### ILSAX Calculation Summary Sheet

<table>
<thead>
<tr>
<th>LOCATION AND LAND USE</th>
<th>TIME AND RUNOFF</th>
<th>PILET DESIGN</th>
<th>PIPE SYSTEM DESIGN</th>
<th>FIT RESULTS</th>
</tr>
</thead>
</table>

#### Entire Catchment Area

**Soil Type**
- 3 Paved 1.596 ha (60.3%)
- Supplementary 0 ha (0%)
- 3 Grassed 1.049 ha (39.6%)

**Total Area 2.645 ha**

### Design Parameters

<table>
<thead>
<tr>
<th>Design</th>
<th>Pit</th>
<th>Catchment</th>
<th>Land-</th>
<th>Percent-</th>
<th>Flow-</th>
<th>Time-</th>
<th>Length-</th>
<th>Slope-</th>
<th>Width-</th>
<th>Depth-</th>
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<td>8.405</td>
<td>8.104</td>
<td>2.18</td>
<td>5.93</td>
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| Du/Do=1.00, Qg/Qo=0.08, S/Do=2.07.75 8.25 | P101 |
| Du/Do=1.20, Qg/Qo=0.06, S/Do=1.27.13 | P101 |
| Du/Do=1.20, Qg/Qo=0.06, S/Do=1.77.69 | P101 |
| Du/Do=1.00, Qg/Qo=0.06, S/Do=1.36.94 | P101 |
| Du/Do=1.00, Qg/Qo=0.05, S/Do=1.06.73 | P101 |
| Du/Do=1.00, Qg/Qo=0.05, S/Do=1.36.82 | P101 |

