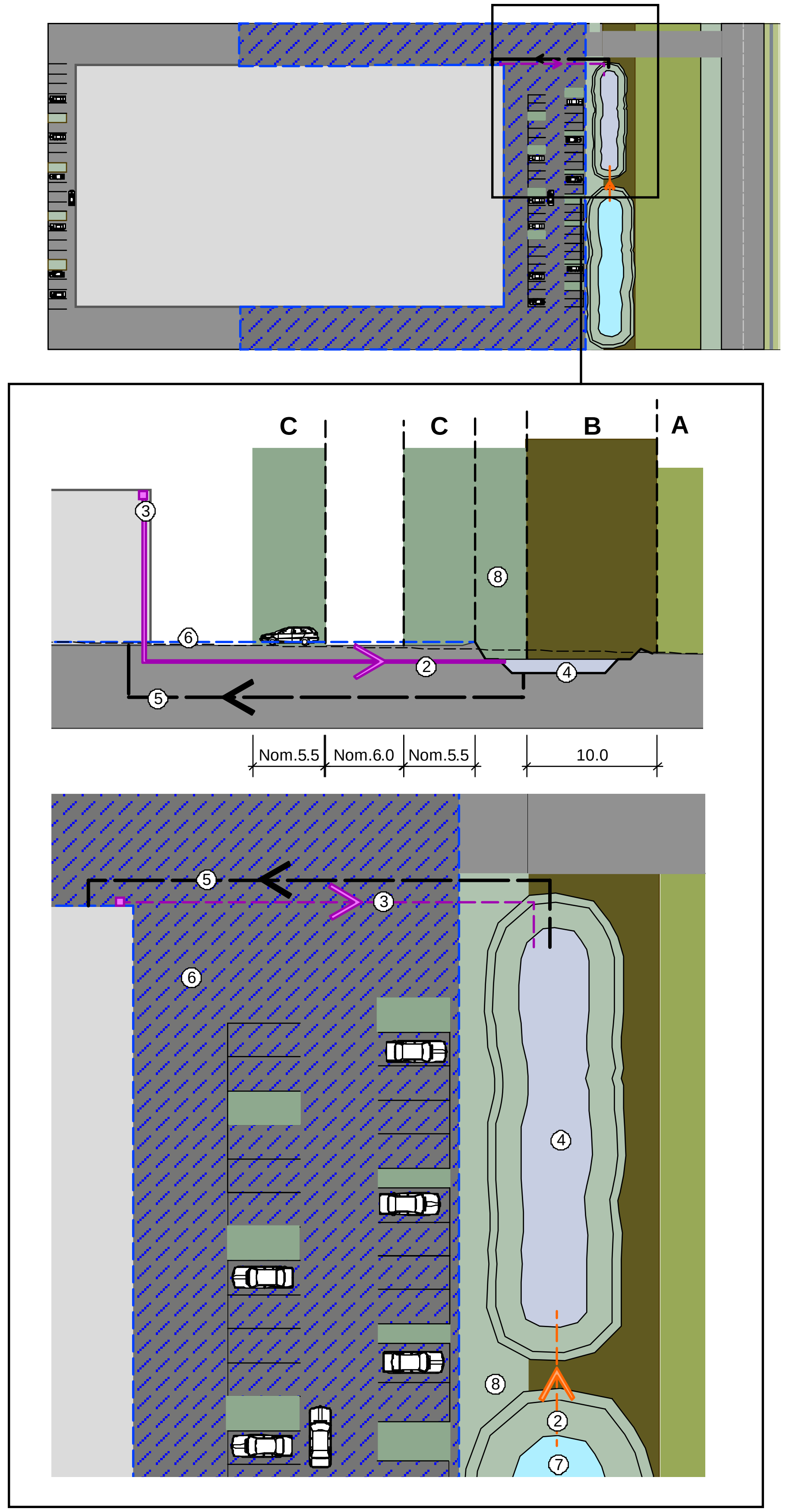
Implementation of wetlands for stormwater treatment shown in

Figure 14 is preferred for sites with little elevation difference between finished lot level and discharge point.

Both examples presented here utilise car parking and hard stand areas for on sited detention, with a maximum ponding extent shown for a depth of 200 mm.



BIO-RETENTION (OPTION)



CONSTRUCTED WETLAND AND DETENTION BASIN (OPTION)

LEGEND

A	Retained Vegetation
B	Retained / Reinstated Vegetation
C	Retained / reinstated and/or modified Vegetation and WSUD zone
(hatched)	1 in 100 flood detention

1. Bio-retention within car park
2. Treated run-off to storage
3. Roof water to underground store
4. Water storage
5. Reticulated storage water to building uses
6. Flood storage up to 1 in 100 year storage. (max 200mm deep)
7. Wetland macrophyte area
8. Where WSUD infrastructure extends beyond Zone B, reinstate vegetation

NOTES

1. Information relating to architectural, electrical, hydraulic, civil and other works as represented on EDAW documentation is for reference and EDAW co-ordination purpose only. All documentation to these and other works outside EDAW scope should be refered to the relevant consultants drawings and specification for details.
2. This drawing should be read in conjunction with EDAW prepared specification and details. Should a conflict exist advice and direction should be sought from EDAW prior undertaking any construction works.
3. All levels shown are in metres Australian Height Datum and dimensions in millimetres unless otherwise specified.
4. To be read in conjunction with landscape guidelines.

