6.3 EXISTING CONDITIONS

The subcatchments contributing flow to the drainage corridor on the site are presented in **Appendix B**. Stormwater runoff from external subcatchments and the site contribute runoff that is conveyed in the existing drainage corridor traversing the site. There are two existing piped outlets that discharge to the drainage corridor. A street drainage network collects runoff from subcatchment B and discharges to the site through a stormwater easement from the southern end of Survey Street. An outlet from the street drainage system within catchment A discharges flow to the northern end on the site. Flow that exceeds the existing pipe networks capacity would flow overland to the drainage corridor.

Cross sections of the existing drainage corridor were created using a 3 dimensional modelling package, 12d. The 12d model produces accurate offset and level information that was utilised to create the HEC-RAS model.

Normal depth was selected for the upstream and downstream boundary conditions, based on the natural surface slope at those locations. A representative Manning's n value of 0.035 was adopted for both overbank areas and channel flow. The Manning's n adopted is representative of a flowpath that is covered with long grass and is mostly cleared.

The resultant water surface profiles are included in **Appendix E**. **Figure 4** shows expected flood extents across the site for the 100 year ARI storm event for existing conditions.

6.4 POST-DEVELOPMENT CONDITIONS

Establishment and embellishment of a riparian corridor approximately 40m wide overall along the drainage corridor would be undertaken with planting of local native species. There are no formal banks in the existing drainage corridor (*because of the minor nature of the upstream catchments*) so the overall width of the planted corridor would be 40m.

It is proposed to construct a road crossing over the existing drainage corridor. This culvert crossing would be constructed to convey both the 100 year ARI and PMF flow without overtopping of the road. A preliminary sizing of the culvert has been undertaken and it was estimated that a 3.6m x 1.2m box culvert would be able to convey all flows. Rock scour protection would be placed at the inlet and outlet of the culvert.

It is proposed to construct a low level footbridge/bicycle crossing of the drainage corridor. An example of the proposed crossing is presented in **Figure 6.1**. This crossing would be designed in accordance with the DNR Guidelines for the Design and Construction of Paths and Cycleways along Watercourses and Riparian Areas.

Figure 6.1 – Proposed pedestrian/cycleway crossing.

The proposed pedestrian/cycleway crossing would be designed so that low flows (i.e. less than 1 year ARI) would be conveyed under the bridge. During larger storm events the bridge would be overtopped.

The deck level of the pedestrian/cycleway crossing would be approximately RL 25.5mAHD. Rock scour protection would be provided both upstream and downstream of the crossing where increases in velocities during storm events would occur.

Both the proposed road and cycleway crossings have been included in the proposed HEC-RAS modelling to allow estimation of affects on flood levels and extents on the site.

The proposed 100 year ARI flood extents are shown on **Figure 5** and water surface profiles are presented in **Appendix E**.

Comparison of existing and proposed 100 year ARI flood levels are shown in **Table 6.1**. The locations of the cross sections are presented on **Figure 5** and in **Appendix E**.

Table 6.1 shows that would not be any significant changes to 100 year ARI flood levels on the site except where the proposed crossings are located.

At cross section 50 the proposed road culvert would induce an afflux of approximately 0.6m. This afflux would be reduced to zero by cross section 52. The proposed culvert (3.6 m x 1.2m) has been designed to convey the 100 year ARI and PMF flow without overtopping of the roadway. This would allow safe egress for residents located on the western side of the culvert.

Cross section 42 shows an afflux of approximately 0.2m. This afflux is a result of the proposed pedestrian/cycleway crossing. This afflux is reduced to approximately zero by cross section 44.

HEC-RAS modelling of the 20 year ARI storm event shows that the impact of these crossing is less during smaller storm events. The afflux during the 20 year storm event is expected to be:-

- Cross section 50 = 0.5m
- Cross section 42 = 0.2m

During the 20 year ARI storm event the afflux is reduce to zero at the next upstream cross section.

