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Northbank Enterprise Hub Business and Industrial Park - Stormwater Assessment

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Northbank Enterprise Hub Business and Industrial Park – Stormwater Assessment

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1 INTRODUCTION

This report outlines an environmental assessment of the potential surface water quality and quantity impacts of the proposed Northbank Enterprise Hub Business and Industrial Park, Tomago (the Project Site). The development proposal is being assessed under Part 3a of the Environmental Planning and Assessment Act, 1979 and Director General Requirements (DGRs) have been issued for the site.

This report addresses elements of the following DGRs:

- Water balance for the site detailing (water sources, water consumption, water recycling), the quality and quantity of water and impact of any water release from the site on surface water and groundwater; and
- Water quality monitoring programs proposed during operation to ensure the development achieves a satisfactory level of environmental performance.

The water balance elements addressed in this report relate specifically to the potential impacts of stormwater runoff on surface water quality and stream stability. Water balance elements including potable water, water recycling and groundwater are addressed in reports prepared by others.

The response to the above DGR's is provided in the following sections:

- Description of the existing water environment (refer Section 2);
- Summary of the potential environmental impacts on water quality and quantity (refer Section 3);
- Water management principles, objectives and targets considered in developing the water management strategy (refer Section 4);
- Description of the mitigation elements within the water management strategy (refer Section 5);
- Description of modelling completed to conceptual size the mitigation measures (refer Section 6);
- Hydrologic regime impacts (Refer Section 7); and
- Preliminary water quality monitoring program (refer Section 8).

The proposed development will increase the total imperviousness within developable areas of the Project Site from approximately 0% to 80%. This increased imperviousness will result in elevated stormwater runoff volumes with an associated increase in the total volume of stormwater pollutants generated from the catchment surfaces. Without mitigation, the proposed development has the potential to convey excessive loads of nutrients, sediment, heavy metals, hydrocarbons, oils/greases, gross pollutants and other common stormwater pollutants to the Hunter River. Management of surface water quality and quantity is of particular importance considering the location of the Project Site in close proximity to the Hunter River Estuary and Ramsar listed Hunter Wetlands.

A series of mitigation measures are proposed within the development to ensure that both the quantity and quality of stormwater are managed within the Project Site prior to discharge into the Hunter River. The proposed mitigation measures apply the principles of Water Sensitive Urban Design (WSUD). WSUD is an approach to mitigate the impacts of increased stormwater runoff volumes and pollutant loads from development. WSUD involves a more distributed approach to managing stormwater runoff when compared to conventional stormwater drainage systems. WSUD provides disconnection of impervious surfaces from receiving waters and provides opportunities to minimise the discharge of untreated stormwater by increasing opportunities for the interaction of stormwater with the landscape.

The assessment outlined in this report is based on a previous development layout that was modified following completion of the modelling. We understand that the only significant change to the previous layout is associated with a reduction in developable land adjacent to the eastern boundary of the Project Site. Specifically, we understand that Sub-catchment 4A and the adjacent reach of Channel 4 (refer to Figure 6-1) are no longer proposed for development as this land (approximately 14.5ha) has been confirmed as part of an area of Endangered Ecological Community (EEC). Therefore, the estimated runoff and pollutant loads outlined in this assessment are likely to be higher (approximately 5%) than would be expected from the reduced development footprint. The development impacts from the modified layout are subsequently expected to be slightly lower than presented in this assessment.

The stormwater assessment presented within this report was completed in conjunction with local flooding and drainage assessment for the proposed development. The local drainage and flooding assessment is provided in a separate report prepared by BMT WBM.

2 DESCRIPTION OF THE EXISTING ENVIRONMENT

2.1 Existing Site

The proposed Northbank Enterprise Hub Business and Industrial Park is located on the left overbank area of the North Arm of the Hunter River (refer Figure 2-1). The Project Site comprises approximately 240 ha of land within the Hunter River floodplain. Approximately 204ha of this land is being considered for development. The remaining land will either be allocated to drainage or remain as undeveloped floodplain.

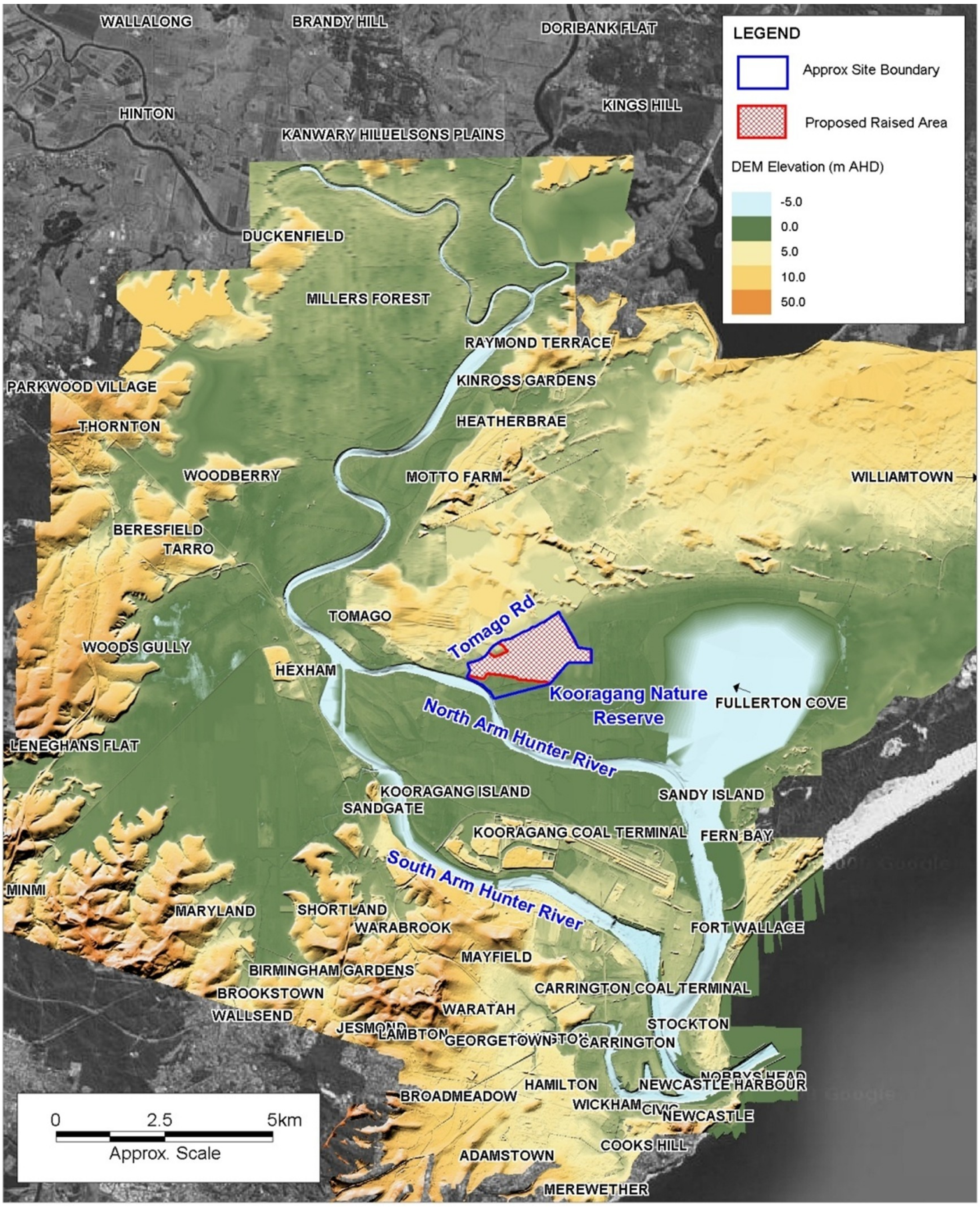


Figure 2-1 Site Locality

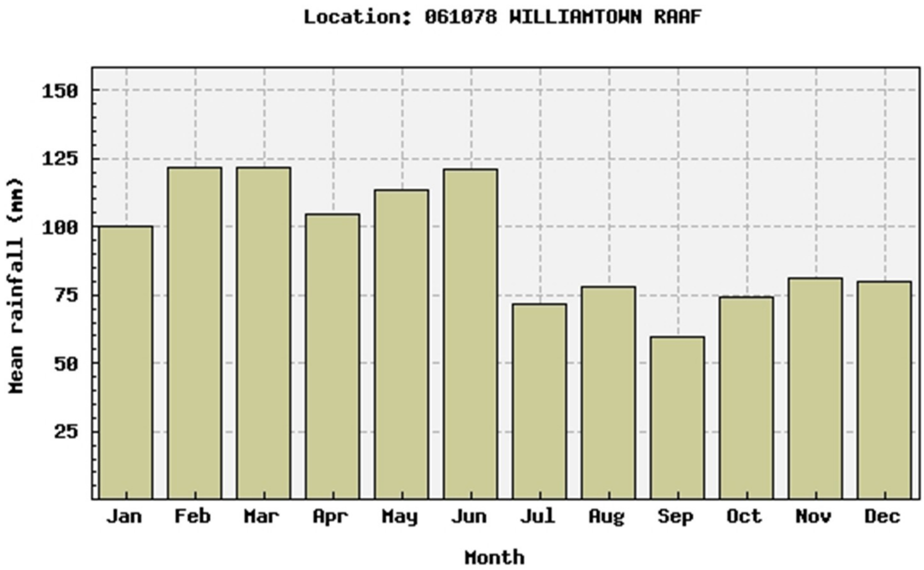
The site hydrology has been extensively modified by past grazing activities and construction of drainage and flood mitigation works. A number of minor channels drain the site through floodgates into the North Arm of the Hunter River which forms the downstream receiving water for the Project Site.

Separated from Kooragang Island to the south by the North Arm of the Hunter River and lying to the west of Fullerton Cove, the site is in close proximity to ecologically sensitive wetland areas. Fullerton Cove is recognised as an estuarine wetland of international significance and is listed under the Ramsar convention. The estuarine wetlands are also protected by NSW State Environmental Protection Policy No. 14 (SEPP14) Coastal Wetlands.

2.2 Rainfall

The Project Site is located approximately 10 km south-west of a long-term Bureau of Meteorology (BoM) weather station at Williamtown (Station 61078) that has recorded rainfall data continuously since 1942. The average annual rainfall at Williamtown is approximately 1122 mm and annual pan evaporation is 1715 mm. Monthly rainfall is typically highest over the summer and autumns months. Measurements of pan evaporation are more variable throughout the year with rates being significantly higher during summer months. The monthly distribution of rainfall and evaporation are shown in Figure 2-2.

The mean annual number of days where rainfall exceeds 0mm, 10mm and 25mm at Williamtown are 136, 28 and 9 respectively. This indicates that, on average, approximately 80% of days where rainfall occurs (i.e. 100*(136-28)/136) could be managed by providing a retention volume equivalent to a runoff depth of 10 mm from impervious site areas. Similarly, approximately 93% of days where rainfall occurs could be managed by providing 25 mm runoff depth volume of storage. Current best practice treatment measures including biofiltration measures that continuously filter runoff during a storm event are highly effective at treating greater runoff depths.



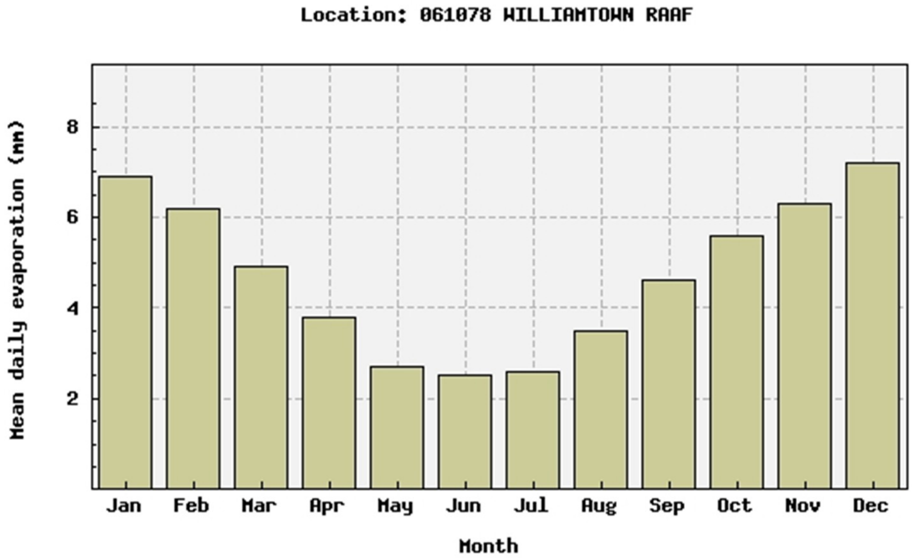


Figure 2-2 Average Monthly Rainfall and Daily Pan Evaporation at Williamtown (BoM, 2008)

2.3 Surface Water Quality

A formal water quality data collection program has been ongoing within the Hunter River Estuary since 1972. A total of 103 water quality monitoring sites have been established between the entrance to Port Newcastle and the tidal limits at Maitland. The NSW Department of Environment Climate Change and Water (DECCW) has collected data since around 1975 with early data collected by the Maritime Services Board (MSB). Unfortunately, data has not been collected regularly, with limited data gathered in the 1979-1987 period. Hunter Water Corporation (HWC) has also collected water quality data since 1993 for the purpose of monitoring water quality objectives for wastewater treatment plant discharges. The HWC data is typically sampled to coincide with wet weather.

The most comprehensive analysis of water quality conditions within the section of the Hunter River near the site was undertaken by Sanderson & Redden (2001) for the Hunter River Estuary Processes Study (MHL, 2003). Data analysis performed by Sanderson & Redden (2001) categorised the sites within the estuary into nine zones (Zones A to I) and these zones are shown in Figure 2-3. Zone C includes 21 water quality monitoring sites along the Hunter River in the vicinity of the site. Results from the HWC and DECCW monitoring enabled spatial and temporal water quality patterns to be analysed by Sanderson & Redden (2001) within the Estuary. The monitoring results for key water quality parameters within the Hunter River in the vicinity of the site are summarised in Table 2-1.