B	Final issue	13-12-07	
A	Client issue	07-12-07	
REV	DESCRIPTION	DATE	APPROVED

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T 02 9212 3666 F 02 9212 4499 E SYDNEY@EDAW.COM

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Project	HEZ PART 3 APPLICATION
Client	HEZ NOMINEES PTY LTD ATF THE HEZ UNIT TRUST
Drawing	LOT WATER MANAGEMENT
Scale	1:250@A1 1:500@A3
Project No.	07502428.01
Drawn	MS

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L19B

7.2 ROAD SCALE IMPLEMENTATION

Existing HEZ roads have been designed to utilise wetlands within detention basins to manage stormwater. Roads drain to these facilities via pits and pipes.

Future road design will incorporate roadside vegetated swales to convey stormwater from lots at suitable grades. One way cross fall will ensure that stormwater from lots and roads do not mix prior to discharge to receiving waters. Bioretention will be used to achieve stormwater pollutant reduction targets from road runoff. This system provides a buffer between the roads and receiving waters and will introduce a level of infiltration to provide creeks with groundwater base flows. The interaction between stormwater and vegetation facilitates an even distribution and slowing of flow, thus retaining any incidental pollutant.

Bioretention will be spaced at suitable intervals which will be determined by the grade of the swale. Typically this interval will be 40 to 50 m.

Water is delivered to the bioretention system via gutter flow through a cut or slotted curb. A section of swale or sediment fore bay will be provided at the front of the bioretention pod to encourage sediment deposition away from the filter media, thereby focussing maintenance requirements in a designated area.

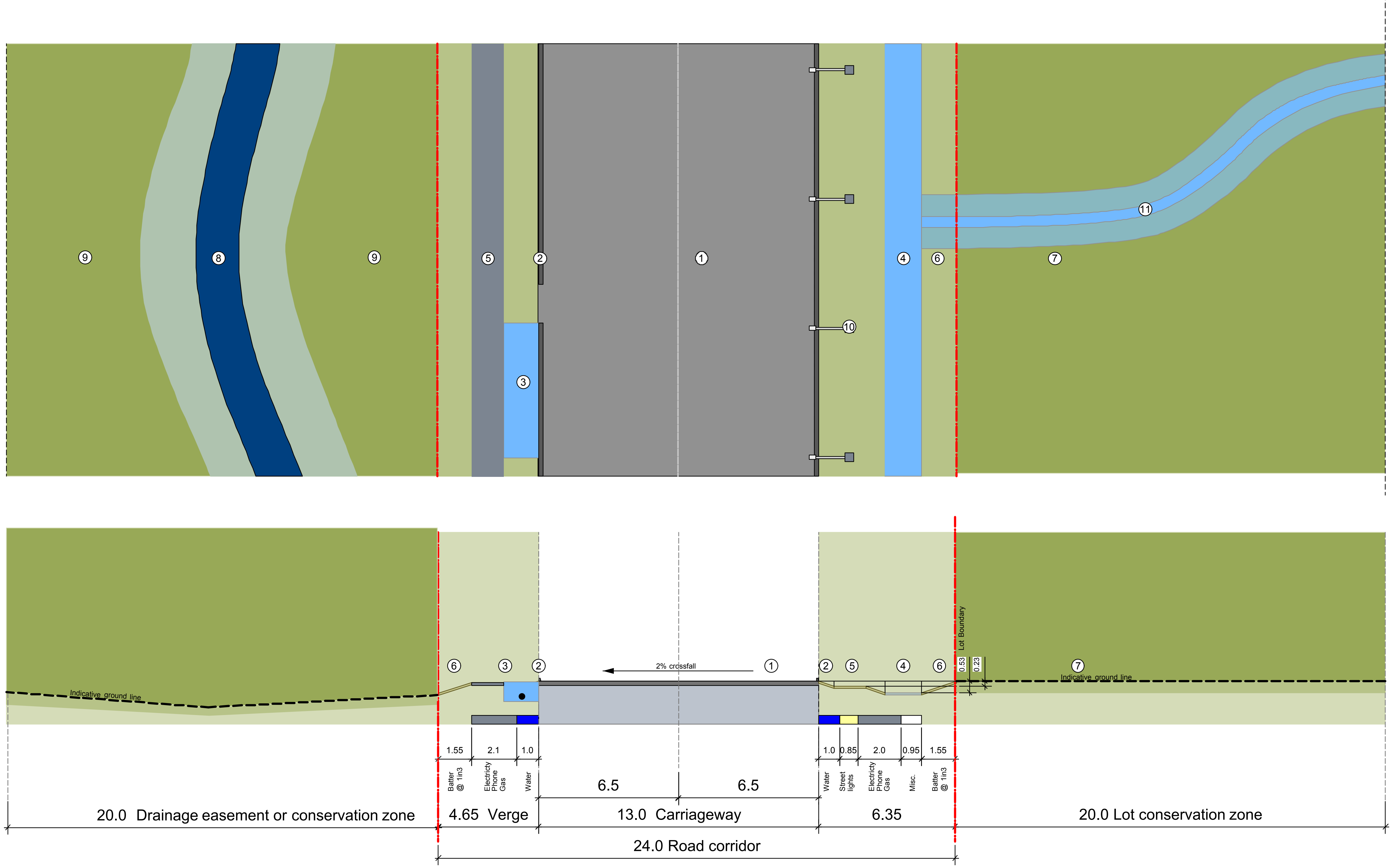
When the capacity of the bioretention is exceeded, water will pond at the surface forcing larger flows to bypass. Treated water will be collected at the base of the system within slotted pipes and conveyed downstream in sealed pipes. The nature of the soils at the HEZ precludes infiltration, and care must be taken in the design of bioretention to prevent reactive clays from contributing sediment loads to the system. A typical swale and bioretention cross-section and set out of stormwater is shown in Appendix 1.