These localised increases in flood levels induced by the proposed crossings are contained within the subject site and would not adversely affect any adjacent properties or the proposed subdivision lots.

Table 6.1 Comparison of 100 year ARI flood levels (mAHD)

Cross Sections	Estimated 100 year ARI Flood Level		
	Existing Conditions	Proposed Conditions	Difference
52	31.8	31.8	0.0
50	29.7	30.3	0.6
48	28.2	28.2	0.0
46	26.8	26.8	0.0
44	26.0	26.0	0.0
42	25.0	25.2	0.2
40	24.5	24.3	-0.2
38	23.2	23.2	0.0
36	22.4	22.4	0.0
34	21.6	21.6	0.0
32	20.4	20.4	0.0
28	19.1	19.1	0.0
26	18.3	18.3	0.0
24	17.6	17.6	0.0
20	17.0	17.0	0.0
16	15.5	15.5	0.0
14	14.8	14.8	0.0

6.5 FLOODING

The site is relatively steep in nature and located high in the catchment. The closest major water body is the Pacific Ocean which as approximately 1km east of the site. Therefore, there will be no regional flooding effects on the site, and hence local rainfall events will govern flood levels across the site.

The proposed flood conditions in the drainage corridor on the site are presented as the flood extents on **Figure 5.** This shows that all of the proposed lots would be flood free during the 100 year ARI storm event.

6.6 FLOOR LEVELS

A comparison of the existing ground levels on the proposed residential lots and the estimated 100 year ARI flood levels presented on **Figure 5** indicate that it is readily possible to locate habitable floor levels a minimum of 500mm above the 100yr ARI flood level. The proposed development therefore would not be adversely affected by flood flows.

6.7 FLOOD RISK

The Probable Maximum Flood (PMF) levels were estimated to ensure that residents located on the western portion of the site would have safe egress during extreme storm events. It has been estimated that during the PMF the road crossing of the drainage corridor would not be overtopped and therefore all residents would have safe egress from the site even during extreme storm events such as the PMF event.

Water surface profiles of the PMF event are included in **Appendix E**.

6.8 IMPACT ON DOWNSTREAM FLOODING

The proposed development would incorporate detention storage to ensure that peak flows in storms are maintained at or below those for existing conditions. As such, the peak flows and flood levels downstream of the site will remain unchanged and there would be no adverse impacts on downstream properties.

6.9 CUMULATIVE DEVELOPMENT IMPACTS

The extent of the catchment for the drainage corridor on the site is presented in **Appendix B**. An aerial photograph of the surrounding area in **Appendix A** indicates that the majority of the catchment has been developed. Notwithstanding this, the flood flows and levels in the drainage corridor on the site were estimated based on full development of the catchment to ensure that the estimated flood levels would be for ultimate conditions. The proposed development therefore would accommodate the cumulative flows from ultimate development of the catchment and would not be adversely affected by the corresponding flood levels.

7 MAINTENANCE OF WSUD ELEMENTS

Ballina Council has limited resources to manage and maintain water sensitive urban design measures even though these measures may represent industry best practice and are part of an integrated strategy to achieve an environmental sustainable outcome for water management. The stormwater management measures to be maintained by Council include the raingardens, vegetated swales and gross pollutant traps.

Constructed wetlands have not been incorporated into the stormwater management strategy partly due to Council's concerns about the cost and expertise required to adequately maintain these features. The control measures adopted were in part selected to complement Council's existing maintenance skills which include landscape features and existing gross pollutant trap maintenance equipment.

The raingardens and vegetated swales are essentially landscape features with dedicated subsurface drainage media and systems. The maintenance will involve maintaining the vegetation and irregularly flushing the subsurface drainage. These are activities within Council's existing maintenance skills and equipment. Similarly for the gross pollutant traps, these have been selected and located such that they can be maintained by existing Council equipment and operational procedures.