Table 2-1 Summary of water quality monitoring results (Sanderson & Redden, 2001)

Parameter	ANZECC guidelines (2000)[1]	10%ile	50%ile	90%ile	No. samples (No. sites sampled)
Chlorophyll-a (µg/L)	4	2	5	13	24 (6)
DO (mg/L)	6.9 to 11.3[3]	4.6	6.9	8.2	32 (1)
Faecal Coliform (col/100ml)	-	4	40	900	106 (8)
Enterococci (col/100ml)	-	20	280	1800	34 (1)
TSS (mg/L)	-	7	23	104	165 (11)
NH_3 (mg/L)	-	0.04	0.13	0.70	294 (19)
NO_3 (mg/L)	-	0.01	0.18	0.33	34 (1)
NO_2 (mg/L)	-	0.01	0.01	0.04	34 (1)
NO_x (mg/L)	0.015	0.01	0.15	0.30	70 (3)
pH	7.0 – 8.5	7.9	8.2	8.3	276 (18)
Secchi Depth	-	0.0	0.23	0.60	30 (1)
TKN (mg/L)	-	0.56	1.40	10.3	119 (9)
TN	0.30	0.57[2]	1.55[2]	10.6[2]	-
TP (mg/L)	0.03	0.04	0.10	0.27	130 (9)
Turbidity (NTU)	10	3.4	7.8	23	46 (4)

1. Trigger values for the slightly disturbed estuarine aquatic ecosystems, 2. Sum of NO_x and TKN, 3. Based on water temperature range of 14 to 22ºC.

Details on background water quality sampling completed within the Project Site are summarised in Douglas Partners (2011).

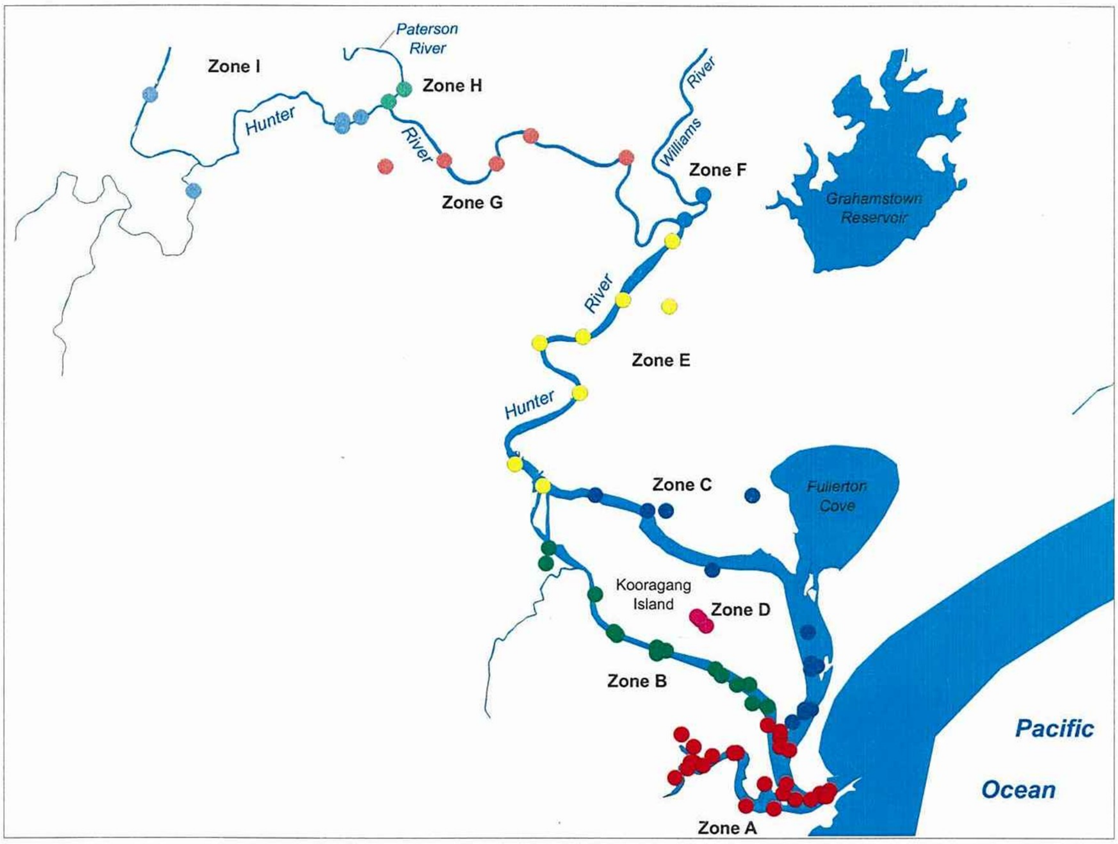


Figure 2-3 Hunter River Estuary Water Quality Monitoring Sites (Sanderson & Redden, 2001)

Surface water quality data gathered since 1975 indicates that conditions in this reach of the Hunter River exceed the ANZECC (2000) trigger values for slightly disturbed ecosystems, and as such suggest a degraded aquatic ecosystem. The median nutrient concentrations are typically 3 to 5 times higher than the ANZECC (2000) trigger values suggesting that the river is susceptible to increased loads of sediment and nutrients.

The monitoring results also indicate that surface water is highly turbid for periods likely to be related to catchment runoff events (10%ile Secchi depth of 0m, 90%ile turbidity level of 23 NTU), which is likely to be limiting algal growth. Chlorophyll-a concentrations are slightly elevated, although due to high turbidity levels, these are likely to be lower than potentially could occur. Median dissolved oxygen (DO) levels are typically lower than acceptable limits for estuarine waters.

3 POTENTIAL ENVIRONMENTAL IMPACTS

Industrial development often results in significant modification to existing soils, topography, imperviousness and vegetation. Surface runoff volumes from industrial development are typically elevated above natural conditions and without mitigation have the potential to convey elevated quantities of pollutants to receiving waters. Water quality impacts that can often be directly attributed to industrial development include:

- increased nutrient loads leading to excessive plant growth in receiving waters;
- increased sediment loads leading to increased turbidity, increased erosion, reduced photosynthesis and smothering of aquatic plants and animals;
- increased contaminants and toxic materials including heavy metals, hydrocarbons and pesticides;
- increased litter and organic debris reducing oxygen levels and degrading aesthetics;
- changes to groundwater levels that impact on soil moisture, acid sulphate soils and vegetation; and
- conveyance of exotic plant and weed seeds resulting in degradation of riparian habitat.

The available surface water quality data within the Hunter River near the site (refer Section 2.3) indicates that the riverine environment is currently influenced by a combination of elevated nutrient and sediment loads. Without mitigation, the construction of new industrial development has the potential to further increase the nutrient and sediment loads discharging into the river, in addition to other pollutants commonly associated with stormwater runoff including hydrocarbons, litter, organic debris, oils/ greases and heavy metals.

The provision of stormwater quality and quantity management measures within the site would assist to detain, retain, harvest, filter, infiltrate and biologically treat surface runoff. This would reduce the concentrations and loads of pollutants discharged into the receiving waters. In addition, infiltrating runoff and increasing the evapotranspiration potential can reduce the volume of runoff which otherwise has the potential to generate additional pollutants through erosion of the receiving watercourses.

Water is our most precious resource and existing urban water supply systems are approaching their limits. Opportunities for expanding existing water supply dams and creating new water supply sources are becoming increasingly limited, and there are growing community demands to increase environmental flows downstream from supply dams. As the urban population increases, we therefore need to make more efficient use of water. Development within the Project Site can contribute to water sustainability by incorporating a range of water efficiency measures.

4 PRINCIPLES, OBJECTIVES AND TARGETS

4.1 Water Management Objectives

The following overarching objectives for stormwater management are proposed for the Project Site:

- Promote sustainable water resources management;
- Protect ecological habitats from water pollution;
- Protect watercourses, wetlands, groundwater and riparian corridors from water pollution;
- Protect watercourses from increased erosion and sedimentation;
- Integrate the management of stormwater, water supply, wastewater and flooding;
- Conserve potable water to achieve more efficient use of water resources; and
- Integrate water management into the landscape.

These water management objectives are consistent with local, regional, state and national objectives relevant to the Project Site. To assist with achieving the water management objectives, specific principles, objectives and targets are described in the following sections for:

- Stormwater quality management (surface runoff);
- Stormwater quantity management (environmental flows, stream forming flows, drainage and overland flows); and
- Water conservation (potable water conservation).

4.2 Stormwater Quality

4.2.1 Principles and Objectives

The following fundamental guiding principles relevant to stormwater quality have been considered in developing a water management strategy for the Project Site:

- Discharge of untreated stormwater from urban catchments into receiving waters and ground water is likely to degrade the water quality in those environments;
- Retention of stormwater will reduce the concentrations and loads of stormwater pollutants discharging to groundwater or a surface water environment; and
- Filtering of stormwater will reduce the concentration and loads of stormwater pollutants discharging to groundwater or a surface water environment.

Surface water quality objectives include:

- To prevent degradation of water quality within the Hunter River and its tributaries;
- To prevent direct pollution of existing surface and groundwater water systems;
- To minimise the risk of indirect water pollution by appropriate management of land uses and activities;
- To ensure the high quality of discharge to the drainage systems;

- To promote the protection of the aquatic environment through the use of Ecologically Sustainable Development (ESD) principles; and
- Adopt a total catchment management approach to water quality and protection of water systems.

4.2.2 Targets

Port Stephens Council's Urban Stormwater and Rural Water Quality Management Plan (2003) outlines stormwater quality performance targets for new small developments (up to 10 ha) in the Local Government Area (LGA). The performance targets are load-based targets requiring it to be demonstrated that a particular development with treatment measures in place would achieve the targeted reductions when compared to the proposed development without treatment. The following default load-based reduction targets have been adopted by Port Stephens Council:

- Total Nitrogen (TN) 45%;
- Total Phosphorus (TP) 45%;
- Total Suspended Solids (TSS) 50%;
- Coarse Sediment 80%;
- Litter 70%; and
- Hydrocarbons 90%.

For developments larger than 10 ha, or development within a sensitive catchment, the development proponent is required to assess the magnitude of any change in stormwater pollution loads caused by the development (with treatment measures in place) and the likely impact of any increase in pollutant levels. The Project Site is larger than 10 ha, but is not located with an area defined by Council as being within a sensitive catchment. Based on our understanding of the water quality and ecological characteristics of the surrounding area and receiving waters, it is suggested that the site should be considered as a sensitive catchment.

The following load-based reduction stormwater quality targets were adopted for the Project Site:

- Total Nitrogen (TN) 45% to 50%;
- Total Phosphorus (TP) 60% to 65%;
- Total Suspended Solids (TSS) 85% to 90%;
- Coarse Sediment 90% to 95%;
- Litter 90% to 95%; and
- Hydrocarbons 90%.

The targets are relevant to surface water discharge to receiving waters and infiltration to ground water. The water management strategy demonstrates how the load reductions would be achieved prior to discharge to watercourses or interception by the groundwater table.

The targets are compared against modelled post development (without WSUD measures) and post development (with WSUD measures) scenarios in this assessment. MUSIC software was applied to model the performance of a Water Management Strategy against the targets.

4.3 Stormwater Quantity

4.3.1 Principles and Objectives

The following fundamental guiding principles are relevant to stormwater quantity management for the Project Site:

- Minimising changes to the volume of runoff for frequent runoff events following development will assist with reducing impacts on environmental flows, maintaining ephemeral flows and reducing impacts on wetting and drying cycles in wetlands.
- Minimising changes to environmental flows will assist with protecting stream and wetland ecology.
- Minimising changes to the duration of flows in the 1 to 2 yr ARI range will assist with reducing changes to erosion and sedimentation within the receiving streams following development.
- Intercepting runoff within the development and conveying these flows within a defined drainage system with sufficient capacity to convey the 5 yr ARI flow will assist with minimising nuisance flooding for the community.

The following objectives are considered to be appropriate for management of water quantity within the Project Site:

- To minimise directly connected impervious areas within development to reduce surface runoff volumes;
- To maximise the retention of runoff;
- To ensure that an adequate and environmentally acceptable method for draining stormwater is implemented;
- To minimise nuisance flows of stormwater from one property to adjoining properties;
- To provide a stormwater system which can be maintained economically;
- To provide a stormwater system which utilises open space in a manner compatible with other uses; and
- To prevent damage by stormwater to the built and natural environment.

4.3.2 Targets

Whilst large natural freshwater/brackish wetlands are located within the surrounding catchment and floodplain areas, the existing and proposed drainage configuration directs surface water discharges from the proposed development to the Hunter River along existing constructed drains without initially draining through these wetlands.

Whilst surface runoff from the Project Site would not be discharged directly to the surrounding wetlands, potential cumulative impacts to the flows from numerous other developments within the Hunter River catchment could impact on the wetland ecology. It is considered that retention and treatment of runoff from increased impervious areas within the Project Site is warranted as a precaution. The environmental flow target adopted for the site is to retain a minimum 10mm runoff depth from directly connected impervious areas within the site. The retention requirement would be incorporated into measures that temporarily store runoff (e.g. biofiltration swales).

Flow velocities within the drainage channels during events up to the 100yr ARI local catchment event are expected to be less than 0.5m/s for the majority of reaches. Control of stream flows following development is therefore unlikely to provide any significant benefit for reducing stream erosion potential. Although no specific discharge controls are proposed, provision of stormwater retention within biofiltration swales will indirectly control flows in the typical stream forming flow range.

4.4 Water Conservation

4.4.1 Principles and Objectives

The following fundamental guiding principles are relevant to water conservation for the Project Site:

- Reducing the capture and consumption of water for human uses will reduce the impact of development on the natural water cycle and aquatic ecosystems that rely on fresh water flows;
- Reducing the consumption of potable water assists with delaying augmentation of existing water supply systems; and
- Replacing potable water with alternative water sources reduces the discharge of pollutants into urban streams.