Where underlying soils are conducive to infiltration, bioretention pods will be designed to allow water to be lost to groundwater.

7.3 MANAGEMENT OF IMPLEMENTATION

The HEZ Authority (HEZA) will play an important roll in overseeing the implementation of water cycle management strategy within Precinct 1 at design. The Strategy will be implemented through the Statement of Commitments requiring all applications for development to be designed in accordance with the stormwater management strategy. Design guidelines incorporating allotment implementation instruction will ensure the strategy is properly interoperated. On-going maintenance and operation commitments will be a requirement for individual consents approvals.

All site designs within Precinct 1 and within HEZA's lands must incorporate the elements of the strategy which will be assessed by HEZA prior to lodgement of Development Applications to Cessnock City Council. HEZA also have control over the location of individual businesses and therefore the ability to locate water-intense industry amongst those with lower water demands. This type of industrial estate planning can ensure the success of stormwater harvesting strategies to control runoff volumes and frequency.



LEGEND

	Lot boundary
1	Road carriageway
2	Slotted kerbing
3	Bio - retention basin
4	Drainage swale
5	Shared pedestrian/cycleway pathway
6	Batter @ 1 in 3 and or retaining wall
7	Retained vegetation
8	Existing ephemeral creek/drainage line
9	Retained HLRF vegetation
10	Street lighting
11	Drainage swale from Lot

TYPICAL ROAD SECTION

REFERENCES

CONSULTANT	DRAWING ID	DATE OF ISSUE
HSO	23693_site_boundary_:	20.12.06
HSO	23403_G_ parviflora po	19.12.06
HSO	Green-thighed Frog Hal	19.12.07
HSO	21489_Pipeline alignme	24.11.07
HSO	21489_Pipeline alignme	24.11.07
HSO	23909_Basedata_7.11.	08.11.06
HSO	pelaw-main-bypass-bas	21.11.07
HSO	Hollow Bearing Tree_C	23.02.07
HSO	Mature Tree Combined	22.02.07
HSO	Threatened Fauna_Cor	22.02.07
HSO	Threatened Fauna_Cor	20.02.07
HEZ	DESIGN.dwg	22.11.07
HEZ	SURVEY.dwg	22.11.07
HEZ	WSP sheet 2 Layout1 (	27.11.07

NOTES

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3. All levels shown are in metres Australian Height Datum and dimensions in millimetres unless otherwise specified.

Project: HEZ PART 3 APPLICATION

Client: HEZ NOMINEES PTY LTD ATF THE HEZ UNIT TRUST

Drawing: P1 ID TYPICAL ROAD SECTION

REV	DESCRIPTION	DATE	APPROVED
B	Final Issue	13.12.07	
A	Client Issue	11.12.07	

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Scale: 1:100@A1
Project No.: 07502428.10
Drawn: MP

2297.10
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8

8 CONCLUDING COMMENTS

The HEZ Water Cycle Management Strategy significantly reduces surface water impacts of industrial development on the ecology of local waterways and downstream receiving water environments through a combination of

- Improvements to waterways that are actively eroding as a result of previous land uses;
- Reducing the volumes of runoff through evaporative losses and stormwater harvesting on the lot thereby preserving ephemeral hydrologic regimes of local creeks;
- Slowing the arrival of stormwater to local creeks through swales and detention storages
- Reducing the generation of industrial stormwater pollutants through good housekeeping practices and industrial site design;
- Reducing the delivery of typical urban stormwater pollutants (suspended solids, litter, oils, heavy metals, nitrogen and phosphorous) through stormwater treatment on lots and roads; prior to discharge into local creeks;
- Controlling erosive flows to preserve the channel structure and geomorphic form of stream habitats through onsite detention;
- Attenuating flood flows to prevent downstream flooding impacts on existing development through on site detention;

The Strategy also minimises the impacts on the greater water cycle by:

- Reducing the volumes of potable water imported from external catchments through demand management and stormwater harvesting; and
- Reducing the generation of wastewater and impacts at the point of wastewater discharge.

This Strategy aims to deliver a sustainable outcome to the HEZ that is supported by sound technical guidelines and practical implementation at each lot.