The Cooperative Research Centre (*CRC*) for Catchment Hydrology has presented a summary of expected maintenance costs for stormwater treatment measures (Andre Taylor, *Structural Stormwater Quality BMP Cost – Size Relationship Information from Literature*, 23 January 2004, Version 1). It should be noted that as stated in the source document, the costs provided are to be used as a guide only.

The following sections detail the expected ongoing maintenance required and their relative costs as derived from the CRC document.

7.1 RAINGARDENS AND VEGETATED SWALES

Once established, it is envisaged that the raingardens and vegetated swales would require occasional trimming of vegetation and occasional flushing (*once a year*) of the underdrain system. Cost of maintenance of a mature bioretention system has been suggested to be $1.50 per square metre of surface area (*using native vegetation*) per annum. The current proposal includes 2500m^2 of raingardens and approximately 750m^2 of swales. Therefore it is expected that the total maintenance cost would be approximately $5,000 per annum.

Graded entrances to raingardens would be provided to give access for ongoing maintenance. These entrances would give access to enable Council to utilise existing maintenance equipment and vehicles.

7.2 GROSS POLLUTANT TRAPS

Ballina Council presently maintain gross pollutant traps in its urban area. Regular cleaning of the proposed gross pollutant traps in the development would be required with Council's existing street sweeper truck and vacuum hose attachment. It is expected that cleaning would be required every three months or after every major rainfall event (*greater than a 3 month ARI storm*).

The GPT's would allow straight vertical lift of collection baskets for cleaning as required by Council.

The estimated cost of maintenance would be approximately $2,500 per annum per GPT. There are three GPT's proposed for the site, and as such, the total maintenance cost would be approximately $7,500 per annum.

The proposed bioretention systems and GPT's have been chosen to allow Council to use its existing infrastructure and maintenance regimes. It is therefore not expected that Council would be required to purchase any specialised machinery to maintain the stormwater management elements proposed on the site.

7.3 INFILTRATION TRENCHES AND TRENCH DRAINS

Infiltration trenches and trench drains would be located on private property and would not require ongoing maintenance by Council. It is expected that a covenant would be placed on title on each lot requiring these trenches to be retained.

8 WATER CYCLE MANAGEMENT

8.1 OVERALL APPROACH

The proposed development incorporates a fully integrated water cycle management approach in order to achieve sustainable water outcomes for our limited water resources. This approach has been formulated based on industry best management practice and the DG's requirements. The overall principles of the approach conform to the Integrated Water Cycle Management Guidelines for NSW Local Utilities (2004). The aims of the integrated approach are presented in **Section 2** and the details of the management strategy for stormwater and groundwater are detailed in this report. The water cycle management aspects relating to potable water and sewage are detailed in the PBP report entitled Infrastructure Strategy (September 2006). The water management aspects during construction of the sub division are detailed in the PBP report entitled Construction Environmental and Waste Management Plan (September 2006).

This section describes the integrated approach proposed for all the elements of the water cycle.

8.2 POTABLE WATER AND SEWAGE

The potable water use in the proposed residences will be minimised by the incorporation of water saving devices in the dwelling and use of recycled water for toilet flushing and external irrigation. The water saving devices would include flow restrictors in the kitchen, laundry and bathrooms, low water usage taps and shower heads, low water usage dishwashers and low water usage dual flush toilets. Ballina Council is committed to delivering recycled water (treated sewage) to this development. This combination of measures would reduce potable water use by approximately 55%. This reduction could be increased further to 68% when recycled water is approved for use in washing machines.

The state government BASIX policy requires a minimum reduction in potable water use of 40%. This target would be readily exceeded by this development which will contribute to the long term sustainability of the potable water supplies and to the long term improvement in receiving water quality by reducing the volume of effluent discharged from the Council's sewage treatment plant (STP). For this site, there would be approximately a 74% reduction in the effluent volume discharged to the waterways from the STP based on the water saving devices and the use of recycled water. When recycled water is approved for use in washing machines, this effluent discharge volume would reduce by approximately 93%. This degree of reduction would obviously contribute substantially to the long term improvement in receiving water quality.