The following objectives are considered to be appropriate for water conservation within the Project Site:

- Match water sources with appropriate water uses;
- Reduce the consumption of potable water;
- Use potable water more efficiently; and
- Minimise the consumption of potable water for non-potable uses.

4.4.2 Targets

No specific targets are proposed for the development. Water conservation potential will be dependent on the characteristics of individual developments within the subdivision for which specific details are currently unknown.

5 MITIGATION MEASURES

5.1 Overview

This section outlines the types and locations of stormwater management measures proposed for the Project Site to protect receiving water quality.

Stormwater quality and quantity management measures can broadly be positioned at lot, street or sub-catchment scales throughout future development within the Project Site. The suitability of each particular scale requires consideration of the water management objectives, physical site constraints and urban design objectives.

Lot scale measures are positioned within private lots and typically only manage water from that lot. Ownership of the measure is typically retained by the property owner who is responsible for future operation and maintenance. Typically lot scale measures should have a relatively simple function with low risk to other properties and the environment if the measure does not function as intended. Street scale measures can be integrated within the streetscape with close consideration of potential conflicts with services, pedestrians, motorists and the community. Sub-catchment scale measures are typically located downstream of subdivisions, minor sub-catchments or adjacent to major watercourses. Typically sub-catchment scale measures would be located downstream of all building development.

The proposed water management strategy for the Project Site includes lot and sub-catchment scale measures and these are described below.

5.2 Reduced Directly Connected Impervious Areas

Increasing the impervious area within the Project Site will significantly increase runoff volumes. Without mitigation, there is a potential for high runoff volumes and associated stormwater pollutant loads to be conveyed to the receiving waters.

Roof and road surfaces comprise the majority of directly connected impervious areas in conventionally drained industrial developments. Conventional drainage systems typically collect and convey stormwater along a series of impervious surfaces prior to point discharge into a receiving watercourse. There is typically limited opportunity for retention, filtration, infiltration or evapotranspiration of stormwater in these systems. A fundamental objective for this site is to break the series of impervious surfaces to reduce flow rates and the volume of additional stormwater runoff that discharges to the Hunter River. Disconnecting impervious surfaces also assists with intercepting pollutant loads.

The water management strategy incorporates grassed swales and biofiltration swales to achieve disconnection of impervious areas from the drainage channels and downstream receiving waters.

5.3 Gross Pollutant Trapping

Gross pollutant traps (GPTs) are typically provided to capture litter, organic debris and coarse sediment conveyed by stormwater in urban areas. GPTs are pre-treatment measures for other downstream measures designed to remove fine sediment, heavy metals, nutrients and other particulate or dissolved pollutants. GPTs concentrate the larger visible stormwater pollutants at one location and thereby avoid the time consuming task of removing this matter when it is dispersed within a downstream measure or receiving water. Capture of these pollutants can also assist in minimising blocking potential for downstream measures.

GPTs either have an above or below-ground detention storage. Above-ground storage GPTs typically store the captured pollutants in a dry state, whilst below-ground GPTs store pollutants wet. Storing gross pollutants dry is preferable for transportation and disposal costs will be lower for future maintenance. Dry storage gross pollutant trapping measures are preferred for the Project Site.

The water management strategy incorporates pre-treatment filtration/settling basins that would be provided adjacent to stormwater drainage outlets from the development. These pre-treatment storages would temporarily retain incoming stormwater to enable gross pollutants to be separated prior to overflow into downstream measures. These storages would be dry between events enabling litter and other debris to be removed mechanically via a suitable designed access.

5.4 Grassed Swales

Grassed swales are a treatment measure that performs by filtering sediment from the flowing water. The height of the grass should be maintained at or above the design flow depth, with a height of approximately 150mm being typical to ensure the swales perform as designed. For grassed swales, a continual falling gradient of 2 to 4% is typically provided along the swale to achieve sufficient drainage. In circumstances where the swale gradient is less than 2%, sub-soil drainage is typically required to improve drainage and prevent excessive ponding of water. Within the Project Site, grassed swales would be constructed at a typical gradient of 0.5 to 1%. The grassed swales within the Project Site will be provided with sub-soil drainage to improve drainage of the base of the swales following completion of each storm event.

Short sections of grassed swale are proposed to be located within the Project Site immediately adjacent to the gross pollutant trapping measures. The primary function of these sections of swale would be to capture the remnant coarse sediment load that passes through the gross pollutant trapping measures to assist with minimising maintenance requirements for downstream biofiltration swales. An example of a grass lined swale is shown in Figure 5-1.

Figure 5-1 Grass lined swale

5.5 Biofiltration Swales

Biofiltration swales comprise an above ground retention/detention storage and below ground filter. The above ground storage performs sedimentation which is a function of the hydraulic residence time and the below ground filter acts to intercept finer particles including heavy metals. Nutrients are removed through uptake by appropriate vegetation planted within the measure. Biofiltration measures assist with disconnecting impervious areas from urban streams by retaining stormwater for an extended period. The filtered stormwater typically infiltrates through the base of the swale (rapidly in sandy soils or slowly in clay soils). If the infiltration potential of the in-situ soils is unsuitable due to low hydraulic conductivity or the presence of saline soils, a sub-soil drainage pipe may be provided at the base of the infiltration storage to collect and convey the filtered stormwater. A typical biofiltration system configuration is shown in Figure 5-2.

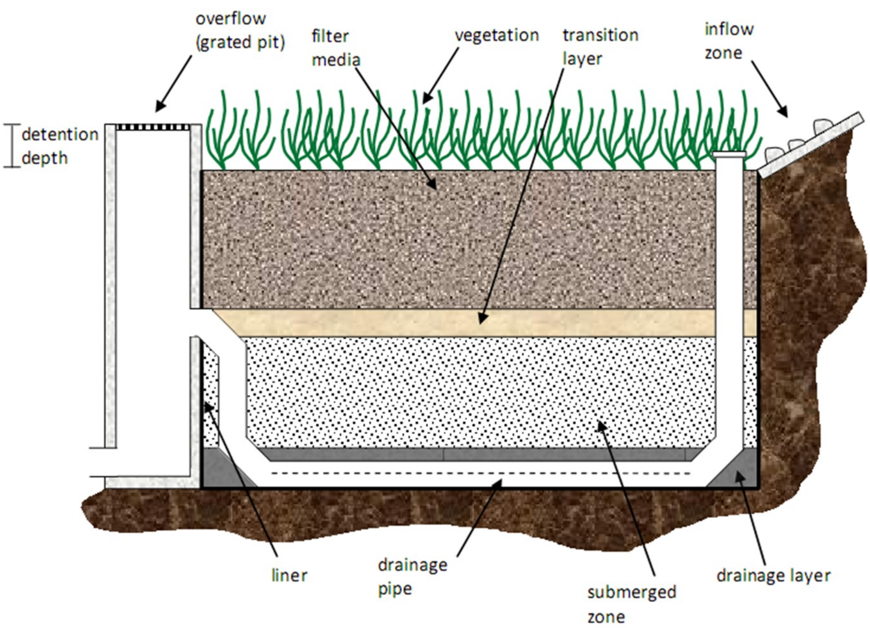


Figure 5-2 Typical Biofiltration Swale Arrangement (FAWB, 2009)

The water management strategy for the Project Site includes provision for biofiltration swales within the drainage corridors. The biofiltration swales would be constructed along benches formed on either side of the central drainage channel. Filtered flows would be collected at the base of the biofilter and discharged into the adjacent drainage channel.

The biofilter would be planted out with indigenous grass species that are appropriate for frequent inundation and are tolerant of extended periods of dry weather. Indicative species include *Carex appressa, Dianella caerulea* and *Lomandra longifolia*.

Figure 5-3 Biofiltration Swale Examples

6 STORMWATER QUALITY AND QUANTITY MODELLING

6.1 Overview of Approach

Conventional stormwater quality management practices on industrial sites have typically focused on the capture of the “first flush” (i.e. the collection of the initial runoff from a storm event). For this site an alternative approach to the management of stormwater is proposed using treatments suitable not only to treat the “first flush” but also continue to function throughout a range of storm events of varying intensities and durations.

The treatment measures considered include combinations of measures that retain and/or filter stormwater runoff. Bypass, overflow or filtered flow from these systems would be conveyed to the downstream drainage system. The measures are typically provided in series to add redundancy that assists with minimising potential risks to the environment resulting from any one particular measure failing.

The performance of these systems can therefore only be properly assessed utilising a continuous simulation model. The performance of possible stormwater treatment strategies in managing stormwater pollutants was assessed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software (Version 4.10) developed by the CRC for Catchment Hydrology. The software has been specifically designed to allow for comparisons to be made between different stormwater management systems and thereby function as a decision support tool.

The key model inputs and MUSIC modelling approach are described in the following sections.

6.2 Meteorological Template

The meteorological template includes the rainfall and areal potential evapotranspiration data. It forms the basis for the hydrologic calculations within MUSIC.

Rainfall data were obtained from the Bureau of Meteorology (BoM) for the pluviograph at Williamtown RAAF base located approximately 10km northeast of the site. The average annual precipitation at Williamtown over the 1942 to 2010 period is 1122 mm. Pluviograph data were available from 1954 onwards.

The available data were reviewed and the 1999 to 2006 period was assessed to have a mean annual rainfall of 1063mm (within approximately 5% of the long-term mean at Williamtown). Data within this seven year period were reviewed and found to include limited periods of missing or accumulated data. The temporal distribution of the rainfall data within this period was evaluated and compared with long-term monthly averages. Overall, the seasonal trends observed between 1999 and 2006 are consistent with that observed over the entire data period. The 1999 to 2006 period was adopted for MUSIC modelling.

Areal Potential Evapotranspiration (APET) rates were adopted from the Bureau of Meteorology’s Climatic Atlas of Australia (BOM, 2001) and these are summarised in Table 6-1.

Table 6-1 Average Areal Potential Evapotranspiration (APET) Data

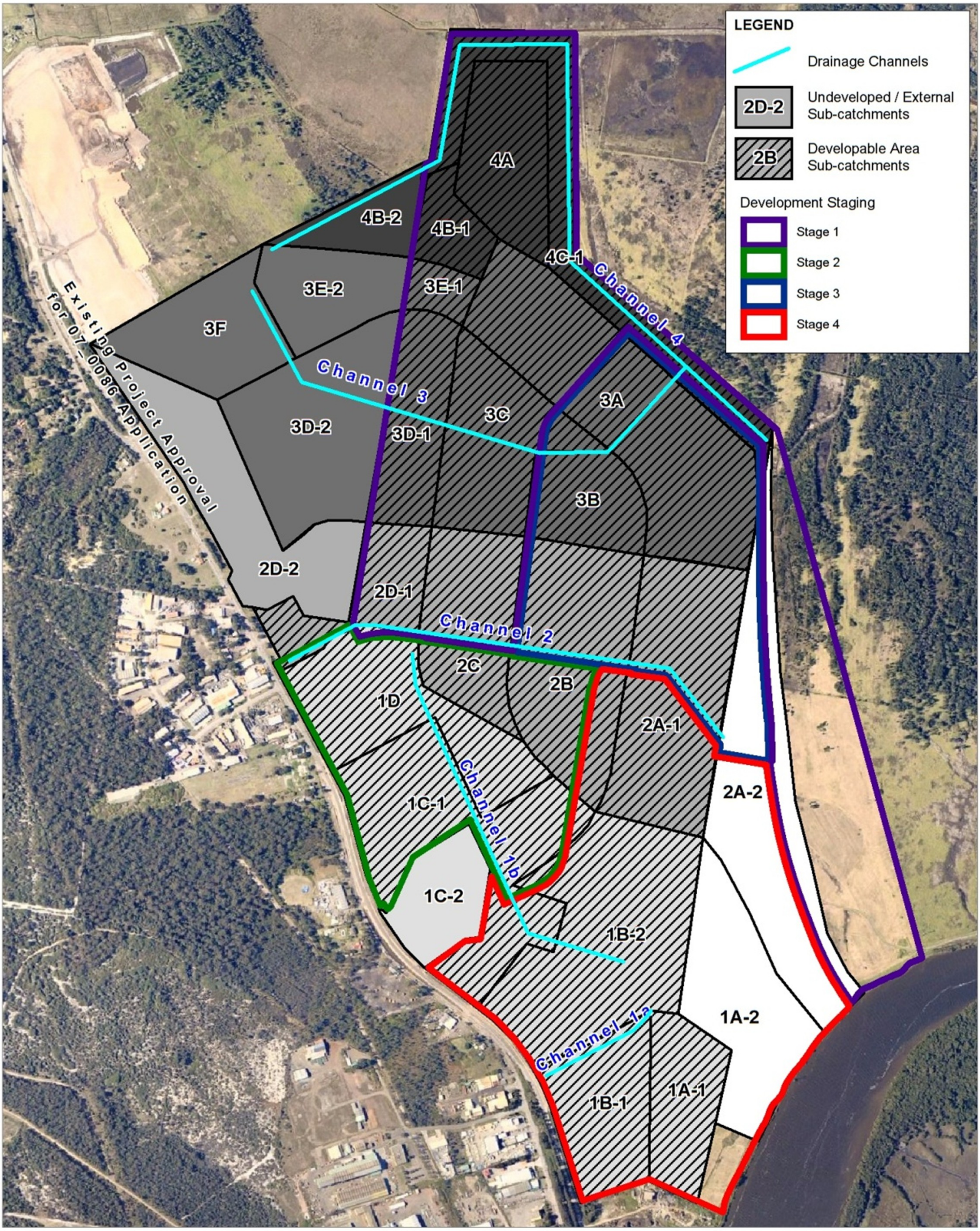
Month	Average APET (mm)
January	190
February	149
March	146
April	95
May	65
June	53
July	56
August	71
September	99
October	138
November	162
December	178

6.3 Source Nodes

Within MUSIC the user defines source nodes which represent the pollutant generating characteristics of particular land uses/surfaces within the site. MUSIC has three default source nodes to represent urban, forest and agricultural land-uses. The source nodes have default parameters for soil properties, storm flow pollutant concentrations and base flow pollutant concentrations.