REFERENCES

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APPENDIX 1 - STORMWATER QUALITY TREATMENT DEVICES

VEGETATED SWALES

Vegetated swales can be used instead of pipes to convey stormwater and provide a 'buffer' between the impervious areas of a catchment and the receiving water. They can be integrated with landscape features in public open space, or incorporated into streetscapes. The interaction with vegetation facilitates an even distribution and slowing of flow, thus encouraging pollutant settlement and retention in the vegetation. A typical swale cross-section is shown in Figure 16.

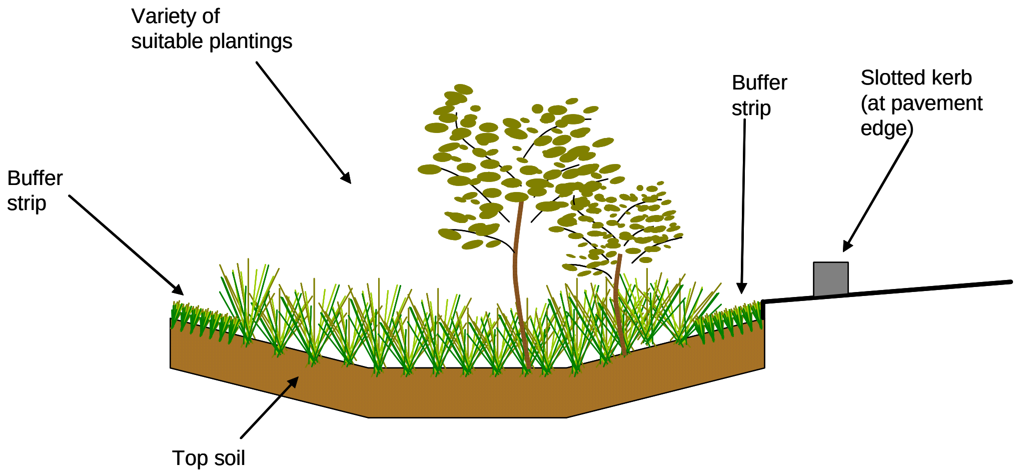

Figure 16: Swale cross-section

The longitudinal slope of a swale is an important consideration. They generally operate best with slopes from 1% to 4%. Slopes milder than this can tend to become waterlogged and have stagnant ponding, although the use of under drains can alleviate this problem. Steeper slopes can lead to the establishment of preferential flow paths and erosion, however this can be managed with the use of check dams to reduce flow velocities, distribute flows and maximise contact with vegetation. Check dams are typically low level (e.g. 100 mm) porous rock weirs that are constructed across the base of a swale.

Some examples of swales are shown in Figure 17. Swales are normally sized for conveyance as well as treatment of stormwater flows, and the conveyance function generally defines the cross-sectional area. However the treatment performance is also affected by a swale's length. Swales are normally sized to provide TSS removal, as they are not particularly effective at nutrient removal. They are ideal as a pre-treatment measure in the stormwater treatment train.

Figure 17: Examples of different types of swales

BIORETENTION SYSTEMS

Bioretention systems filter stormwater runoff through a vegetated soil media layer. The treated stormwater is collected at the base of the system via perforated pipes, from where it flows to downstream waterways or storages for reuse. Temporary ponding above the vegetated soil media provides additional treatment. Bioretention systems are not intended to be infiltration systems where treated stormwater would discharge into groundwater.

Typically flood flows bypass the system thereby preventing high flow velocities that can dislodge collected pollutants or scour vegetation. Bioretention systems can be installed at various scales, for example, between car parking bays, in streetscapes or as larger basins at the fronts of lots. A typical cross-section of a bioretention system is shown in Figure 18 and some examples of bioretention systems are shown in Figure 19.

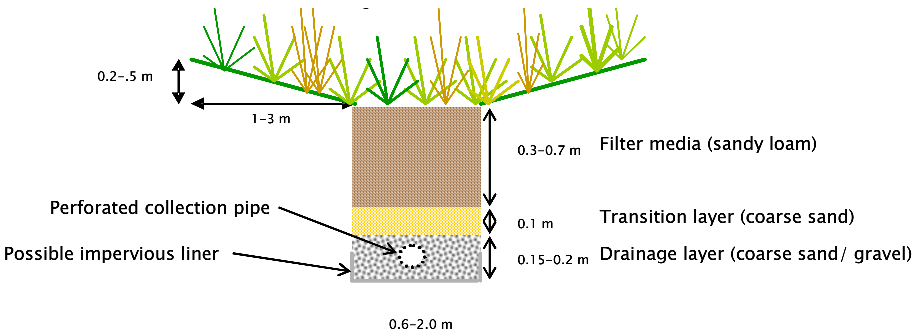

Figure 18: Typical bioretention cross-section

Figure 19: Examples of bioretention systems in car parks and in the streetscape

Sizing curves for bioretention systems are shown in **Figure 20**. Bioretention systems are normally sized to achieve 45% TN removal and at this point they will exceed the targets for 45% TP removal and 80% TSS removal.