**Note:** The table above shows various summaries of test results for different grading and drainage conditions.
<p>| 5% | P3/5 | 0.071 | Paved | Grassed | 0.043 | EFV1 | 0.042 | 2 | 0.05 | Coated inlet pits | 0 | 0.04 | 0.01 | 1.06 | 0.02 | 0.53 | 4.6 | 0.83 | 758 | 6.12 | 6.1 | 7.012 | 7.056 | 0.76 | 1.88 |
| 1% | P3/5 | 0.071 | Paved | Grassed | 0.089 | EFV1 | 0.211 | 2 | 0.16 | Coated inlet pits | 0 | 0.27 | 0.165 | 8.15 | 0.365 | 7.293 | 7.29 | 0.87 | 1.86 |
| 5% | P1/2 | 0.155 | Paved | Grassed | 0.067 | Coated inlet pits | 600x600 | 0.067 | 0.026 | 2 | 0.04 | 0.83 | 13.6 | 1.1 | 358 | 7.9 | 7.75 | 8.073 | 8.059 | 0.7 | 5.83 |
| 1% | P1/2 | 0.155 | Paved | Grassed | 0.076 | Coated inlet pits | 600x600 | 0.076 | 0.038 | 2 | 0.05 | 0.07 | 8.392 | 8.303 | 0.52 | 4.67 |
| 5% | P3/2 | 0.036 | Paved | Grassed | 0.02 | P1/2 | 0.036 | 2 | 0.04 | Coated inlet pits | 600x600 | 0.068 | 0.016 | 2 | 0.03 | 0.053 | 12.3 | 1.1 | 308 | 7.75 | 7.6 | 8.013 | 7.991 | 0.8 | 1.82 |
| 1% | P3/2 | 0.036 | Paved | Grassed | 0.028 | P1/2 | 0.058 | 2 | 0.05 | Coated inlet pits | 600x600 | 0.066 | 0.033 | 2 | 0.04 | 0.064 | 8.317 | 8.294 | 0.88 | 1.71 |
| 5% | P2/2 | 0.0188 | Paved | Grassed | 0.048 | P1/2 | 0.016 | 2 | 0.03 | Coated inlet pits | 600x600 | 0.064 | 0.027 | 2 | 0.04 | 0.065 | 12.2 | 1.23 | 308 | 7.6 | 7.45 | 7.867 | 7.823 | 1.26 | 1.82 |
| 1% | P2/2 | 0.0188 | Paved | Grassed | 0.063 | P1/2 | 0.032 | 2 | 0.04 | Coated inlet pits | 600x600 | 0.066 | 0.027 | 2 | 0.07 | 0.069 | 8.191 | 8.152 | 1.33 | 1.5 |
| 5% | P4/2 | 0.0196 | Paved | Grassed | 0.017 | P3/2 | 0.017 | 2 | 0.04 | Coated inlet pits | 600x600 | 0.075 | 0.033 | 2 | 0.04 | 0.141 | 12.5 | 1.2 | 375 | 7.45 | 7.3 | 7.607 | 7.644 | 1.67 | 1.79 |
| 1% | P4/2 | 0.0196 | Paved | Grassed | 0.023 | P3/2 | 0.037 | 2 | 0.07 | Coated inlet pits | 600x600 | 0.139 | 0.134 | 2 | 0.11 | 0.159 | 8.965 | 8.946 | 1.36 | 1.95 |
| 5% | P5/2 | 0.0305 | Paved | Grassed | 0.034 | P4/2 | 0.032 | 2 | 0.04 | Coated inlet pits | 600x600 | 0.068 | 0.024 | 2 | 0.03 | 0.168 | 12.9 | 1.78 | 375 | 7.3 | 7.07 | 7.328 | 7.446 | 2.61 | 1.11 |
| 1% | P5/2 | 0.0305 | Paved | Grassed | 0.033 | P4/2 | 0.134 | 2 | 0.11 | Coated inlet pits | 600x600 | 0.181 | 0.145 | 2 | 0.12 | 0.198 | 7.968 | 7.942 | 1.58 | 1.26 |
| 5% | P6/2 | 0.0196 | Paved | Grassed | 0.011 | P5/2 | 0.032 | 2 | 0.03 | Coated inlet pits | 600x600 | 0.035 | 0.011 | 2 | 0.02 | 0.165 | 9.8 | 1.62 | 375 | 7.67 | 6.97 | 7.327 | 7.305 | 2.14 | 0.81 |</p>
<table>
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<th>Grated inlet</th>
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<td>0.022</td>
<td>0.031</td>
<td>0.043</td>
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<tr>
<td>1% P7/2</td>
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<td>0.031</td>
<td>0.043</td>
<td>0.022</td>
<td>0.031</td>
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<td>0.031</td>
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<td>H/Do=1.7, Vo2/(2gDd)=0.01</td>
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| A1-4/A2-3 | Du/Do=0.90, Qg/Qo=0.00, S/Do=0.8 | H/Do=0.6, Vo2/(2gDd)=0.01 | 7.25, 7.65, 0.49 |

| A1-7/A2-8/A2-9 | Du/Do=1.00, Qg/Qo=0.00, S/Do=3.9 | H/Do=1.2, Vo2/(2gDd)=0.01 | 7.64, 7.55, 0.24 |

| A1-7/A2-8/A2-9 | Du/Do=0.60, Qg/Qo=0.00, S/Do=0.6 | H/Do=1.7, Vo2/(2gDd)=0.01 | 7.64, 7.55, 0.24 |

| A1-4/A2-3 | Du/Do=0.60, Qg/Qo=0.00, S/Do=0.6 | H/Do=1.7, Vo2/(2gDd)=0.01 | 7.64, 7.55, 0.24 |

| A1-4/A2-3 | Du/Do=0.00, Qg/Qo=0.00, S/Do=0.0 | H/Do=1.7, Vo2/(2gDd)=0.01 | 7.64, 7.55, 0.24 |
This sheet presents results from a pipe system model using ILSAX, the rational method, extended rational method (ERM), or initial loss - continuing loss (IL-CL) model implemented in the DRAINS program (www.watercom.com.au) involving considerable calculations with multiple rainfall patterns, and complex hydraulic computations. Therefore, unlike older rational method calculation sheets, this sheet does not portray hand calculations. It presents the key model inputs and outputs of interest to reviewers.

