stormwater treatment measures (*treatment train*) to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

To undertake the water quality assessment, a long-term MUSIC model was established for the proposed rezoning site. The model was used to estimate the annual pollutant load generated under existing state and developed conditions for a mean rainfall year.

MUSIC was chosen for this investigation because it has the following attributes:

- it can account for the temporal variation in storm rainfall throughout the year;
- modelling steps can be as low as 6 minutes to allow accurate modelling of treatment devices;
- it can model a range of treatment devices;
- it can be used to estimate pollutant loads at any location within the catchment; and
- it is based on logical and accepted algorithms.

4.2.2 Existing Conditions

The existing pollutant export from the site was estimated to establish the base case against which to measure the performance of proposed development.

The catchment as defined in the water quantity section was adopted to create a MUSIC model for the rezoning site. An existing impervious area of 1 % was assumed based on the existing concrete-lined channel and an investigation of the site.

4.2.2.1 Rainfall

In order to develop a model that could comprehensively assess the performance of water quality treatment devices such as bio-retention swales, the use of 6 minute pluviograph data was considered necessary. Council's DCP states that the average annual rainfall for Penrith is 900 mm/year. The 1997 pluviograph record at Sydney Observatory Hill measured 1019 mm during the year and was adopted for the analysis. This was considered to be representative of the average annual rainfall experienced at the Emu Plains site. **Figure 5** compares the Penrith mean monthly rainfall with the observed mean monthly rainfall for Sydney Observatory Hill in 1997.

4.2.2.2 Evaporation

Monthly areal potential evapotranspiration values were obtained for the site from default values in MUSIC, which were obtained from Bureau of Meteorology data and are shown in **Table 4-2**.

Table 4-2 Monthly Areal Potential Evapotranspiration

Month	Areal Potential Evapotranspiration (mm)
January	180
February	135
March	128
April	85
May	58
June	43
July	43
August	58
September	88
October	127
November	152
December	163