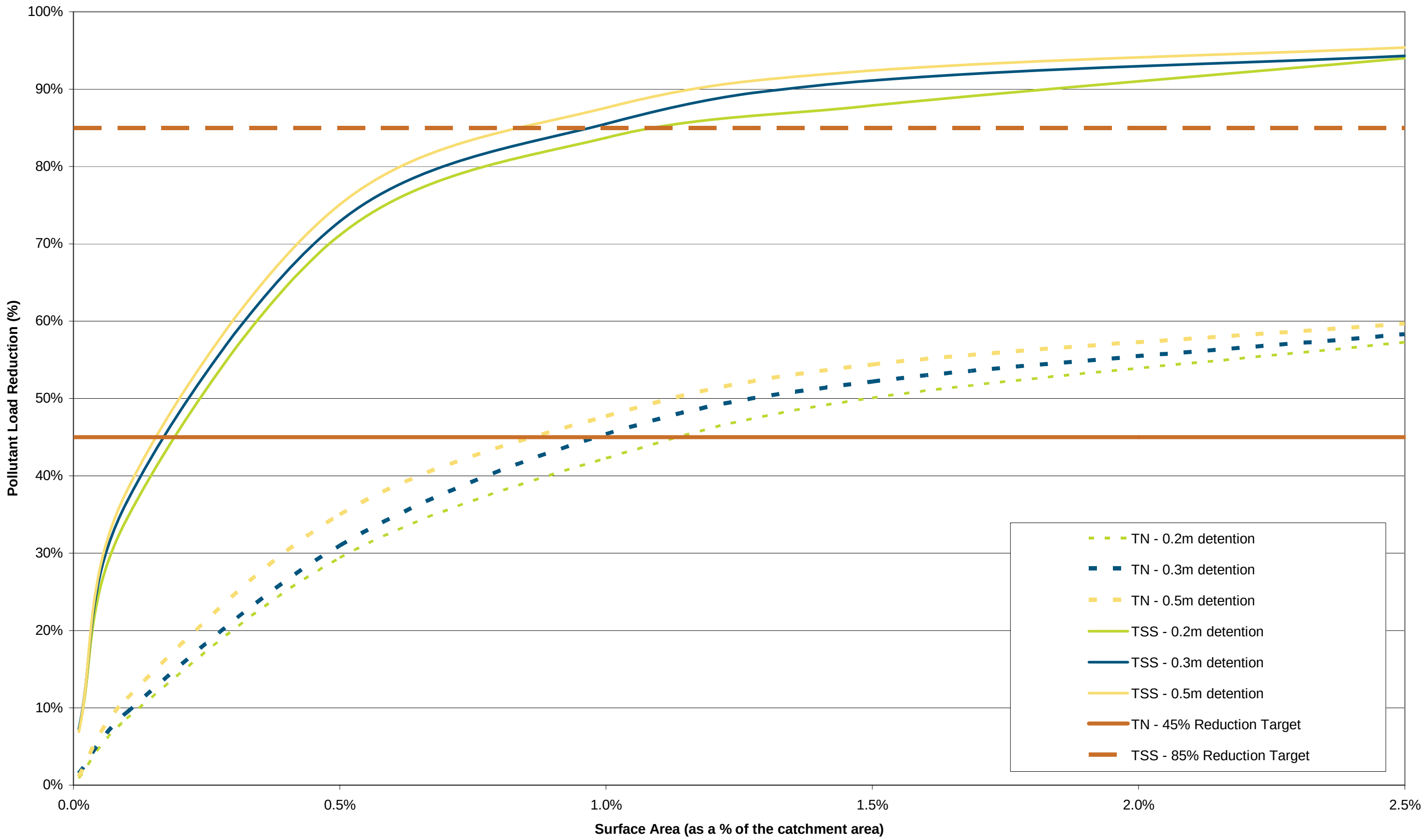

Figure 20: Sizing curves for bioretention systems

WETLANDS

Constructed wetland systems remove pollutants through sedimentation and absorption of nutrients and other associated contaminants. They generally consist of an inlet zone, that is a sediment basin to remove coarse sediments, a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and take up soluble pollutants) and a high flow bypass channel (to protect the macrophyte zone).

While wetlands can play an important role in stormwater treatment, they can also have significant community benefits. They provide habitat for wildlife and a focus for recreation, such as walking paths and resting areas. They can also improve the aesthetics of new developments and can be a central landscape feature.

Wetlands can be constructed on many scales. In highly urban areas they can have a hard edge form and be part of a streetscape or building forecourts such as the pictured on the right.

A wetland requires an inlet zone, macrophyte zone and high flow bypass. An important operating characteristic of macrophyte zones is well distributed flows that pass through various bands of vegetation. Strong vegetation growth is required to perform the filtration process as well as withstand flows through the system. Different bands of a wetland are shown in Figure 21.