8.3 STORMWATER

Stormwater runoff provides a further water resource for use in the development. However, the potential uses for stormwater in the development would be the same for recycled water. The availability of stormwater for reuse is dependent on rainfall while there is a consistent supply of recycled water. The use of recycled water therefore provides a greater reduction in potable water use and has been preferred for this development.

Stormwater runoff from the site would be managed to maintain peak flows at or below existing rates and the runoff pollutant load would be less than for existing conditions thereby contributing to the long term improvement in receiving water quality.

8.4 GROUNDWATER

Groundwater has been intercepted in boreholes drilled as part of the geotechnical investigations reported by Coffey in their report dated August 2006. Near to the drainage corridor, the groundwater was at a depth of approximately 1m while high on the eastern slope, the depth to groundwater increased to approximately 10.4m. This groundwater level would be mainly controlled by regional factors as evidenced by the presence of a groundwater spring low on the eastern slope on the site. This spring has a low flow which appears continuous.

The soils on the site consist of dense clays overlaying basalt rock. The permeability of the subsurface profile is therefore limited.

Groundwater would not be used as a source of water for the development because its potential uses would be satisfied by supply of recycled water.

The proposed stormwater management measures would serve to minimise changes in the hydrology of the site. The measures would capture low flows preventing runoff in small events and would slow down flows in larger events to more closely mimic the runoff behaviour in the existing conditions. The stormwater measures provide their own drainage media to promote infiltration of runoff into these special media. The measures do not rely upon infiltration into the existing sub soils for their performance. However, by capturing runoff, there is longer exposure to the existing soils around the perimeter of the treatment measures to promote infiltration. The spring waters would continue to be directed as at present to the drainage corridor by the proposed trench drains.

Importantly the stormwater management measures are distributed over the site in a treatment train. This will also assist to maintain the existing hydrology of the site. The use of extensive sub surface drainage media and vegetation in treatment measures will maximise the potential for runoff losses and reductions in runoff volume during the important small rainfall events.

9 DIRECTOR GENERAL'S REQUIREMENTS

The Director General's Requirements for this project were issued on the 15 May 2006 and are presented in four sections:

- general requirements;
- key issues;
- consultation; and
- technical and policy guidelines.

This section discusses the way in which the proposed development conforms to these requirements related to water cycle management or infrastructure and identifies the sections of the report which are relevant to each requirement.

9.1 BALLINA DCP NO. 11 - MOSQUITO MANAGEMENT

The proposed development has been formulated to conform to DCP No. 11. The use of wetlands in the development has been avoided partly due to the mosquito risk posed to residents. The stormwater measures have included features which are dry and only pond water for matters of hours not days. Special drainage media has been incorporated into all the stormwater measures to promote infiltration and avoid longer term ponding of water which might promote mosquito breeding The drainage system has been designed with reasonable grades to be free draining and to avoid accumulation of silt. Minor works would be undertaken in the drainage corridor where possible to minimise the extent of water ponding. Extensive works are not possible in the drainage corridor given flora and fauna constraints.

The stormwater management measures proposed in the development are described in **Sections 3.2, 3.3** and **4.3**.

9.2 BALLINA DCP NO. 13 – STORMWATER MANAGEMENT

The objectives of DCP No. 13 – Stormwater Management are:

- no net increase in the average annual load of key stormwater pollutants compared with existing conditions;
- no net increase in peak discharge flow rates compared with existing conditions;
- minimum of industry best practice stormwater treatment to achieve the following reductions:
  - 80% suspended solids;
  - 45% total phosphorus and total nitrogen;
  - retention of litter greater than 5mm for flows up to 25% of the 1 year ARI peak flow;
  - retention of coarse sediment above 0.125mm for flows up to 25% of the 1 year ARI peak flows;
  - no visible oils for flows up to 25% of the 1 year ARI peak flow.