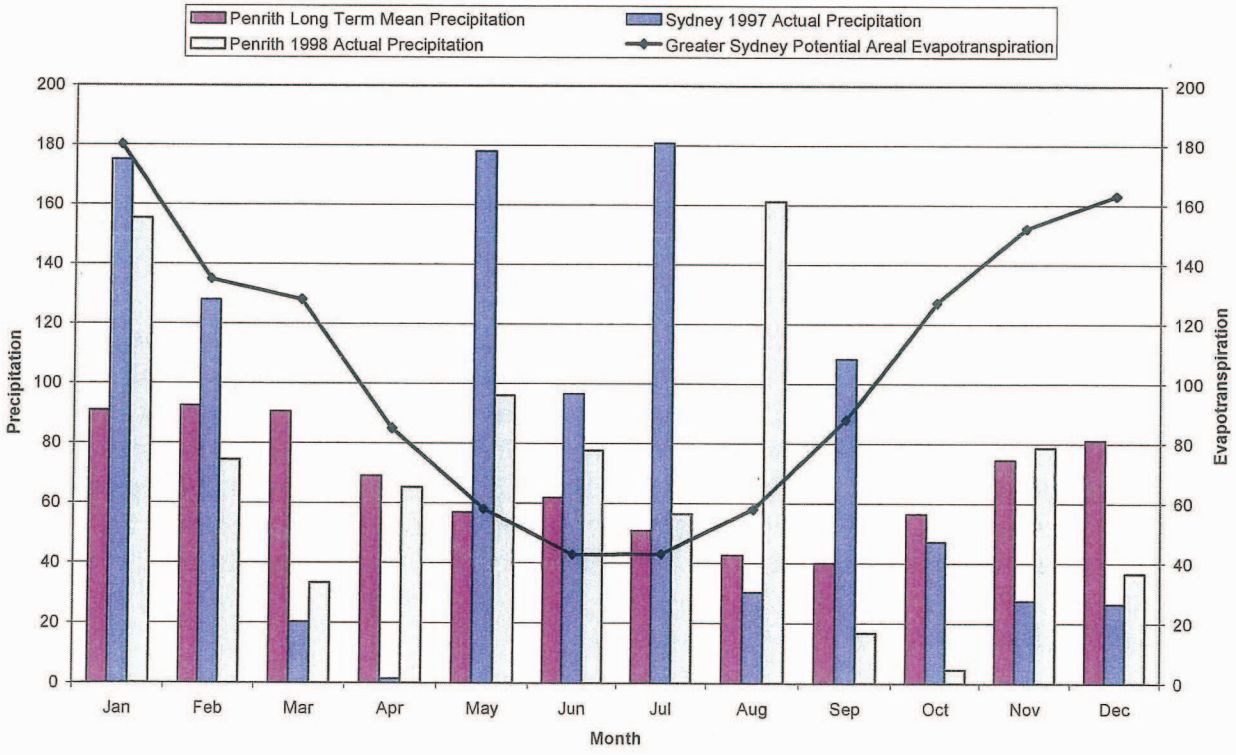


Figure 5 Comparison of Monthly Precipitation and Evapotranspiration

The 1997 pluviograph record at Sydney Observatory Hill can be considered to represent a typical year at the Emu Plains site with the sum of all rainfall events totalling average precipitation for nearby Penrith. A typical year would include monthly and daily events in excess of and well below long term averages, representative of the stochastic nature of storm behaviour. This can be seen in **Figure 5**. The diagram shows that the rainfall data used for modelling purposes includes more extreme rainfall events than an average year, which means the model results are more conservative than if average data had been used.

4.2.2.3 Soil Data And Model Calibration

A rainfall-runoff calibration was undertaken prior to modelling. The model was calibrated to achieve a natural state volumetric runoff coefficient close to the value of 0.15 given in Council's DCP. A value of 0.15 was achieved using appropriate parameters for the site. This gave a volumetric runoff coefficient of 0.17 for the existing conditions of the site (*assuming 1% impervious*).

Based on the calibration process, the following soil parameters were adopted for the site:

field capacity	200 mm
soil capacity	250 mm
initial storage	25 mm
coefficient '*a*'	170
coefficient '*b*'	0.1

A rainfall threshold of 3 mm per day was adopted for impervious areas. This is representative of the estimated volume of storage available in depressions on impervious surfaces or in constructed storage areas (i.e. bio-retention systems) across the site.

4.2.2.4 Pollutant Concentrations

The pollutant concentrations used for the various land-uses in the existing and developed catchments were derived from '*Urban Stormwater Quality: A Statistical Overview*' (*Duncan, February 1999*) and Default MUSIC values. The adopted pollutant concentrations are shown in **Table 4-3.**

Table 4-3 Adopted Pollutant Concentrations

	Pollutant Concentration (mg/L)		
	Suspended Solids	**Total Phosphorous**	**Total Nitrogen**
Source Values			
Forested (MUSIC default)	79	0.079	0.84
Urban (MUSIC default)	158	0.355	2.63
Agricultural (MUSIC default)	199	0.54	3.89
Low Urban (*Duncan*)	102	0.205	2.05
Industrial (*Duncan*)	105	0.28	2.2
Roads (*Duncan*)	111	0.26	2.1
Adopted Local Existing Land Use	102	0.205	2.05
Adopted Post-Developed Land Use	105	0.28	2.2

4.2.2.5 Existing State Pollutant Export

The MUSIC model, once calibrated for runoff, was used to simulate the pollutant export generated during a mean rainfall and evaporation year using the typical pollutant concentrations contained in **Table 4-3**.

The estimated annual export of pollutants at the outlets of the existing subcatchments for a mean year are shown in **Table 4-4**.

Table 4-4 Annual Pollutant Export Loads – Existing State

Location	Pollutant Load (kg/yr)			
	Suspended Solids	**Total Phosphorous**	**Total Nitrogen**	**Gross Pollutants**
Proposed Industrial Estate	266	0.86	17.1	0

4.2.3 Developed (*No Treatment*) Pollutant Export

To assess the requirements of the treatment system, the existing state model was modified to reflect the degree of possible development. No treatment techniques were implemented in the developed (*no treatment*) model. The model was modified to reflect the impervious proportions of the catchment as defined in the section on water quantity. The runoff coefficient was calculated to be 0.74, conservatively higher than Council's advisory rate of 0.52 for industrial sites.

The estimated annual export of pollutants from the developed (*no treatment*) site for a mean rainfall year are shown in **Table 4-5**.

Table 4-5 Annual Pollutant Export Loads – Developed State (*No Treatment*)

Location	Pollutant Load (kg/yr)			
	Suspended Solids	Total Phosphorous	Total Nitrogen	Gross Pollutants
Proposed Industrial Estate	9820	26.4	208	2220

4.2.4 Proposed Treatment Strategy

It was considered appropriate at the current level of planning, to assume a single wetland could be used to treat all low flow runoff from the proposed development. A wetland typically consists of a deep sedimentation zone and a shallow macrophyte zone. However, a other treatment measures may be incorporated, which would be investigated for a development application.

The proposed water management strategy was simulated for a mean rainfall year. The results showed that a wetland of 6,500 m^2could provide the required treatment. An indicative location for the wetland is shown on **Figure 6**. This location would be subject to revision during concept design, but has been preliminarily located within the flood zone toward the lower end of the site.

Additional water quality treatment facilities could be incorporated into an overall treatment train strategy at a later stage, on the condition that Council's pollutant reduction objectives were still attained. Additional treatment facilities could include:

- Bio-retention systems;
- Permeable paving; and
- Gross pollutant traps.