For modelling purposes, it was assumed that 80% of the developable area would be industrial lots with the remaining 20% comprising the road reserve. The final configuration of individual industrial lots would be confirmed at development application stage. For modelling it was assumed that on average the industrial lots would comprise 50% roof area, 40% paved area (internal road pavement and landscaping) and 10% vegetated landscaped area. Within the road reserve it was assumed that 50% would be road pavement and 50% would be vegetated/paved footway. Based on these assumptions, it was estimated that the industrial lots would be approximately 85% directly connected impervious area (DCIA) and the road reserve 65% DCIA. The modelling extents included the developable areas (i.e. future industrial lots and road reserves) and internal drainage corridors. It was assumed that the drainage corridors would be 20% impervious to allow for direct rainfall on the central drainage channel.

The sub-catchment locations and proposed project staging are shown on Figure 6-1. Table 6-2 provides a summary of the sub-catchment areas, land uses and relevant project stages. The sub-catchments have been defined based upon preliminary fill levels for the development and the locations of the main drainage channels. The project staging boundaries were defined considering infrastructure requirements and other relevant factors.



Title:

Developed Sub-catchments

Figure: **6-1**

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BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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Table 6-2 Developed Sub-catchments Adopted for MUSIC Modelling

	Sub-catchment Area (ha)				Relevant Stage
Sub-catchments	**Developable Area**	**Drainage Corridors**	**Floodplain**	**External**	
Channel 1a / 1b					
1A-1	6.77	0	0	0	Stage 4
1A-2	0	0	12.31	0	Floodplain
1B-1	7.87	0.84	0	0	Stage 4
1B-2	18.83	1.44	0	0	Stage 4
1C-1	16.19	1.82	0	0	Stages 2, 4
1C-2	0	0	0	5.56	Tomago House
1D	12.10	0.56	0	0	Stage 2
Channel 2					
2A-1	15.06	1.23	0	0	Stages 3, 4
2A-2	0	0	18.58	0	Floodplain
2B	14.92	0.84	0	0	Stages 2, 3, 4
2C	9.14	0.70	0	0	Stages 1, 2
2D-1	5.28	0.98	0	0	Stage 1
2D-2	0	0	0	13.66	T1 lands
Channel 3					
3A	19.39	3.69	0	0	Stages 1, 3
3B	5.52	0.62	0	0	Stage 3
3C	9.89	0.70	0	0	Stage 1, 3
3D-1	7.45	0.42	0	0	Stage 1
3D-2	0	0	0	14.97	T1 lands
3E-1	1.96	0	0	0	Stage 1
3E-2	0	0	0	7.06	T1 lands
3F	0	0	0	9.04	T1 lands
Channel 4					
4A	8.93	0	0	0	Stage 1
4B-1	3.33	0	0	0	Stage 1
4B-2	0	0	0	4.34	T1 lands
4C-1	0	0	12.21	0	Floodplain

The developable areas with the Project Site will be primarily industrial land uses. Internal drainage corridors between the developable areas are expected to generate similar source pollutant concentrations to forested conditions due to the absence of impervious surfaces. To simulate these land uses, base flow and storm flow concentrations of TSS, TN and TP were sourced from Fletcher et al (2005) which provides values recommended by NSW DECC for site/catchment modelling within

NSW. Storm flow and base flow event mean concentrations adopted in MUSIC are presented in Table 6-3.

Table 6-3 Storm and Base Flow Event Mean Concentrations (EMCs) adopted in MUSIC

Land Use	Parameter	Storm Flow EMC (mg/L)	Base Flow EMC (mg/L)
Floodplain areas (Forest)	Total Suspended Solids	40	6
	Total Phosphorus	0.08	0.03
	Total Nitrogen	0.9	0.3
Drainage corridors (Forest)	Total Suspended Solids	40	6
	Total Phosphorus	0.08	0.03
	Total Nitrogen	0.9	0.3
Developable area (Industrial)	Total Suspended Solids	140	16
	Total Phosphorus	0.25	0.14
	Total Nitrogen	2.0	1.3

It is envisaged that the industrial development would also generate elevated heavy metal concentrations from roof and road runoff within the development. MUSIC does not directly model treatment of heavy metals, although it is considered that the modelled Total Suspended Solids removal provides a reasonable surrogate for the expected removal of particulate heavy metals.

6.4 Treatment Nodes

MUSIC enables the user to specify treatment nodes which represent the mitigation measures proposed to improve the quality of stormwater discharged from the site. MUSIC includes the capability to simulate the performance of a range of treatment nodes including gross pollutant traps, ponds, constructed wetlands, swales, biofiltration systems, infiltration systems, sedimentation ponds and buffer strips. Each treatment node has a range of default parameters that may be altered by the user to allow the treatment node to be ‘customised’ to best represent the treatment measure proposed for the development.

For the Project Site, stormwater quality is proposed to be managed primarily through biofiltration swales constructed along elevated benches within the main drainage channels. The dimensions and properties of these swales were estimated to achieve the water quality objectives discussed in Section 4.2.2. The biofiltration swales would be formed at the same time as filling occurs to create the channels and adjacent developable areas for each stage. In this manner, construction of the biofiltration swales will correspond with the construction of the developable areas that the biofiltration swales will treat. Each section of biofiltration swale will treat a discrete section of the adjacent developable area prior to discharge into the adjacent central drainage channel for conveyance to the Hunter River. This would avoid overloading of any one particular section of biofiltration swale. Biofiltration swales would be provided on both sides of the drainage channel (with the exception of Channel 4) which provides flexibility with staging construction on either side of each channel. This approach will enable the site to be progressively developed with some flexibility whilst ensuring that runoff from each development stage is treated appropriately prior to discharge. Typical sections showing the indicative location of the biofilters relative to the proposed drainage channels are shown in Figure 6-2 to Figure 6-4. The bioretention units indicated (i.e. biofiltration swales) would also incorporate an above ground detention component as shown in Figure 6-5.

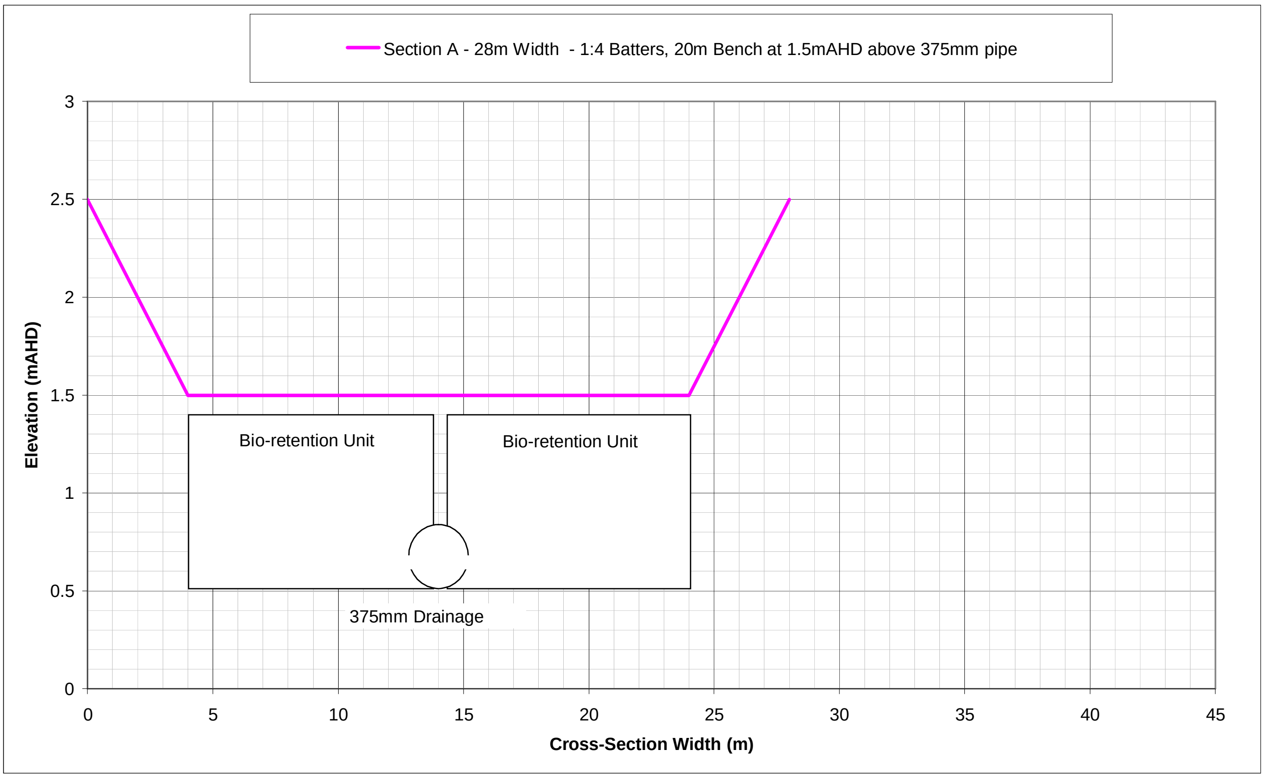


Figure 6-2 Typical Section - Upper Reaches of Channels 1a, 1b, 2 and 3 (BMT WBM, 2012a)

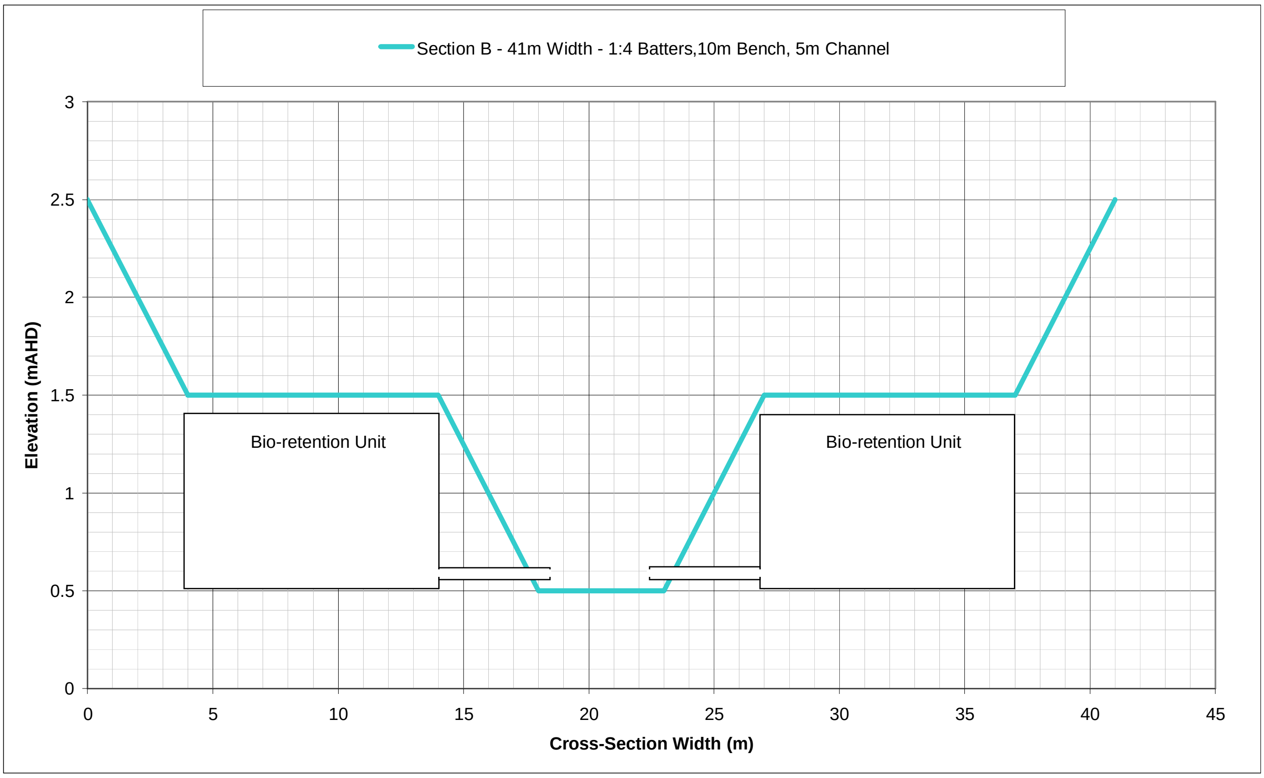


Figure 6-3 Typical Section – Lower Reaches of Channels 1a, 1b, 2 and 3 (BMT WBM, 2012a)