- for the construction phase, erosion and sediment controls sufficient to achieve:
  - 50 percentile suspended solid concentrations of 50mg/L
  - treatment of 90% of daily rainfall events ie up to 4 month ARI.

The DCP promotes the use of a water sensitive urban design approach in the stormwater management strategy. It promotes use of stormwater management measures such as infiltration trenches, vegetation swales, infiltration basins *(raingardens)* and gross pollutant traps.

The proposed stormwater management strategy is based on a water sensitive urban design approach and would achieve the peak flow and water quality objectives in DCP No. 13. The inclusion of GPTs in the stormwater system would achieve the objectives for removal of the litter, coarse sediment and oils/greases in the DCP.

The performance of the stormwater measures is detailed in **Sections 4.4, 4.5** and **5.2**.

9.3 NORTHERN RIVERS LOCAL GOVERNMENT DEVELOPMENT AND DESIGN MANUAL

The Northern Rivers Local Government Development and Design Manual, Version 2 provides detailed design guidance for a range of engineering aspects of development. The general aspects relevant to the subject development are:

- subdivision;
- road design;
- stormwater;
- erosion control;
- cycleway and pathway design.

The preliminary design details formulated for the development conform to these guidelines. The infrastructure details are presented in the PBP report Infrastructure Strategy dated September 2006. The erosion control measures proposed during construction are presented in the PBP report Construction Environmental and Waste Management Strategy dated September 2006. The stormwater management details are described in this report.

9.4 STORMWATER MANAGEMENT PLAN

The stormwater management plan is described in **Section 3** of this report and presented diagrammatically in **Figure 1**. This addresses the DG's requirement 2.1 under the key issues heading.

9.5 OFFLINE TREATMENT MEASURES

All treatment measures would be located outside the riparian corridor and hence would be outside the flow area within the drainage corridor (refer **Figure 1**). This is defined as being located off-line. As such, the proposed location of the stormwater management measures would be off-line as required by the DG's requirement 2.2 under the key issues heading.

9.6 FULLY DEVELOPED CATCHMENT

The estimation of flood levels in the drainage corridor through the development has been based on full development of the external catchment (refer **Sections 5.9** and **6.9**). The proposed development therefore would accommodate the flows related to the cumulative impact of a fully developed catchment without adverse impact on the proposed development.

This addresses the DG's requirement 2.3 under the key issues heading.

9.7 LINKAGES BETWEEN STORMWATER MEASURES

The linkages between the proposed stormwater management measures including the pipe drainage system are depicted on **Figure 1**. These linkages are described in **Sections 3.2** and **4.3**.

This addresses the DG's requirement 2.4 under the key issues heading.

9.8 MANAGEMENT AND MAINTENANCE

Extensive discussions where held with Ballina Council regarding the management and maintenance of the proposed stormwater management measures. Agreement was reached that the proposed measures could be maintained by Council given their existing skills and equipment.

The management and maintenance of the measures is discussed in **Section 7**.

This addresses the DG's requirement 2.5 under the key issues heading.

9.9 STATEMENT OF JOINT INTENT

It is noted that the Healthy Rivers Commission has been dissolved and the Catchment Management Authority is responsible for tasks previously managed by the Healthy Rivers Commission. As such, the Northern Rivers Catchment Action Plan (May 2006) has been used to replace a relevant statement of joint intent for this development.

The Northern Rivers Catchment Action Plan has developed the following relevant water targets:

- Catchment Resource Condition Target: By 2016, river and aquifer condition is improved.

The proposed stormwater quality treatment measures would significantly reduce pollutant loads below that for existing conditions *(between 32 to 72% reduction)* and provide a substantial reduction in sediment load by alleviating erosion on site due to external flows. As a consequence, it would provide a considerable contribution to the long term improvement in receiving water conditions.

In addition to this, the use of recycled water in the development would reduce the volume of sewage discharged to the waterways from the Council's STP due to the development by at least 74%.

These aspects are addressed in **Sections 4.4** and **8.2** of this report. As such, consistency with this Action Plan target would be achieved.