The contents of each column are discussed below:

Column 1: Design or assumed mean monthly rainfall (mm) values for urban storms, major storms or both may be displayed. Numerical values are not available for the rational method, but users can enter these values if desired.

Column 2: Pit Name from DRAINS. (The connecting sub-catchment, downstream pipe and overflow route are assumed to have the same name).

Column 3: Sub-Catchment Area (ha).

Column 4: Land-Use Type: paved, supplementary and grassed areas (in the same row).

Column 5: Percentages of paved, supplementary and grassed areas for ILSAX, or impervious and pervious areas for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 6: Constant flow times for the paved, supplementary and grassed area flow path segments (minutes) for ILSAX, or impervious and impervious areas for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 7: Lengths of paved, supplementary and grassed area flow path segments (m) for ILSAX, or impervious and impervious areas for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 8: Slopes of paved, supplementary and grassed area flow path segments (%) for ILSAX, or impervious and impervious areas for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 9: Roughnesses of paved, supplementary and grassed area flow path segments (Manning’s values) for ILSAX, or impervious and impervious areas for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 10: Total flow times for the paved, supplementary and grassed area flow path segments (minutes) for ILSAX, or impervious and impervious areas for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 11: Peak Sub-Catchment Flowrate (m³/s). For the rational method, the output indicates whether this is a full catchment or partial area estimate.

Column 12: Peak Overflows from upstream pits or nodes (m³/s), which may include flows from the sub-catchment through which they flow.

Column 13: Approach Flow Width (m) - not outputted for the rational method.

Column 14: Approach Flow Depth x Velocity (m²/s).

Column 15: Inlet Family, in the DRAINS classification.

Column 16: Inlet Size, in the DRAINS classification.

Column 17: Bypass Flow (m³/s), the overflow occurring because of lack of inlet capacity or overflowing of the pipe system.

Column 18: Overflow Width (m) at downstream of the pit - not outputted for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 19: Overflow Route Depth x Velocity (m²/s) just downstream of the pit - not outputted for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 20: Overflow from upstream pits or nodes (m³/s), which may include flows from the sub-catchment through which they flow.

Column 21: Overflow Width (m) - not outputted for the rational method.

Column 22: Overflow Route Depth x Velocity (m²/s) just downstream of the pit - not outputted for the rational method and ERM, or equivalent impervious areas (EIAs) and remaining areas for the IL-CL model.

Column 23: Flow in Pipe (m³/s).

Column 24: Pipe Length (m).

Column 25: Pipe Slope (%).

Column 26: Pipe Diameter (mm) or Box Dimensions (m).

Column 27: Upstream Pipe Hydraulic Grade Line Level (m AHD).

Column 28: Downstream Pipe Hydraulic Grade Line Level (m AHD).

Column 29: Water Surface Level (m AHD).

Column 30: Freeboard (m), the difference between the levels in the two previous columns.

Column 31: Pit Name (repeated).
### Catchment Summary

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<th>Area</th>
<th>Area (m²)</th>
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<td>0 (0%)</td>
<td>14800 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>9900</td>
<td>45</td>
<td>2215 (23%)</td>
<td>2240 (23%)</td>
<td>5445 (55%)</td>
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<td>3</td>
<td>17600</td>
<td>35</td>
<td>1846 (10%)</td>
<td>4313 (25%)</td>
<td>11441 (65%)</td>
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</table>

**Average Slopes**

- Area 1: 1.8% towards southern boundary.
- Area 2: 1% towards eastern boundary.
- Area 3: 1.2% towards south east corner.