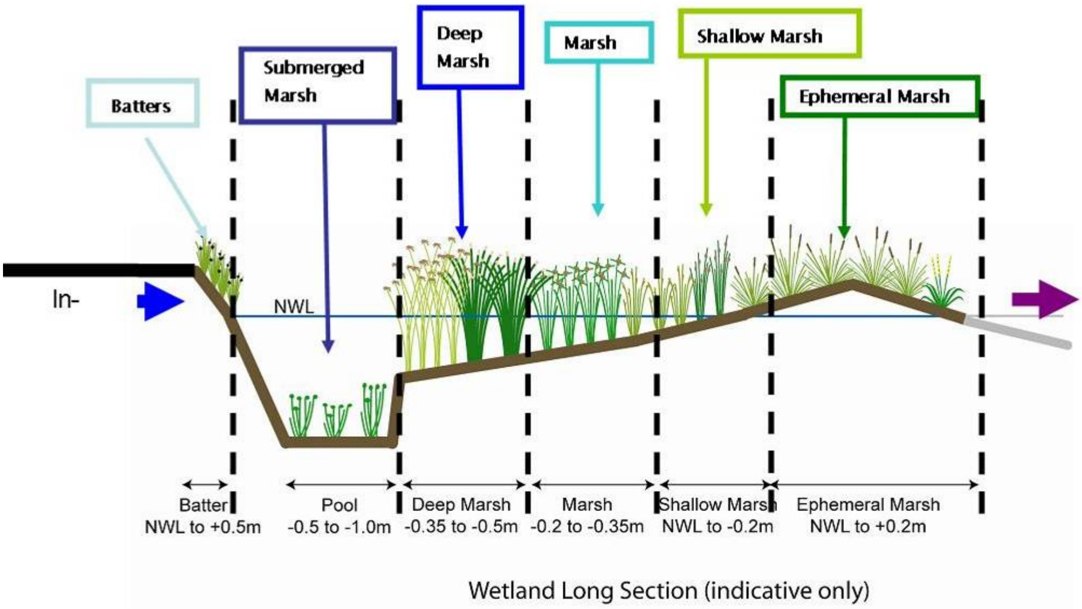

Figure 21: Indicative long section for a wetland.

Sizing curves for wetlands are shown in **Figure 22**. These sizing curves assume that the wetland receives suitably pre-treated water with course suspended solids removed.