- Management Target W2 – Urban Water Cycle Management: By 2016, 100% of local water utilities to have undertake planning for managing their water systems using an integrated approach, with 33% of priorities from this planning implementation (50% of planning and 10% of implementation to be completed by 2009).

The proposed development would contribute to Council achieving this target.

These aspects are addressed in **Sections 2** and **8** of this report.

This addresses the DG's requirement 2.6 under the key issues heading.

9.10 DEC RIVER FLOW AND WATER QUALITY OBJECTIVES

The Department of Environment and Conservation's River Flow and Water Quality objectives aim to achieve long-term goals for NSW's surface waters, such as:

- water quality management to assess water quality in terms of whether the water is suitable for a range of environmental values (including human uses); and
- surface water flow management to identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

The proposed development is expected to contribute to the improvement in the quality of surface runoff when compared to existing conditions and thus contribute to the long term improvement of receiving water quality. This improvement in water quality would contribute to improvement of the environmental values of receiving waters.

The proposed Stormwater measures have been integrated into the proposed development to allow the post development runoff regime to mimic the pre development runoff regime. These measures will slow down runoff from the site, it will reduce the runoff volume especially in small storms, it will better match the frequency of runoff compared with a rural site and will encourage infiltration to maintain throughflow in the shallow subsoil areas. Importantly, the base flows into the creeks and receiving waters would not be reduced.

These aspects are addressed in **Sections 2, 4.4** and **8** of this report.

This addresses the DG's requirement 2.7 under the key issues heading.

9.11 RIVERS AND FORESHORES IMPROVEMENT ACT

It is considered that the Rivers and Foreshores Improvement Act is not applicable to the subject site because it does not contain a 'river' as described in the Act and hence does not have any 'protected land'. Notwithstanding this, the proposed development would comply with the principles of the Act.

A riparian corridor is to be established along the drainage corridor in accordance with the DPI personnel onsite recommendations. Stormwater measures would be located off-line the riparian corridor. An 'ecological polygon' area has been established as a buffer to the endangered hairy-joint grass located within a small area of the riparian corridor. No major earthworks are proposed within the vicinity of the polygon. Road and pedestrian crossings of the corridor have been limited to one each. These are acceptable to DPI as this is not a fish passage area. Runoff into the corridor will be controlled to existing peak flow rates and considerably lower pollutant loads compared to existing conditions. Also any rock scour protection areas would be restricted and designed to complement the riparian corridor embellishment.

These aspects are addressed in **Sections 3.2, 3.4** and **6.4**.

This addresses the DG's requirement 2.8 under the key issues heading.

9.12 DPI GUIDELINES

The consultation and compliance with the DPI guidelines is addressed in **Section 7** of Peter Parker's Flora and Fauna report dated August 2006.

The DPI guideline requirement for a 50m buffer to the drainage line on site was reduced to between 20 to 25m during a site meeting with DPI personnel *(Patrick Dwyer)*. The proposed development complies with this requirement. This addresses the DG's requirement 4.1 under the key issues heading.

9.13 FISHERIES MANAGEMENT ACT

The requirements of the Fisheries Management Act are dealt with in **Section 7** of Peter Parker's Flora and Fauna report dated August 2006.

His finding was that the proposed development will not affect any of the listed threaten species or result in an increase in any of the listed threatening species.

This addresses the DG's requirement 4.2 under the key issues heading.

9.14 EROSION AND SEDIMENT CONTROL

The proposed measures for best management erosion and sediment control during the subdivision construction are described in the PBP report 'Construction Environmental and Waste Management Plan' dated September 2006. These measures are based on "The Blue Book" which is the government's best management practice guideline. In addition to this there are specific additional controls for the three threatened species areas in the 'ecological polygon', Amber Drive Reserve and the littoral rainforest.

These aspects are addressed in summary form in **Section 5.4**.

This addresses the DG's requirement 6.1 under the key issues heading.