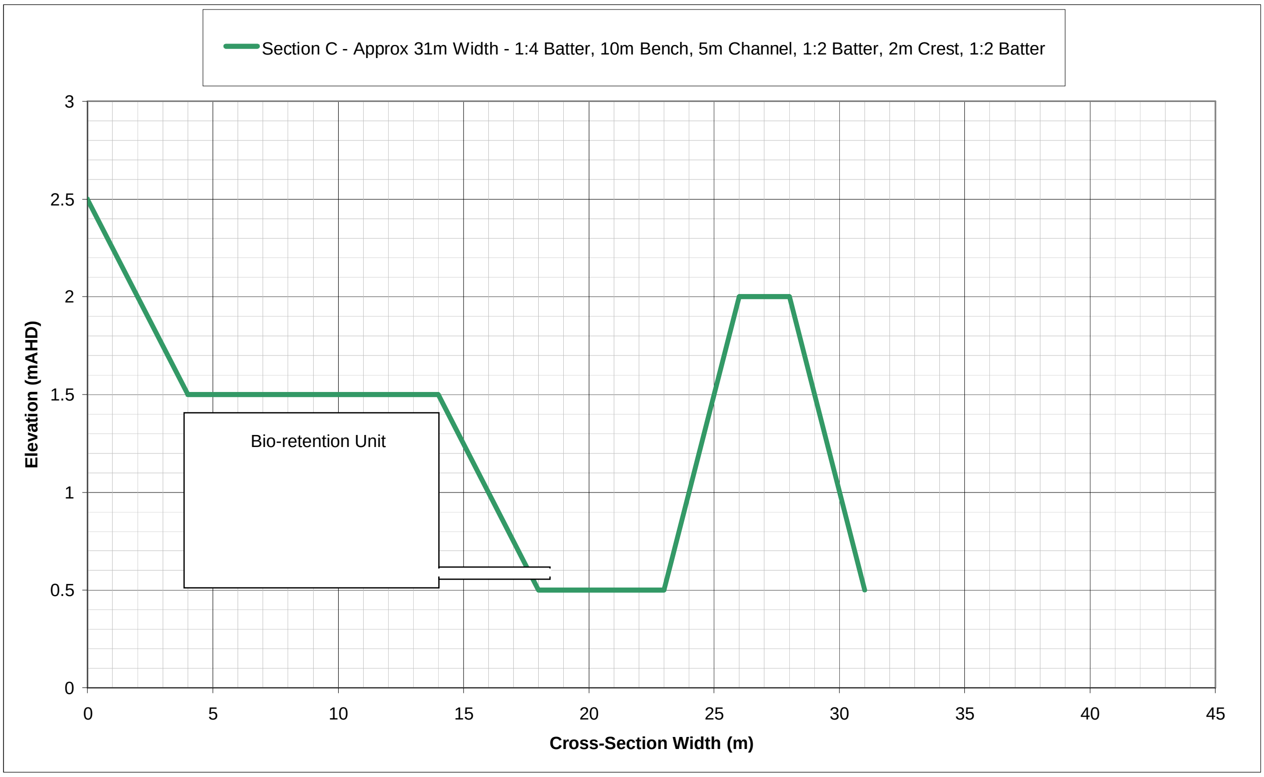


Figure 6-4 Typical Section – Channel 4 (BMT WBM, 2012a)

Gross pollutant traps, sediment traps and vegetated swales are also planned to provide pre-treatment of stormwater runoff draining to the biofiltration swales to reduce the quantity of coarser pollutants (e.g. litter, organic debris and coarse sediment). At this stage, gross pollutant traps and vegetated swales were conservatively not included within the MUSIC models. Inclusion of these measures within the models would increase the modelled load reductions summarised in Table 6-5.

6.5 Modelling Results

6.5.1 Existing Scenario

The existing conditions for the Project Site were modelled in MUSIC. Forested conditions were adopted as representative of the existing site conditions (floodplain areas and drainage channels) and runoff quality parameters for this land use were adopted from Fletcher et al (2005) (adopted values for floodplain areas presented in Table 6-3). Rainfall runoff parameters were calibrated to achieve a long-term volumetric runoff co-efficient of 0.25 and baseflow index of 0.20, which in the absence of gauged flow data is considered to be reasonably representative of hydrologic conditions for the site. The modelling results for the existing conditions are summarised in Table 6-4.

Table 6-4 MUSIC Results – Existing Scenario

	Flow (ML/yr)	TSS (t/yr)	TP (kg/yr)	TN (kg/yr)
Existing Source Loads	467	17	36	424

6.5.2 Developed Scenario

The MUSIC modelling results for the developed scenario are summarised in Table 6-5. The results indicate that the proposed water management strategy would achieve the runoff quality targets summarised in Section 4.2.2. The results indicate that the TSS loads for the developed with mitigation scenario would be similar to the existing conditions. The TN and TP loads from the site (following treatment) are expected to increase over existing conditions. This is primarily associated with the increased stormwater runoff volumes from the impervious areas within the developable areas of the Project Site increasing from 0% to 80%. This increased imperviousness will result in the stormwater runoff volumes increasing by approximately 200%. To achieve the estimated existing TN and TP loads, load reductions of approximately 85% and 90% respectively would be required. This exceeds the capability of current best practice mitigation measures.

Table 6-5 MUSIC Results – Development with Biofiltration Swales

		Flow (ML/yr)	TSS (t/yr)	TP (kg/yr)	TN (kg/yr)	GP (t/yr)
Channel 1	Source load	512	91	146	1100	14.1
	Outlet load	474	8	38	584	0.4
	Reduction (%)	*7%*	*92%*	*74%*	*47%*	*97%*
Channel 2	Source load	370	65	107	792	10.2
	Outlet load	339	5	27	414	0.4
	Reduction (%)	*8%*	*92%*	*75%*	*48%*	*97%*
Channel 3	Source load	386	69	112	831	10.7
	Outlet load	355	5	27	427	0.3
	Reduction (%)	*8%*	*93%*	*76%*	*49%*	*98%*
Channel 4	Source load	98	18	29	215	2.7
	Outlet load	90	2	7	113	0
	Reduction (%)	*8%*	*91%*	*74%*	*48%*	*100%*
Total	Source load	**1370**	**243**	**394**	**2940**	**37.7**
	Outlet load	**1260**	**19**	**100**	**1540**	**1.0**
	Reduction (%)	***8%***	***92%***	***75%***	***48%***	***97%***

The modelling results indicate that the key stormwater pollutant controlling the mitigation measure sizing is TN which is often the limiting nutrient in marine waters. Therefore, increasing the capture of nitrogen from industrial development should assist with reducing the potential for eutrophication and associated algal blooms within the receiving waters. The modelling results indicate that the strategy would also achieve the performance targets for TSS and TP. The modelled biofiltration basin dimensions for each drainage channel catchment are summarised in Table 6-6.

Table 6-6 Biofiltration Swales Dimensions

		Biofiltration Swale Dimensions		
Channel ID	**Developable Area (ha)**	**Total Length[1] (m)**	**Total Width[1] (m)**	**Total Footprint (m^2/developable ha)**
Channel 1	61.8	1600	13.0	340
Channel 2	44.4	1000	16.5	370
Channel 3	44.2	950	16.5	355
Channel 4	12.3	1200	3.5	340

1. Total length is the length of drainage channel that biofiltration swales would be constructed on both sides of (except for Channel 4 where the swale would be constructed on one side only). The total width is the width of biofiltration swale per metre length of drainage channel. Typically this width would be equally divided between both sides of the drainage channel (except for Channel 4 where the total width would be provided along one side of the channel).

The modelled biofiltration swale properties and design characteristics were the same for all swales. A saturated hydraulic conductivity of 100 mm/hr was assumed for the biofilter media. The biofiltration swales were modelled with an average extended detention depth of 0.3 metres and biofilter depth of 0.4m. It was assumed that the biofiltration swales would include a 0.3m submerged zone for denitrification of stormwater during inter-event periods. A slotted sub-soil drain would be positioned at the base of the submerged zone and connected at appropriate intervals to the adjacent drainage channel. The sub-soil drain outlets to the drainage channel would be elevated 0.3m above the base of the submerged zone. Further typical details of the submerged zone configuration within a biofilter are shown in Figure 5-2. For all swales it was assumed that 67% of the swale width would be biofilter media planted with appropriate vegetation. Figure 6-5 shows a typical schematic cross section of the biofiltration swale. Biofiltration swales would be provided on both sides of the drainage channels for Channel 1, 2 and 3 and only on the development side for Channel 4. Proposed locations of the biofiltration swales are shown in Figure 6-6.

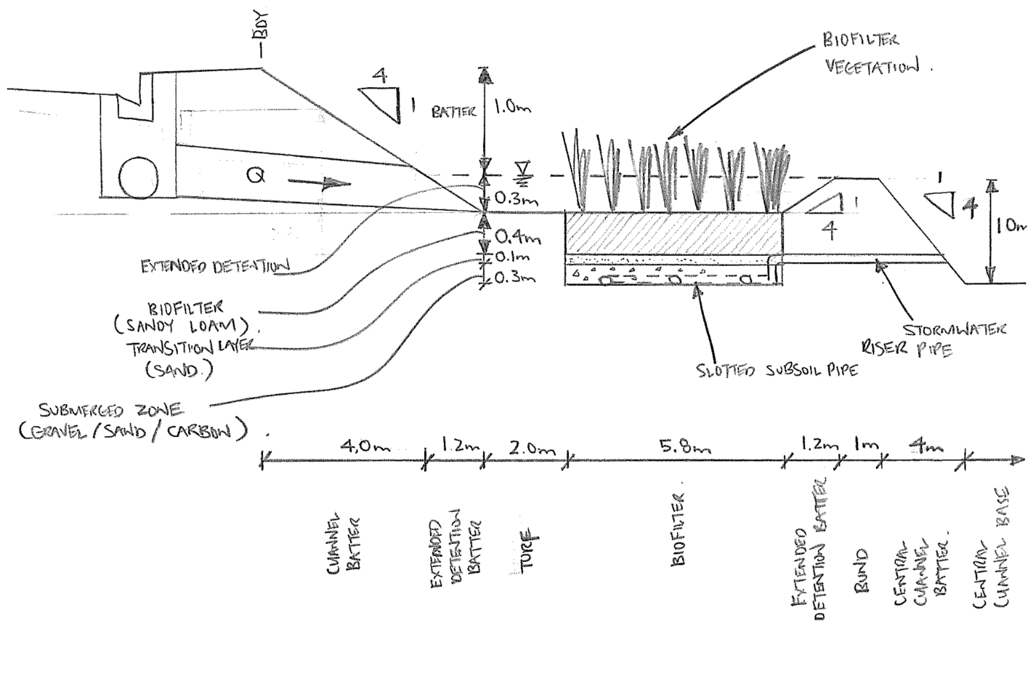
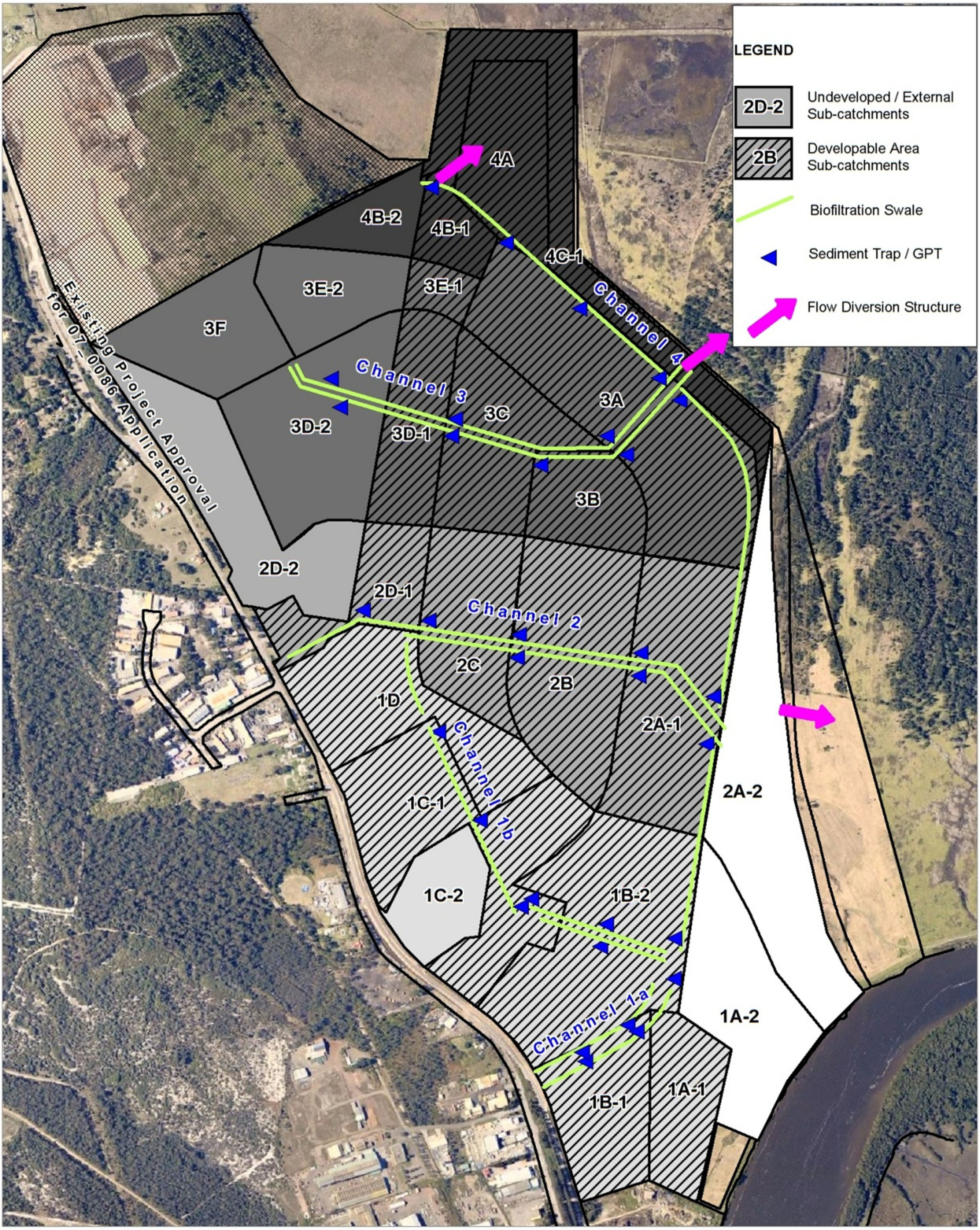


Figure 6-5 Typical Biofiltration Swale Configuration (one side of the channel shown)



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The MUSIC modelling results presented in Table 6-5 conservatively consider only incorporation of biofiltration swales into the channel benching adjacent to the main drainage channels. In addition to the modelled biofiltration swales, additional barriers for water quality protection would be provided between the future street drainage system outlets and the Hunter River receiving waters. Specifically, further stormwater pollutant removal is anticipated from:

- Interception of roof runoff in rainwater tanks and re-use of the captured runoff within appropriate developments in the Project Site;
- Pre-treatment gross pollutant traps (GPTs), sediment traps and grassed/vegetated swales located at drainage system outlets in advance of the discharge points into the biofiltration swales (indicative locations of GPTs and sediment traps are shown on Figure 6-6);
- Further optimisation of the biofiltration swale design;
- Additional attenuation of stormwater pollutants in the flat grading drainage channels conveying stormwater from the development to the Hunter River. It is expected that the increased hydraulic residence time in the slow flowing channels would further enhance sedimentation of finer pollutants;
- Aquatic vegetation within the channels would provide additional filtration of the flow, promoting sedimentation and cycling/uptake of nutrients. It is expected that aquatic vegetation in the central section of each channel would function similarly to a linear wetland; and
- Additional filtering and treatment through proposed rehabilitated wetlands areas located in the lower reaches of the site upstream of the existing floodgates.