**Total Area** = 42,300 m²

**Impervious Area** = 31,700 m²

**Impervious Area** = 10,600 m²
Area 1 catchment analysis:

Total area = 14,800 m².
average slope (total) = 1.8 %
up to mid point of swale = (11.5 - 8.0) \[ \frac{11.5 - 8.0}{18} \] = 3 %

Swale length for concentrated flow = 100 m

---

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<th>ARI</th>
<th>Sheet flow t1 (min)</th>
<th>Con flow t2 (min)</th>
<th>tC (min)</th>
<th>V (m/s)</th>
<th>V \times d (m³/s)</th>
<th>( d ) (m)</th>
<th>Qswale (l/s)</th>
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<td>10</td>
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<td>3.4</td>
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<td>20</td>
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## WEIR OUTFLOW CALCULATION

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<tr>
<td>Manning's n</td>
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</tr>
<tr>
<td>A</td>
<td>0.0707 m²</td>
</tr>
<tr>
<td>P</td>
<td>0.9426 m</td>
</tr>
<tr>
<td>R</td>
<td>0.075 m</td>
</tr>
<tr>
<td>Discharge velocity</td>
<td>2.52 m/s</td>
</tr>
<tr>
<td>Q</td>
<td>0.178 m³/s</td>
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<td></td>
<td>178 l/s</td>
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<td>2 (Broad crested weir)</td>
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<td>R</td>
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<tr>
<td>Discharge velocity</td>
<td>2.515103 m/s</td>
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<tr>
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<td>177.8052 l/s</td>
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<td>Weir coefficient</td>
<td>2 (Broad crested weir)</td>
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<td>R</td>
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Appendix D

Stormwater Quality (MUSIC) Model

and GPT Maintenance Information
## Treatment Train Effectiveness - Receiving Node

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<td>12.2</td>
<td>0.3</td>
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<tr>
<td>Total Suspended Solids (kg/yr)</td>
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<td>252</td>
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<tr>
<td>Total Phosphorus (kg/yr)</td>
<td>3.33</td>
<td>1.27</td>
<td>81.9</td>
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<td>Total Nitrogen (kg/yr)</td>
<td>25.1</td>
<td>12.6</td>
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<td>Gross Pollutants (kg/yr)</td>
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<td>0.372</td>
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Appendix E

Sediment & Erosion Control Plans
PROPOSED LAKE CATHIE PUBLIC SCHOOL UPGRADE AT;
LOT 2, DP 1193553,
No.1240 OCEAN DRIVE,
LAKE CATHIE

CIVIL DRAWING INDEX
C01.00 - COVER SHEET, SITE PLAN AND DRAWING INDEX
C02.00 - SEDIMENTATION AND EROSION CONTROL PLAN SHEET 1
C02.01 - SEDIMENTATION AND EROSION CONTROL PLAN SHEET 2
C02.50 - SEDIMENTATION AND EROSION CONTROL DETAILS
C03.00 - STORMWATER CATCHMENT PLAN
C03.01 - STORMWATER PLAN SHEET 1
C03.02 - STORMWATER PLAN SHEET 2
C03.50 - STORMWATER DETAILS

NOT FOR CONSTRUCTION
Sedimentation / Erosion Control, Soil and Water Management Details

1. Strip the topsoil, level the site and compact the subgrade.

2. Follow Standard Drawing 6-8 for installation procedures for the straw bales or geofabric. Reduce the picket spacing to 1 metre centres.

3. In waterways, artificial sag points can be created with sandbags or earth banks as shown in the drawing.

4. Place the filter at the opening leaving at least a 100-mm space between it and the kerb. Form a seal with the kerb to prevent sediment bypassing the filter.

5. Form a seal with the kerb to prevent sediment bypassing the filter.

6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile. The filter must be placed so that they firmly abut each other and sediment-laden waters cannot pass between.

7. Construct the emergency spillway.

The catchment area should be small enough to limit water flow if concentrated at one point to purpose is not satisfactory.

The project is not to be used unless specified on SWMP/ESCP.