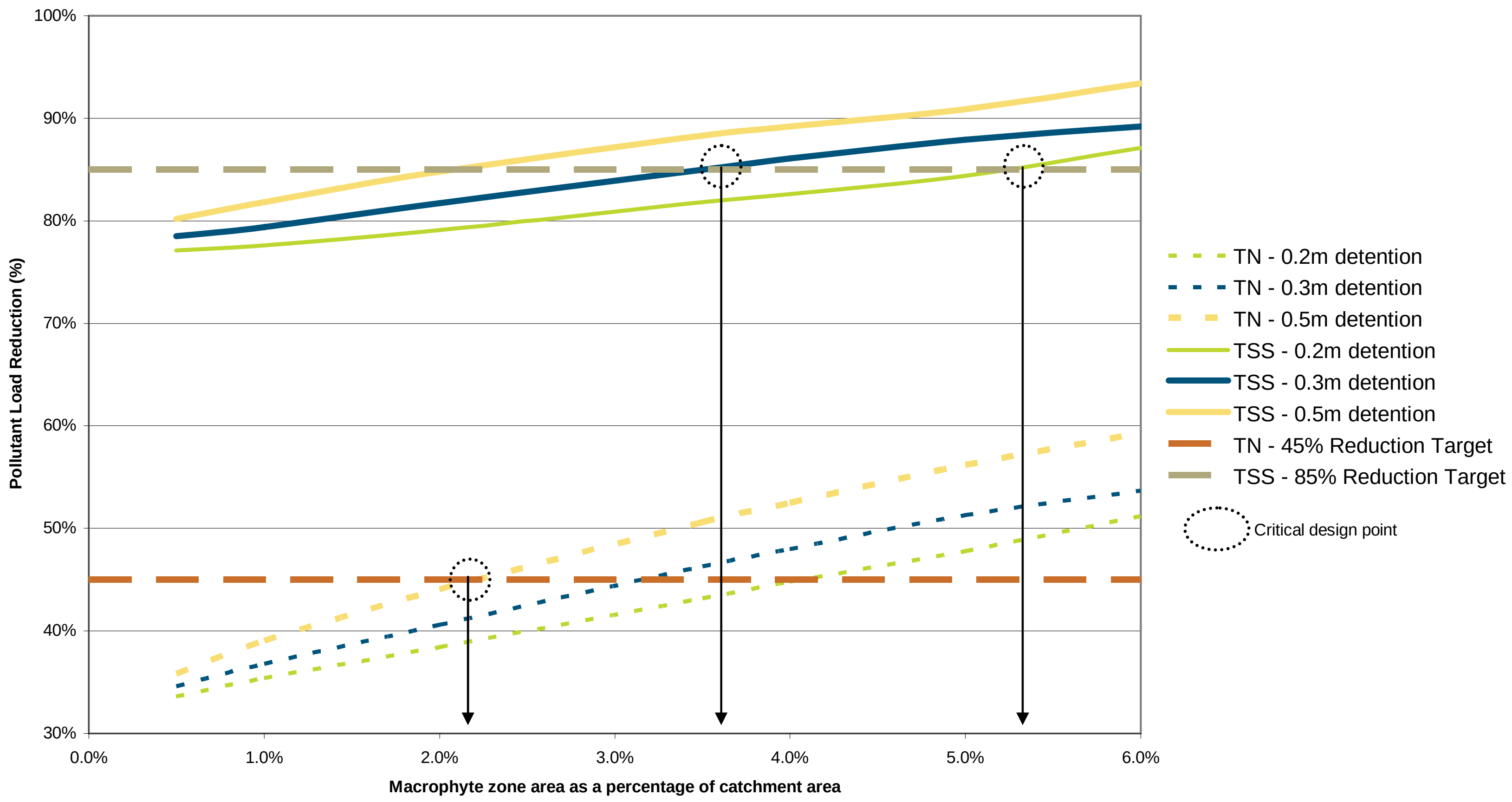

Figure 22: Sizing curves for wetlands

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304
Phone (02) 4960 9600
Fax (02) 4960 9601
www.douglaspartners.com.au

SAM:kmj
Proposal No: 39809.03
Doc Ref: P:\39809.03\Docs\39809.03 (groundwater).doc
4 April 2008

HEZ Nominees Pty Ltd (Trustee for the HEZ unit Trust)
PO Box N817
GROSVENOR PLACE NSW 1220

Attention: Mr Scott Barwick

Email: Scott.Barwick@valad.com.au

Dear Sir,

GROUNDWATER ASSESSMENT
PRECINCT 1 & ASSOCIATED DEVELOPMENT
HUNTER ECONOMIC ZONE

1. INTRODUCTION

This report presents the results of a groundwater desktop data review for the above site. The work was undertaken for HEZ Nominees Pty Ltd (HEZ) and in consultation with EDAW (Aust) Pty Ltd.

It is understood that an environmental assessment report has been prepared by EDAW (Aust) Pty Ltd for the development at HEZ to include Precinct 1 and the broader HEZ site.

It is further understood that the Department of Water and Energy (DWE) have requested additional information on the groundwater at the subject site which will be used by EDAW (Aust) Pty Ltd to assess the groundwater interaction of the water resources within the local area, and any relevant impacts such as affect on Groundwater Dependant Eco-systems (GDEs).

The Hunter Economic Zone lies to the south-west of Kurri Kurri and to the south of Weston and covers an area of about 500 ha. Precinct 1 of the development is situated on the southern part of the broader HEZ development with stages 2 and 3 situated on the northern parts of the site (refer attached Master Plan of the site).

The purpose of this assessment was to provide comment on the groundwater at the site to be used for submission to the DWE.

A desk-top review was undertaken to establish a geological model of the site. The following resources were used for this desk top study:

- Previous and current geotechnical investigations held on Douglas Partners files.
- Geological maps;
- Topographical maps;
- Soil landscape plans;
- Records search of registered groundwater wells.

A summary of the data review is presented in the following section of this report:

2. DATA REVIEW

Topographical Plan

Reference to the Cessnock 1:25,000 scale topographical plan (Ref 9132-2N) indicates that the site is situated on the northern and north-eastern slopes of a hill named "Tomalpin" which has an elevation of 201 m AHD.

The surface slopes fall away from the crown of the hill at about 15° over an elevation of about 110 m before gradually flattening near the southern boundary of the HEZ site at the location of a reservoir. The reservoir is currently under construction which has a surface elevation of 78 m AHD.

The surface slopes generally to the north via intermittent gullies which feed into Hebburn Dam at the northern end of the site. Hebburn Dam has a surface elevation of about RL 25 AHD.

Overflow from Hebburn Dam flows to the north by about 500 m where it connects into Swamp Creek. Swamp Creek flows to the north east towards the Wentworth Swamps which are situated about 5.5 km from the northern boundary of the site.

The eastern boundary of Stage 1 of the HEZ project lies close to the catchment boundary of the Wallis Creek. Based on the topographical plan, intermittent creeks flow from the catchment boundary to the east towards Wallis Creek which is situated about 4.5 km to 5.0 km from the HEZ site. The topographical plan indicates several "wet swamps" along the creek which flow toward Wallis Creek.

Wallis Creek flows generally to the north were it connects into the Hunter River at Maitland.

Regional Geology

Reference to the 1:100,000 scale Newcastle Coalfield Regional Geology plan (Ref 9231) indicates that the site is underlain by three geological formations as indicated below in order of geological sequence:

Location on site	Group	Formation	Typical Lithologies
Southern two thirds of the site	Maitland Group (Permian aged)	Branxton Formation	Conglomerate, Sandstone and siltstone
Northern part of site	Greta Coal Measures (Permian aged)		Sandstone, conglomerate, siltstone and coal
Northern end of the site	Dalwood Group (Permian aged)	Farley Formation	Silty sandstone (sandstone)

The Greta Coal Measures include the Greta, Holmesville Top and Bottom Seams which have been worked at the site by underground mining. The seams subcrop at the northern end of the site and dip at about 3° to the SSW (i.e. opposite direction to surface topography).