It is expected that these additional barriers of water quality protection would achieve further significant reductions in pollutant loads to those presented in Table 6-5.

7 SURFACE WATER HYDROLOGY

7.1 Water Balance

A preliminary site water balance was completed for the Project Site considering the existing, developed and developed with treatment measures scenarios. The water balance calculations are based on the total site area that would be modified by the development (i.e. total of developable areas and new drainage corridors summarised in Table 6-2).

The existing hydrologic conditions for the Project Site were modelled in MUSIC. Rainfall-runoff parameters for the existing site conditions were calibrated to achieve a volumetric runoff co-efficient of 0.25 and baseflow index of 0.20 which in the absence of gauged flow data for the site is considered to provide a reasonable representation of hydrologic conditions.

The developed hydrologic conditions for the Project Site were also modelled in MUSIC. For modelling purposes, it was assumed that 80% of the developable area would comprise industrial lots with the remaining 20% being road reserve. For hydrologic modelling it was assumed that on average the industrial lots would comprise 50% roof area, 40% paved area (internal road pavement and landscaping) and 10% vegetated landscaping area. Within the road reserve it was assumed that 50% would be road pavement and 50% would be vegetated/paved footway. It was assumed that the entire road pavement (50% of road reserve) and 30% of the vegetated/paved footway (15% of road reserve) would be directly connected impervious area. Based on these assumptions, it was assumed that the industrial lots would be 85% directly connected impervious area (DCIA) and the road reserve 65% DCIA. The drainage channels were modelled with a DCIA of 20% to allow for direct rainfall on the central drainage channel.

Table 7-1 Estimated Average Annual Project Site Water Balance (ML/yr)

	Rainfall	Evapotranspiration	Surface Runoff	Baseflow
Existing Site	1876	1418	370	88
Developed Site	1876	525	1328	23
Developed Site (treated)	1876	625	1230	21

The average annual water balance estimates presented in Table 7-1 indicate that annual surface runoff volumes from the Project Site would increase from 370ML/yr to 1328ML/yr following development. The increased surface runoff estimate is due to modification of Project Site surfaces from a primarily pervious condition to more than 80% impervious for developable areas. It is estimated that baseflow/groundwater recharge from the Project Site will reduce from 88ML/yr to 23ML/yr following development. The reduced baseflow/groundwater recharge is associated with a loss of pervious soil storage. Currently the highly pervious site would intercept and store a high proportion of rainfall in shallow depressions or within the upper soil layers prior to evapotranspiration. Following development, the majority of insitu soils will be covered by impervious surfaces, which will reduce the soil storage that is available for holding water prior to evapotranspiration. It is estimated that incorporation of biofiltration swales within the site would reduce developed surface runoff volumes by approximately 7%.

7.2 Flow Regime

The MUSIC models developed to evaluate the water balance and pollutant load reductions were also applied to evaluate daily flow volume estimates for flow duration frequency analysis. Flow duration frequency analysis was undertaken considering low and high flow periods. The flow regime comparisons include consideration of changed runoff volumes from the developable areas and drainage corridors within the Project Site only.

Flow frequency analysis was undertaken adopting the annual series flood frequency methods applied for peak instantaneous flow analysis as outlined in Australian Rainfall and Runoff (ARR) Volume 1 (Institution of Engineers Australia, 1987). The analysis was undertaken using the daily flow volumes predicted from the 6-minute time step MUSIC models.

Modelled daily flow volumes from MUSIC for the natural, developed and developed with treatment scenarios were input to a spreadsheet for analysis. For each scenario, moving average daily flow volume estimates for 7, 30 and 60 day continuous periods were calculated for the Project Site. The moving average totals were then analysed to select the maximum (flooding hydrology) and minimum (drying hydrology) daily average flow volumes for 7, 30 and 60 day periods.

The maximum yearly totals were calculated for the high flow duration analysis considering all months in each calendar year. The minimum yearly totals were generally calculated for the monthly rainfall deficit period for each site (i.e. period where the monthly areal PET rate exceeds monthly rainfall). For Tomago, a rainfall deficit occurs between September and March. The low flow analysis was performed considering modelling results within the rainfall deficit period.

The minimum (low flow duration analysis) and maximum (high flow duration analysis) total for each 7, 30 and 60 day period for each year (or annual rainfall deficit period for low flows) were then selected. The minimum and maximum flow volumes for the 7, 30 and 60 day periods were ranked and plotting position exceedance probabilities calculated applying the following equation recommended for annual flood frequency analysis in ARR Volume 1 (Institution of Engineers Australia, 1987):

$PP(m) = (m-0.4)/(N+0.2)$

PP (m) = plotting position exceedance probability

N = number of years of modelled period

m = rank of flow volume total

The low and high flow duration frequency curves were plotted for each site and these are shown and discussed in the following sections.

7.2.1 High Flow Duration Frequency Curves

The estimated high flow duration frequency curves for 7, 30 and 60 day periods are shown in Figure 7-1 to Figure 7-3. The calculated maximum average flows are moving averages over the periods indicated. The 7-day maximum average flows (m^3/day) are higher than the equivalent 30 and 60-day flows. This is due to the 30 and 60-day average periods including an increasingly higher proportion of drier days which tends to lower the average flow as the duration being considered increases.