A description of these additional treatment facilities is listed below.

4.2.4.1 Bio-Retention Systems

Bio-retention systems consist of low relief areas of grasses, shrubs and trees with an underlying infiltration area. Bio-retention systems can be either long strips of swales for narrow areas, or wider areas of open space heavily vegetated or grassed with a series of infiltration trenches throughout the basin area.

The purpose of bio-retention is to provide a filtering effect when the runoff flows in the surface through the vegetation to remove pollutants in the runoff. Further treatment is achieved by filtering through the gravel trench and biological action due to growth on the gravel. Low flows are maintained as much as possible on the surface exposed to sunlight and with turbulence introducing oxygen to the flows. The role of the bio-retention systems is not to promote infiltration into the subsoils, although it would be appropriate in areas of suitable soils.

Bio-retention systems may or may not be located within building set-back areas.

Due to the industrial nature of the development, it may be necessary to prevent damage to any bio-retention systems by vehicular activity through the use of physical protection measures such as a low post and rail fences or bollards.

4.2.4.2 Permeable Paving

Permeable paving could be used to allow greater design flexibility allowing otherwise impervious surfaces such as carparks to be incorporated into the water treatment strategy.

4.2.4.3 Gross Pollutant Trap

GPTs capture litter, debris, coarse sediment, oils and greases. GPTs would need to be installed on outlets to Lapstone Creek and treatment facilities such as wetlands.

The GPTs would be designed to treat the peak 3 month ARI flow (i.e. approximately 90% of annual runoff volume).

4.2.4.4 Developed (With Treatment) Pollutant Export

The water quality controls outlined were incorporated into the developed MUSIC model for the developed scenario. The estimated annual export of pollutants from the developed (*with treatment*) site for a median rainfall year are shown in **Table 4-6**.

Table 4-6 Performance of Proposed Water Quality Management Strategy

Location	Treated Pollutant Load (kg/yr)			
	Suspended Solids	Total Phosphorous	Total Nitrogen	Gross Pollutants
Proposed Industrial Area	1890	9.28	113	0

Table 4-7 details the reduction in pollutant export from the post untreated to the post treated conditions. It can be seen that the requirements of 80% reduction in suspended solids export, and 70% reduction in litter and 45% nutrient export have been achieved.

Table 4-7 Percentage Pollutant Load Reductions from Post Untreated to Post treated.

Location	Percentage Pollutant Load Reductions (%)			
	Suspended Solids	Total Phosphorous	Total Nitrogen	Gross Pollutants
Proposed Industrial Area	80.8	62.8	45.5	100

5 SERVICES

To support the proposed rezoning of the subject site, a servicing feasibility study was carried out, in consultation with servicing authorities. The results of the study support the rezoning of the site.

5.1 ELECTRICITY

The site is located directly adjacent to the Emu Plains Zone Substation, which is on the corner of Old Bathurst Road and Russell Street, in the southwest corner of the site. Integral Energy has advised that due to this location, this substation would be the only possible source of power for the site.

It is estimated that the site, once developed as an industrial estate, would require a single primary feeder to supply power requirements estimated to be 3 to 4 MVA. Integral Energy has advised that the zone substation currently has no capacity to supply additional feeder lines.

Integral Energy have a program in place to upgrade the zone substation, which would be completed mid 2007. The upgrade would provide sufficient capacity to supply the required feeder to the subject site.

Refer **Appendix A** for correspondence from Integral Energy.

5.2 WATER

Sydney Water has advised that there are existing water mains fronting the site in both Russell Street and Old Bathurst Road, and a water easement transects the site. Hence, locations for connection to water supply are readily available.

5.3 SEWER

Sydney Water sewer mains to service the site are located in Russell Street.

Sydney Water has advised that due to the low-lying nature of the northern area of the site, it may not be possible to gravity drain to the sewer main. Hence, a pump station may be required to service lots in the north. However, the extent of development in the north will be limited by the required flood zone, thus a pump station may not be required, depending on the development extent, once determined.

5.4 TELECOMMUNICATIONS

Information from Telstra indicates that there are existing telephone services to the site. Services are also present along the Russell Street and Old Bathurst Road frontages.

5.5 GAS

Information from Agility indicates that gas supply is available in the local area. A secondary gas main is present on the south side of Old Bathurst Road. A smaller line is also present in Russell Street.

FIGURES

APPENDIX A
LETTER FROM INTEGRAL ENERGY

INTEGRAL energy

Fiona Coe
Patterson Britton & Partners
PO Box 515
North Sydney 2059

1 February 2006

Dear Fiona

Industrial Rezoning - Russell St Emu Plains

Thank you for your enquiry on electricity capacity at the above location. This enquiry has been registered under CAP number ENL 0330, please use this number for any future correspondance. Once again thank you for attending the meeting held at our head office , I hope it was informative and answered any concerns you might have had. I would like to take this opportunity to confirm what was discussed at the meeting.