Soil Landscape Plans

Reference to the Singleton Soil landscape Series Sheet SI 56-1, indicated that the majority of the site is underlain be the Neath soil group typically containing Solodic soils. These soils have been derived from the weathering of the underlying Permian siltstone, sandstone and coal.

The south and south-eastern part of the site is underlain by the Aberdare soil group typically containing yellow podsolic soils. These soils are sandy in nature and are typically located on the elevated parts of the site. The soils are derived from the underlying Permian sandstone, conglomerate and siltstone.

Registered Groundwater Wells

An on-line records search of registered groundwater wells with the Department of Natural Resources (DNR) indicated that the nearest registered groundwater well is about 4 km south west of the site to the Tomalpin (Well GW050724).

Construction details of the well indicated that the well was installed to a depth of 46 m. The water bearing zones are from 10 m to 11 m and 38 m to 39 m depth.

Previous investigations

Several investigations have been undertaken at the HEZ site and adjacent sites. A summary of the investigations is presented below:

- ***Douglas Partners investigation – Mine and Pavement Investigation – Extension to Station Street, Weston***

    The report for the above investigation has not been completed for the current assessment. The investigation includes drilling of five bores to target the Holmesville Top Seam for an assessment of mine stability along the proposed extension to Station Street.

    The site is situated at the northern end of the HEZ project in the area described on the attached drawing as “Hebburn Village”.

    Groundwater measurements were undertaken following the drilling and observations were also made with regard to water loss during the drilling of the bore holes.

    A summary of the water observations that were encountered during the drilling of the bores are summarised below:

Bore	Depth to groundwater (m)	Comments
DP1	Obscured by drilling fluids	100% water loss at 8.45 m (coal seam)
DP1A	Obscured by drilling fluids	
DP1B	Obscured by drilling fluids	100% water loss at 6.9 m (above coal seam)
DP3	11.9 m	100% water loss at 9.6 m (possible void)
DP4	18 m	100% water loss from 10 m to 11.2 m (possible void) 100% water loss from 14.7 m to 15.3 m (possible void)

- ***PPK report " HEZ Stage 2 Spine Road, Mine Subsidence Drilling Investigation"***

  The report included the drilling of five bores to target the Holmesville Top and Greta Coal Seams for an assessment of the stability of the underground mines. The bores were drilled to depths ranging between 28.8 m and 77.3 m typically on the northern part of the HEZ site.

  The area where the bores were drilled by PPK is situated in the area described on the attached plan as "Stage 2" and "Northern Stage 2" :

  The bores did not encounter groundwater during the drilling but water loss of drilling fluids was encountered at several layers, particularly associated within coal seams, mined areas (either voids or fracturing in the rock possible associated with roof collapse).

- ***Rock Cutting for Proposed Reservoir (HEZ).***

  A stability assessment was undertaken by DP on a 5 m high cutting at a site of a proposed water reservoir at the southern boundary of the HEZ site.

  The profile exposed in the cutting indicated that the subsurface profile comprised a thin layer (<0.5 m) of residual clay overlying predominately weathered sandstone. Seepage of groundwater was not observed during the inspection of the wall.

- ***Douglas Partners Investigation (North West of HEZ – Hebburn Estate)***

  This site is situated just beyond the north western boundary of the HEZ site. Investigation by Douglas Partners included the drilling of bores to intersect the Holmesville Bottom Seam which had been mined in the area.

  The investigation comprised the drilling of three bores to depths of about 27 m to 29 m. The results of the investigation indicate that the subsurface conditions comprised an alluvial profile to depths of about 8 m to 10 m overlying weathered sandstone, conglomerate and coal.

Groundwater was not encountered in the alluvial profile at the time of the investigation. Furthermore, the underlying workings associated with the mining of the Holmesville Top Seam were dry (i.e. no groundwater).

Discussions with EDAW (Aust) Pty Ltd

Based on discussions with EDAW (AUST) Pty Ltd, Hebburn Dam experiences large water fluctuations consistent with rainfall events and prolonged dry weather.

Hebburn Dam is situated at the low point of the HEZ site in the area described on the attached drawing as “Hebburn Village”.

3. COMMENTS

Based on the data review, the following comments are made with respect to the groundwater at the site.

- The groundwater at the HEZ site is typically encountered within the underlying rock and has been measured to be at depths greater than 10 m to 20 m. This is consistent with the groundwater bearing zone within the nearest registered groundwater well about 4 km to the south west of the site.
- The groundwater is expected to be largely controlled by the coal seams / underground mines (mine induced fracturing) together with angle of geological dip which has been recorded to be to the south-southwest (i.e. opposite direction to the regional topography).
- It is expected that during periods of prolonged rainfall that a perched groundwater table may develop within the upper residual and alluvial soils but the perched groundwater is likely to be transient. The perched groundwater is expected to flow towards the north i.e. towards Hebburn Dam and Swamp Creek.

If you have questions in relation to this matter, please do not hesitate to contact the undersigned.

Yours faithfully
DOUGLAS PARTNERS PTY LTD

Reviewed by:

Scott McFarlane
Associate

Will Wright
Principal

Attachment
Masterplan of HEZ site