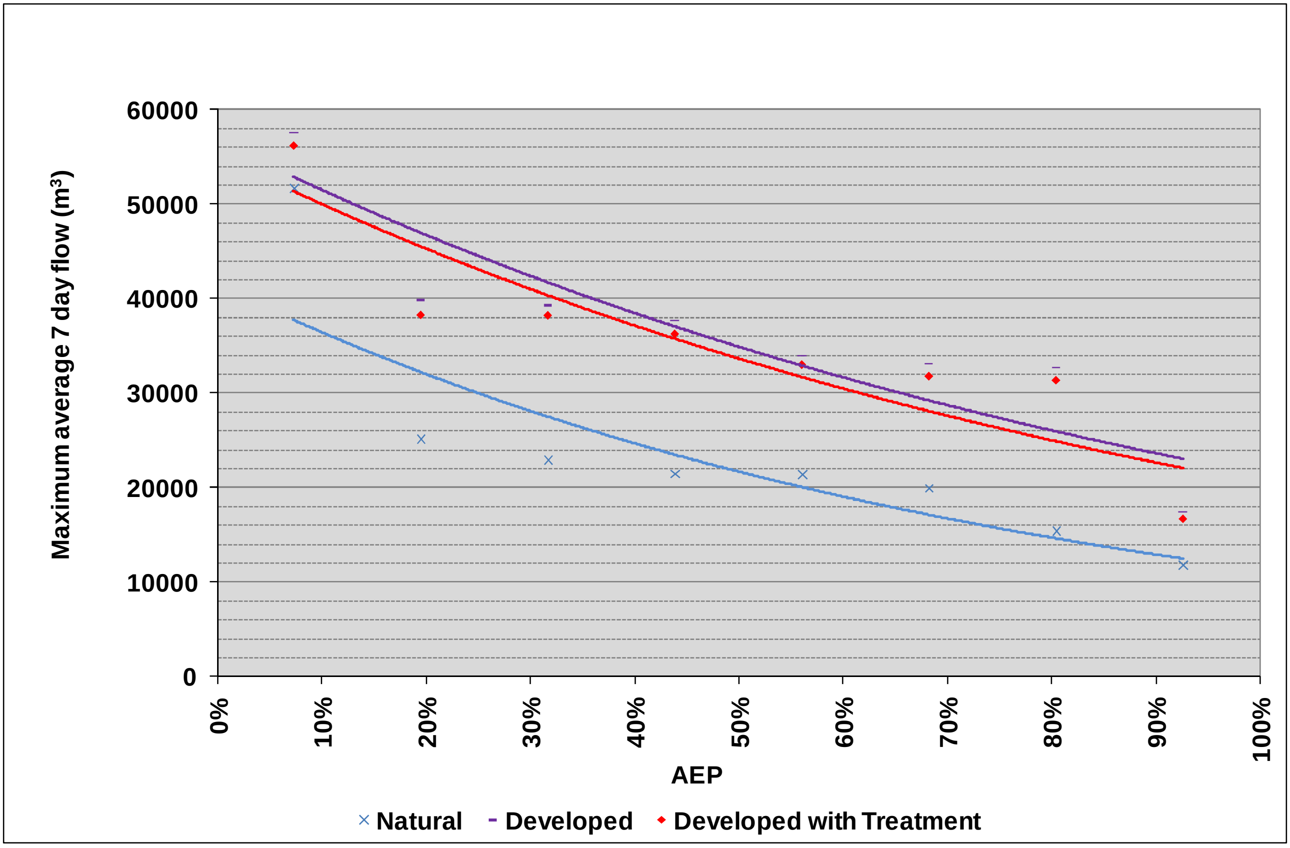


Figure 7-1 7-day High Flow Duration Frequency Curves

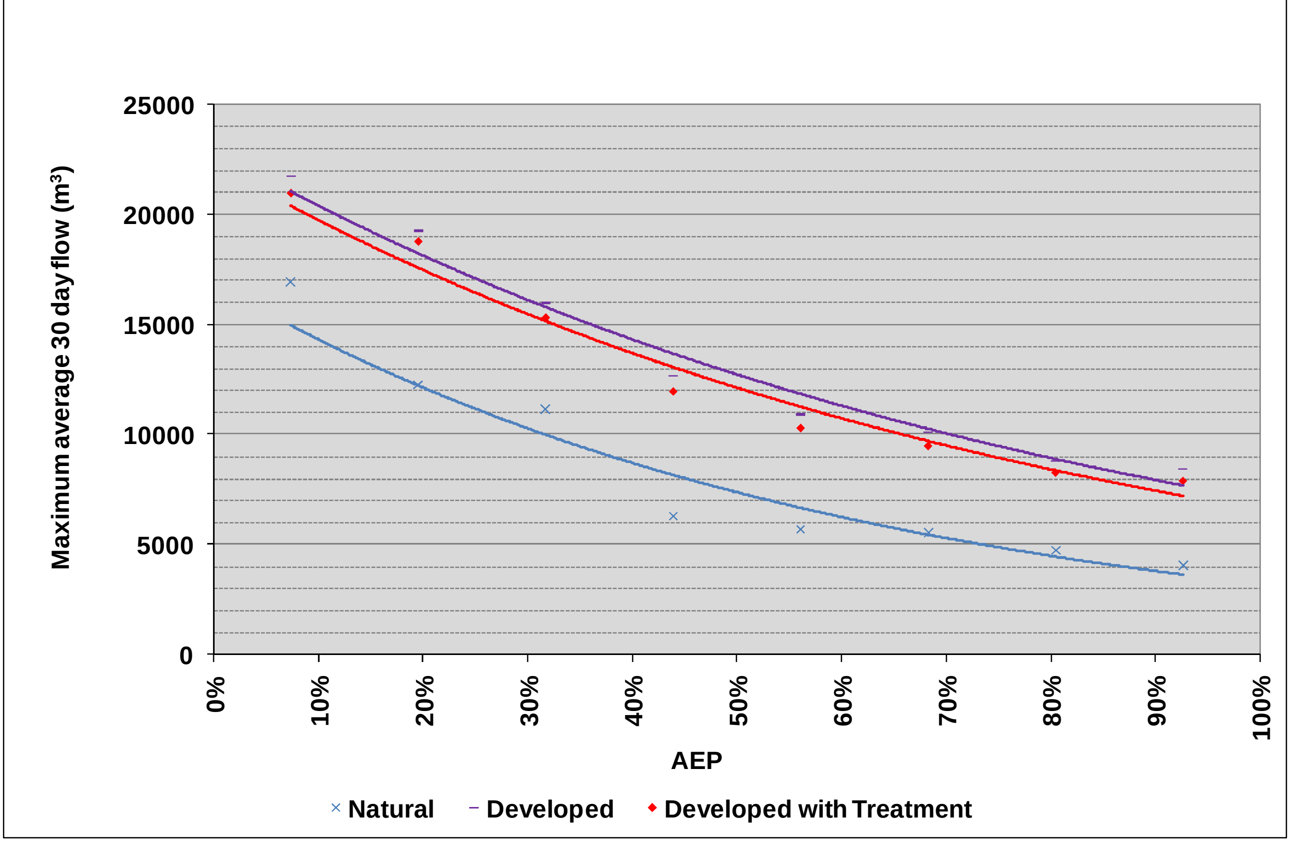


Figure 7-2 30-day High Flow Duration Frequency Curves

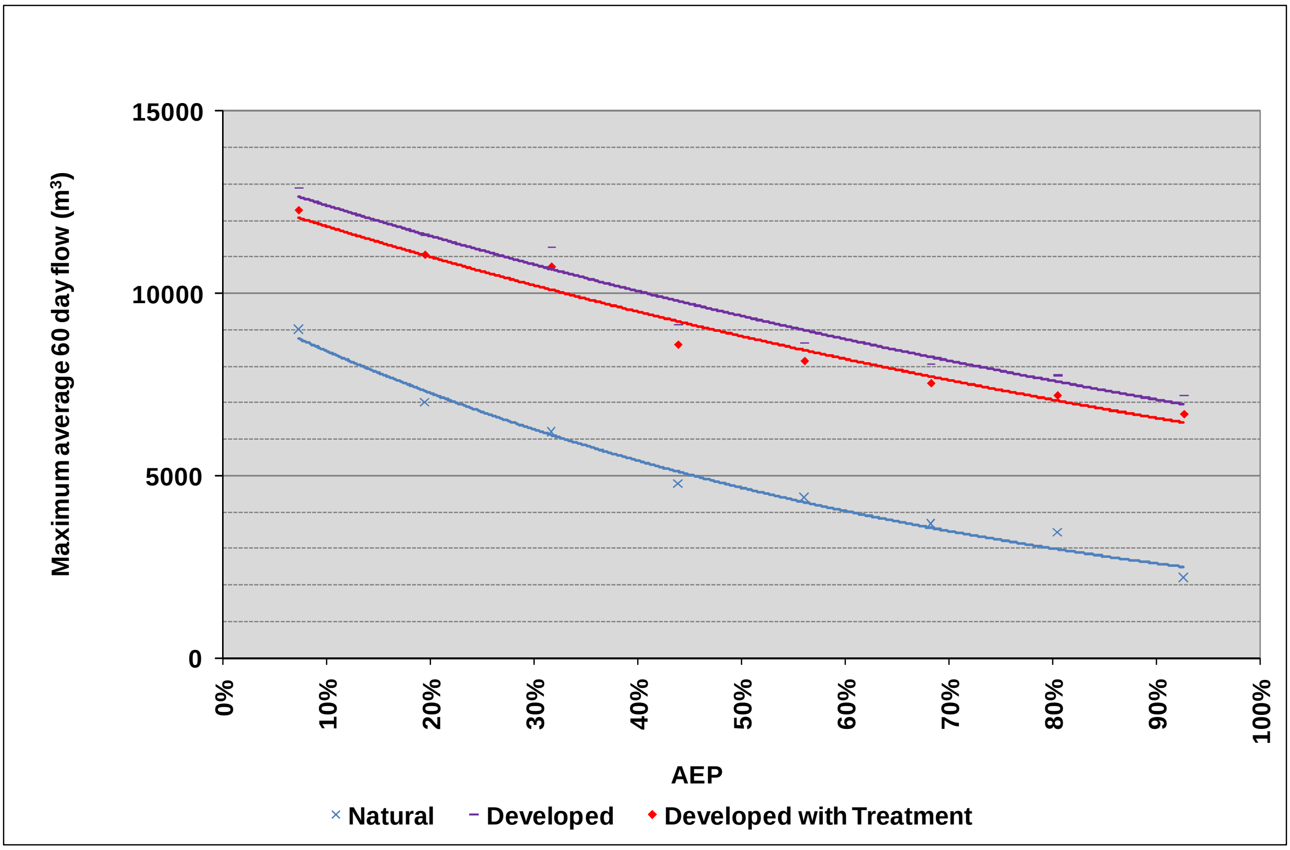


Figure 7-3 60-day High Flow Duration Frequency Curves

The maximum 7-day average flow volumes are higher than the estimated natural conditions for both the developed and developed with treatment scenarios. The developed with treatment scenario slightly reduces the flows when compared to the developed scenario due to retention and evapotranspiration of runoff within the biofiltration measures. Similar trends are apparent for the 30-day and 60-day flow periods.

The 1yr ARI average daily flow is approximately equivalent to the 63% AEP flow. It is considered that the changes in flow regime up to the 1yr ARI are likely to be most critical for ecology within the receiving environments. The 1yr ARI 7-day maximum average daily runoff volume for the natural (existing) site conditions is estimated to be approximately 18 ML/day. The 1yr ARI runoff volumes for the developed and developed with treatment conditions are estimated to be 30 ML/day and 29 ML/day respectively. This suggests that development within the Project Site would typically increase the total weekly runoff volumes during the wettest week of an average year from 126 ML to 210 ML (increase of 12 ML/day). Similarly, the 1yr ARI maximum total 30-day runoff volumes are estimated to increase from 180 ML to 330 ML (5 ML/day increase), and total 60-day runoff volumes are estimated to increase from 240 ML to 510 ML (4.5 ML/day increase) following development.

It is estimated that the bunded floodplain area in the downstream part of the site has sufficient storage for 100 ML of runoff prior to the bund being breached (BMT WBM, 2012a). The bunded floodplain area therefore provides sufficient storage for approximately 50% of the 1yr ARI maximum 7-day runoff volume under developed conditions (i.e. 50% of 210 ML). Including consideration of discharges through the existing flood gates that will occur diurnally, the increased runoff would be retained within the bunded floodplain area and would not overflow into the adjacent wetland areas (unless controlled discharges through the bund are initiated).

It will be important that formation/rehabilitation of any wetlands in the bunded floodplain area is undertaken in a manner that considers the increased frequency and volume of runoff that would occur from the development site. Aquatic species tolerant to frequent inundation would be required, and/or surface grading within the rehabilitated areas would be required to elevate some areas of aquatic vegetation that are less tolerant of frequent and/or higher depths of inundation.

7.2.2 Low Flow Duration Frequency Curves

The calculated low flow duration frequency curves for 7, 30 and 60-day periods are shown in Figure 7-4 to Figure 7-6 and discussed below.

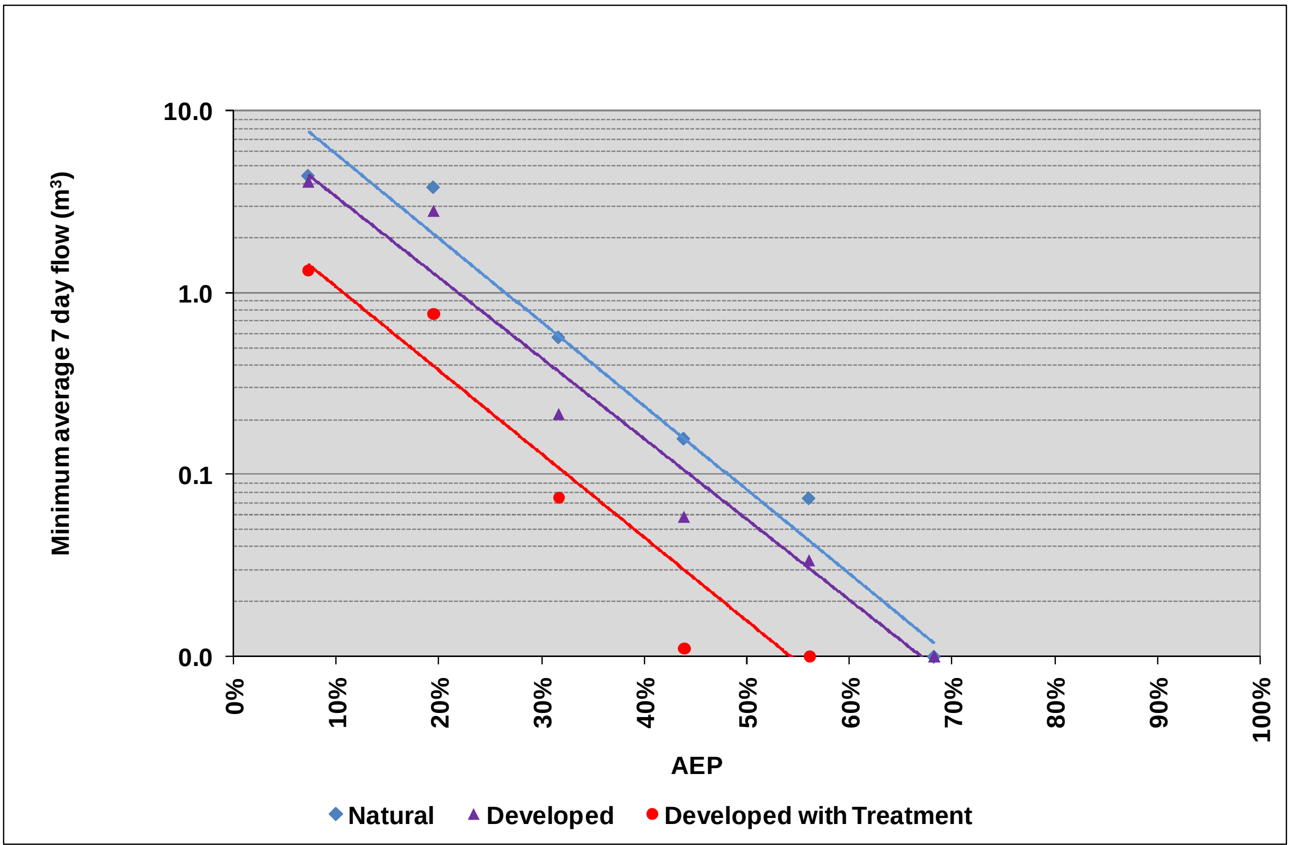


Figure 7-4 7-day Low Flow Duration Frequency Curves

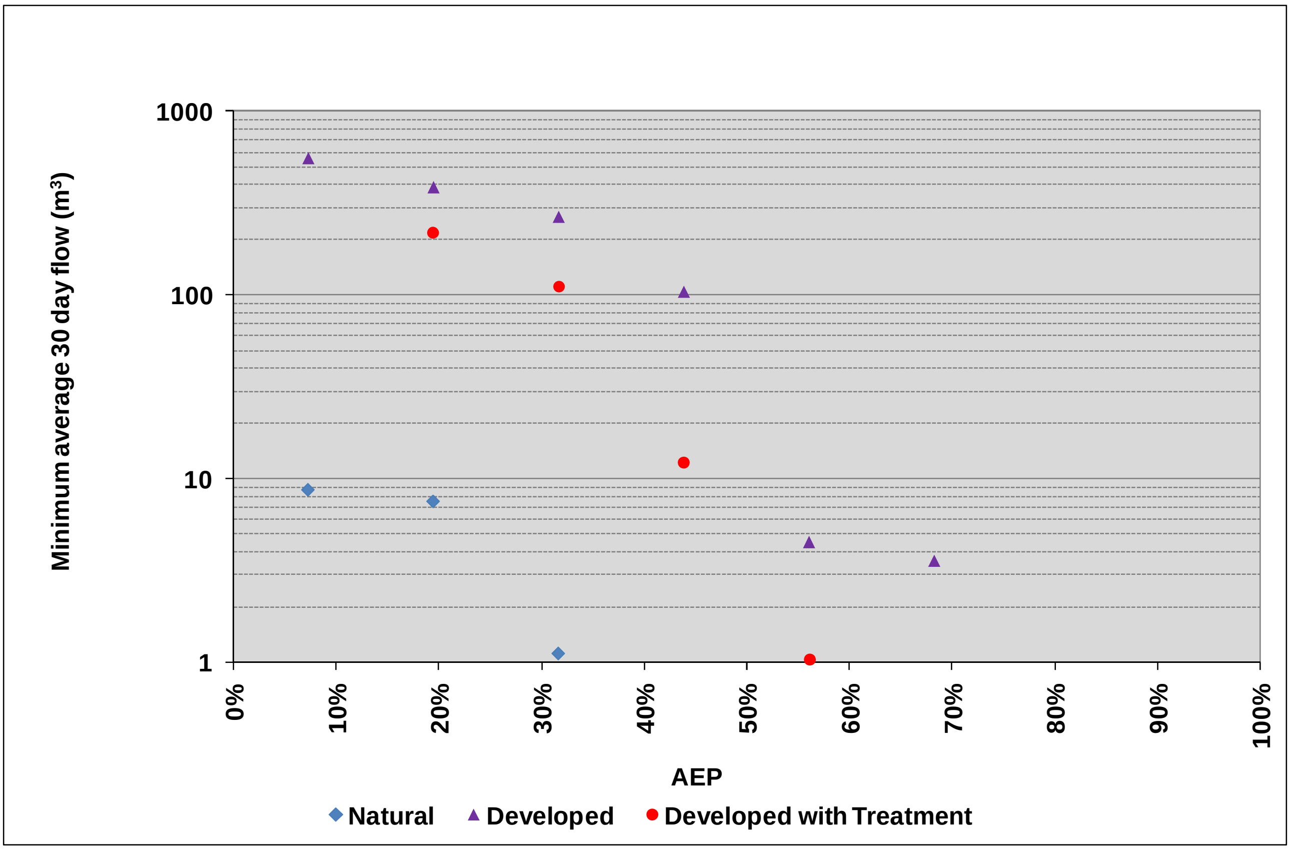


Figure 7-5 30-day Low Flow Duration Frequency Curves

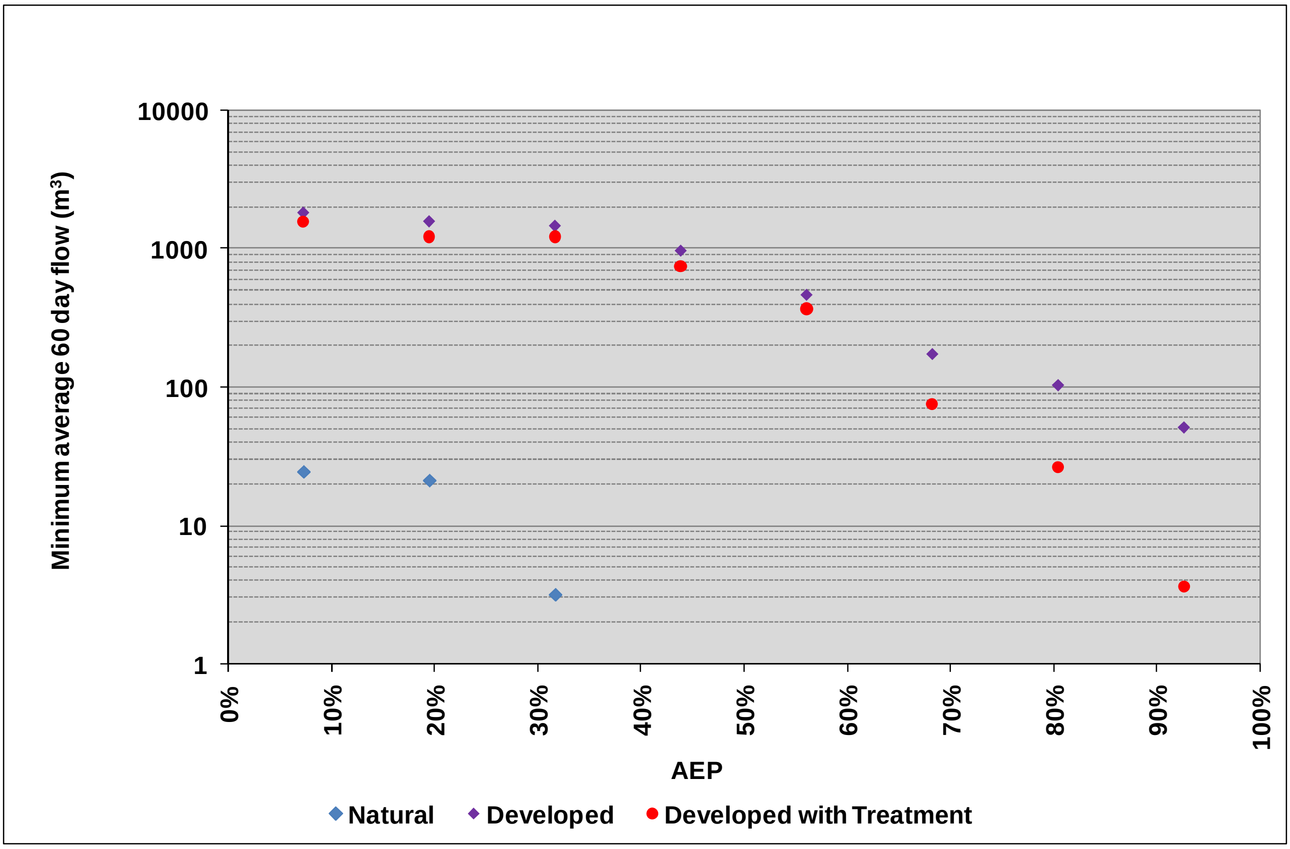


Figure 7-6 60-day Low Flow Duration Frequency Curves

The minimum 7-day average runoff volumes are estimated to be lower than the natural conditions for the developed scenario and developed with treatment scenario. The developed impervious site conditions would result in lower base flow from the Project Site due to the developable areas increasing from 0% to 80% imperiousness. Base flow will dominate the site hydrology during drier periods.