1. The load was assessed to be in the order of 3 MVA based on the area of the developable land and assuming it to be light industrial.

2. Currently there is no provision to connect this load to our Emu Plains Zone Substation or the nearest high voltage feeder.

3. A project has been approved to augment the Emu Plains Zone Substation by installing and additional 25 MVA power transformer, 11 kV bus bar and 6 spare 11 kV circuit breakers. This work is expected to be completed by mid 2007 which will enable the connection of your load.

4. You will need to engage the services of the appropriate service providers to undertake the contestable works associated with the connection of your site.

5. These works are deemed as contestable by IPART and as such all works will be funded by the customer.

Contact name Craig Willebrand Direct phone 9853 5189 Fax 9853 6488
51 Huntingwood Drive Huntingwood NSW 2148. PO Box 6366 Blacktown NSW 2148. DX 8148 Blacktown
Integral Energy Australia ABN 59 253 130 878 Telephone 02 9853 6666 Facsimile 02 9853 6000 www.integral.com.au

6. As this is an enquiry it does not reserve any capacity on our network, you will need to submit a formal application for connection of load form, which I have included with this letter.

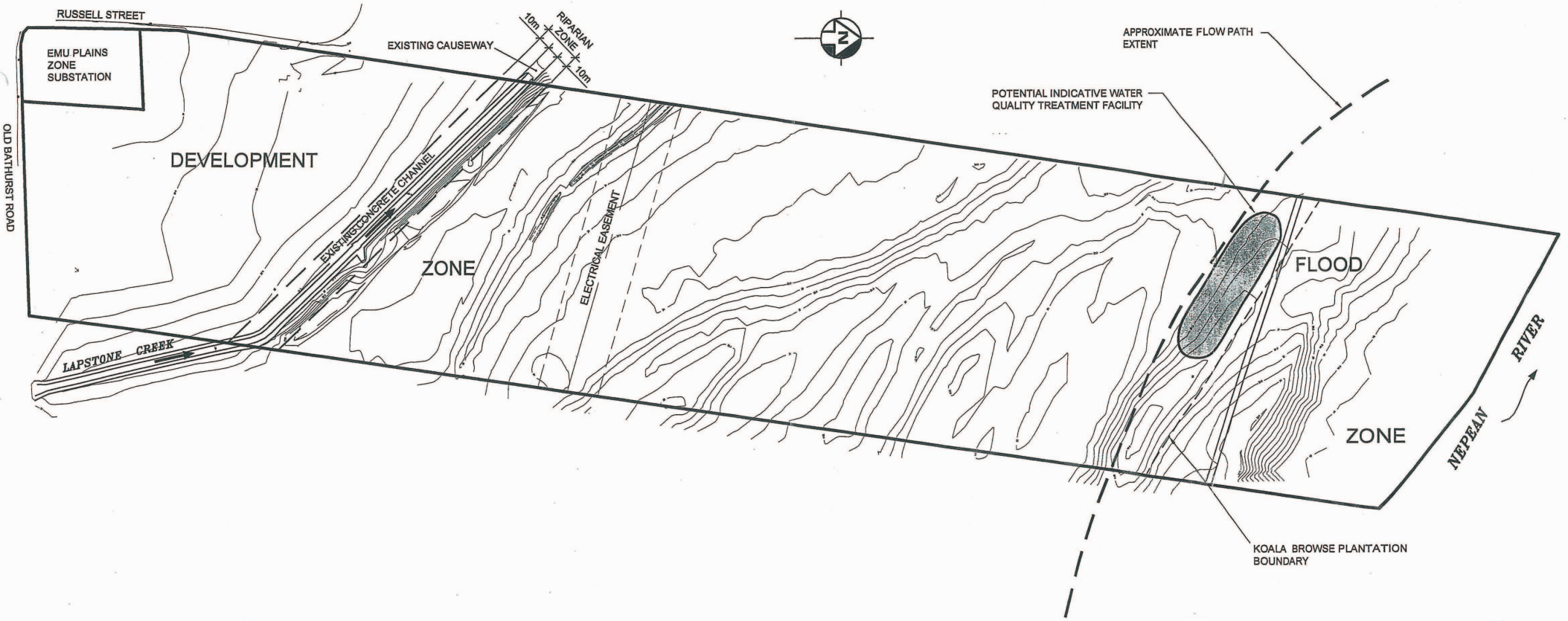
7. If you require any further advice please do not hesitate to contact me on the numbers above.

Yours faithfully

C. Willebrand

Craig Willebrand
Engineering Officer
Engineering Performance
In reply please quote file no.: ENL 0330

FIGURE 6



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OLD BATHURST RD
EMU PLAINS

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