The developed with treatment scenario incorporates a relatively high volume of retention storage in the biofiltration measures that is capable of intercepting a high proportion of the developed runoff during low flow periods, and consequently the flows are reduced further from the developed conditions. For the 30-day and 60-day runoff periods, a higher proportion of days will have runoff occurring from the directly connected impervious surfaces within the developed site. For these periods, only the smallest of rainfall days would result in runoff being completely retained within the biofiltration measures.

The estimated 1yr ARI minimum average 7 and 30-day daily runoff volumes for the natural (existing), developed and developed with treatment site conditions are lower than 10ML/day. The total 1yr ARI 60-day minimum average runoff volumes are expected to increase from close to 0 ML to 15 ML (0.25 ML/day increase) following development. It is expected that more frequent and increased flows during the low flow periods will provide some benefit to improve the resilience of the existing aquatic environments.

The stormwater quality management concept incorporates provision for flow diversion structures to be formed within the bund adjacent to Channel 4 (refer Figure 6-6). These flow diversion structures would comprise a short section of pipe linking the drainage channel to the wetlands. A concrete pit would be constructed in the bund midway along the pipe section and flow control valves/gates/boards provided within the pit to control flows from the channel to the wetlands. Runoff from the development will provide a regular source of flow that potentially could be diverted through the bund during extended dry periods (if considered necessary) to support wetland ecology when natural flows to the wetlands would typically be reduced.

8 SURFACE WATER MONITORING

8.1 Overview

A preliminary surface water monitoring program is outlined below. It is envisaged that the surface water quality monitoring program would be progressively developed throughout the later design development phases. The preliminary surface water monitoring program is based upon the approved monitoring plan for the adjacent WesTrac development prepared in consultation with the NSW Office of Water (NoW) and NSW Office of Environment and Heritage (OEH). It is envisaged that the stormwater pollutants from this development would have similar characteristics to those from the adjacent WesTrac development.

8.2 Monitoring Sites

Water quality monitoring sites would initially be established upstream of the existing floodgates outlets into the Hunter River and within the existing drains adjacent to the proposed filling extents. Proposed locations of surface water monitoring sites are shown in Figure 8-1.

8.3 Monitoring & Analysis Standards

The sampling of surface waters, sample preservation and handling techniques would be undertaken in accordance with AS/NZS 5667.1:1998 Water Quality-Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples. Analysis of water samples would be completed at a NATA accredited laboratory. The testing methods shall be selected to ensure that detection limits for testing are no greater than half of the relevant water quality criteria for each parameter.

8.4 Sampled Parameters

Surface water monitoring parameters would include a range of physical and chemical parameters. Key parameters to sample will include:

- Category 1 parameters - pH, temperature, electrical conductivity, salinity, turbidity;
- Category 2 parameters – cations, anions, suspended solids, nutrients;
- Category 3 parameters – heavy metals, TPH, PAHs, BTEX, pesticides, PCB, hydrogen cyanide, phenols;

The specific parameters monitored would be consistent with the approved monitoring program for the adjacent WesTrac facility.

8.5 Flow Monitoring

A flow monitoring site will also be established within Channel 4 adjacent to the endangered ecological community (EEC) on the eastern side of the development site. The flow monitoring equipment would be installed within a concrete pit constructed within the bund separating the drain from the EEC. The flow monitoring equipment would measure and assist with controlling the volume of runoff diverted from Channel 4 into the EEC. The flow monitoring equipment would be linked with a valve controlling the release of water through the bund. The volume of water discharged into the EEC would be managed to minimise changes to the natural flow regime to the EEC.

8.6 Baseline Monitoring

Initially baseline monitoring would be completed for Category 1, 2 and 3 parameters for a period of 12 months with samples gathered every three months (i.e. four sampling events). The baseline monitoring test results will be analysed to assist with establishing appropriate background levels that can be compared with the post development monitoring results.

The relevant water quality criteria will initially be established by reference to the ANZECC guidelines and default trigger values for protection of estuarine aquatic ecosystems. Locally specific criteria/targets will be established in accordance with appropriate statistical methods outlined in the ANZECC guidelines following completion of baseline surface water quality monitoring at the site.

8.7 Sampling Frequency

Monitoring of water quality during construction would be undertaken in accordance with the contraction phase soil and water management plan.

Following completion of the baseline monitoring and construction activities, regular surface water quality monitoring will be undertaken at the following intervals:

- Category 1 – three monthly sampling at each site;
- Category 2 – six monthly sampling at each site;
- Category 3 – yearly sampling at each site.

8.8 Maintenance Monitoring

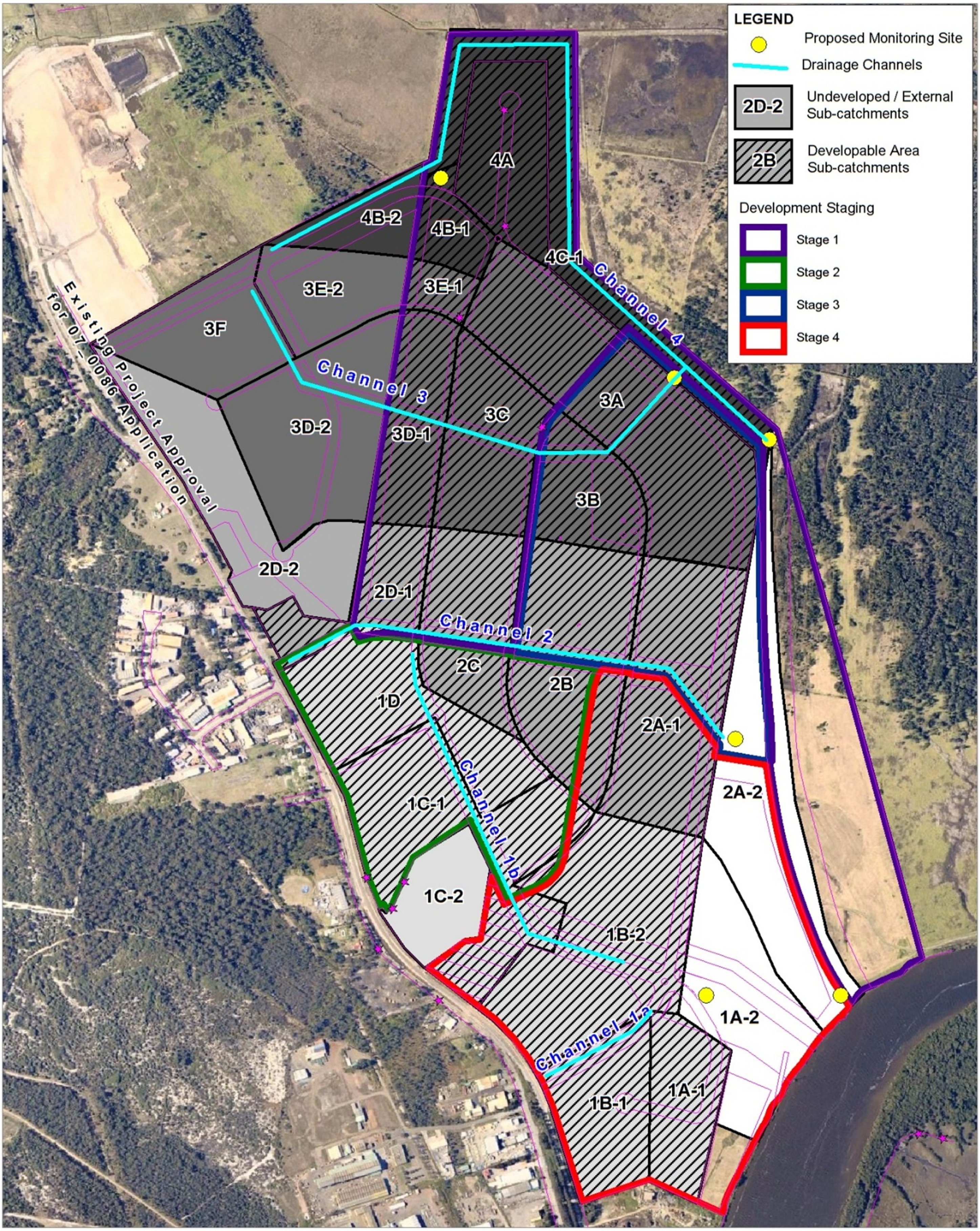
In addition to monitoring of water quality, a maintenance monitoring plan will be established to assist with quantifying the load of sediment, organic debris, litter other solid matter removed from stormwater management measures. Monitoring of pollutant load volumes will assist with identifying any additional source control actions that may need to be implemented to reduce pollutant volumes.

8.9 Analysis and Reporting

The monitoring test results will be analysed annually and compared with the water quality criteria. The test results would also be initially reviewed when received to identify the presence of any clear spikes that warrant further investigation.

In addition to comparisons with the established criteria, results for each monitoring location would be compared to ascertain any clear deviations from previous relationships to identify any unusual variations in water quality.

The annual report would also include a review of parameters sampled and sampling frequency. Where parameters have not been detected throughout this period, consideration would be given to reducing the sampling frequencies of these particular parameters.



Title:

Surface Water Monitoring Sites

Figure: **8-1**

Rev: **A**

N

0 250 500m

Approx. Scale

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Filepath : K:\N1900_Tomago_Northbank_FloodStudy\MI\Workspaces\DRG_003_110802 Monitoring Sites.WOR

9 CONCLUSIONS

The proposed development will increase the total imperviousness within the developable areas of the Project Site from approximately 0% to 80%. This increase in imperviousness will increase the total stormwater runoff volume with an associated increase in the total volume of stormwater pollutants generated from the catchment surfaces. Without mitigation, the proposed development has the potential to convey excessive loads of nutrients, sediment, heavy metals, oils/greases, gross pollutants and other common stormwater pollutants to the Hunter River. A series of mitigation measures are proposed within the Project Site to ensure that both the quantity and quality of stormwater are managed prior to discharge into the Hunter River.

Conventional piped stormwater drainage systems will convey stormwater runoff from the development surfaces to the proposed major drainage channels. Gross pollutant trapping basins would be formed adjacent to each stormwater outlet discharging into the drainage channels to capture gross pollutants and coarse sediment. Overflow from the gross pollutant trapping basins would be directed through short sections of grassed swales remove the remaining coarse sediment load. Runoff filtered through the grassed swales would be directed to biofiltration swales.

Biofiltration swales would be formed along benched areas on each side of a central drainage channel. The biofiltration swales would temporarily retain stormwater in an above ground detention storage, prior to filtration through an engineered filter media designed to filter pollutants, enhance plant uptake of nutrients and provide opportunities for denitrification. After filtering through the biofilter media, distributed discharge of flow to the central part of the major drain via sub-soil pipes would occur. The biofiltration swales have been sized to retain a minimum 10mm runoff depth from impervious areas in the above ground detention storage. This will ensure that the biofiltration swales would function during the majority of rainfall events.

The biofiltration swales would be progressively constructed as development proceeds throughout the Project Site in conjunction with the formation of the major drains and project staging. The proposal to construct the biofiltration swales in conjunction with the major drains ensures that stormwater quality would be managed sufficiently from all stages as development proceeds.

The MUSIC modelling results demonstrate that the proposed water management strategy would achieve estimated 93%, 75% and 48% reductions in TSS, TP and TN loads respectively. These reductions exceed Port Stephens Council's and DECCW's runoff quality targets for industrial development. The MUSIC modelling conservatively considered the treatment achieved through the proposed biofiltration swales only and it was assumed that stormwater should be treated to an acceptable level prior to discharge into the central section of each drainage channel.

Gross pollutant trapping measures and grassed swales are also included within the strategy and these measures would increase the load reductions. In addition, large storage potential in the drainage channels, and aquatic vegetation along the drainage channels and rehabilitated wetland areas would provide further filtration and nutrient uptake between the development and the discharge points into the Hunter River. The shallow longitudinal gradients and related low velocities ensures that matter deposited in the biofiltration swales and central drainage channel would not be eroded to any significant degree during high flow periods. These additional barriers of protection are expected to provide further improvement to runoff quality from the Project Site.

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