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SD 4-1 Replacing Topsoil

SD 4-2 Stockpiles

SD 5-1 Temporary Waterway Crossing

SD 5-4 Rock Check Dam

SD 5-5 Earth Bank (Low Flow)

SD 5-6 Earth Bank (High Flow)

SD 5-7 Recp: Concentrated Flow

SD 5-8 Energy dissipater

SD 5-9 South Bank - Retaining Wall

SD 5-10 Geotextile Filter

SD 5-11 Mesh and Gravel Inlet Filter

SD 5-12 Geotextile Inlet Filter

SD 5-13 Kerbside Turf Strip

SD 5-14 Stabilised Site Access

SD 6-1 Sediment Fence

SD 6-2 Temporary Sediment Fence

SD 6-3 Earth Bank

SD 6-4 Sediment Control Blanket

SD 6-5 Silt Fence

SD 6-6 Channel

SD 6-7 Riprap Drains

SD 6-8 Filtered Waterway

SD 5-7 Sediment Fence

SD 6-1 Sediment Fence

SD 6-2 Temporary Sediment Fence

SD 6-3 Earth Bank

SD 6-4 Sediment Control Blanket

SD 6-5 Silt Fence

SD 6-6 Channel

SD 6-7 Riprap Drains

SD 6-8 Filtered Waterway
Appendix F

Extracts from Previous Stormwater Reports

F1 - Public Works - Lake Cathie Public School Stormwater Management Concept Plan
F2 - Public Works - Report Addendum
F3 - 491.1 Section 68 Approval Educational Establishment
F4- Extract - Rainbow Beach Stormwater Treatment and Functionality Report, by AECOM (Ref: 06502366.03, revision 4)
F5 - Extract - Lake Cathie Public School Stormwater Management Concept Plan
LAKE CATHIE PUBLIC SCHOOL
STORMWATER MANAGEMENT CONCEPT PLAN

Report Number: DC13105
Date: August 2013
LAKE CATHIE PUBLIC SCHOOL
STORMWATER MANAGEMENT CONCEPT PLAN

Report Number: DC13105
Date: August 2013

Document Control

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<th>Reviewer</th>
<th>Approved for Issue</th>
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<td>B. Nguyen, E. Lin</td>
<td>J. Gan</td>
<td>J. Gan 02/08/2013</td>
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Executive Summary

NSW Public Works – Dams and Civil Section has been engaged by Government Architects Office (GAO), to prepare a Stormwater Management Concept Plan (SMCP) in support of a Development Application for the proposed development of Lake Cathie Public School to satisfy the requirements stipulated by Port Macquarie-Hastings Council.

In accordance with Council’s Development Design Specifications (DCP) a SMCP is to be prepared and adopted to cater for the proposed works on the school site. The piped stormwater system is to be designed with a capacity to cater for the 20 year ARI storm event and to provide long-term overland flow paths of sufficient capacity to carry the major flows up to the 100 year ARI storm event. It is also a requirement that On-Site Detention (OSD) and WSUD initiatives be designed and constructed to control stormwater runoff from the development site based on the principal of restricting post-development discharge to pre-development rates for all storm events up to and including the 100 year ARI event.

The proposed school site is located within the new sub-division of Area 14 residential development by the St Vincent’s Foundation, also known as Rainbow Beach, Bonny Hills, which is still in the planning phase. Specifically, the Project and Concept Plan approvals for the precinct include the provision of ‘end of line’ type stormwater storage and treatment facilities within the central vegetated corridor and Lake. However, as the school development is likely to proceed prior to the downstream and surrounding subdivision residential work, a temporary OSD would be constructed to cater for the additional stormwater runoff generated from the proposed school works as result of the increased impervious surface areas to avoid any risk of downstream flooding that may be caused.

Hydrologic and hydraulic water quantity modelling has been carried out using DRAINS (Watercom, Pty Ltd, 2012) for the new stormwater pit and pipe drainage system which incorporates an OSD system. Modelling results have been verified using the Probabilistic Rational Method (PRM).

The key objectives of this Stormwater Management Concept Plan consists of the following:-

- New stormwater pit and pipe drainage system to convey the stormwater flows through the proposed works site. The pipes used have a minimum size of 300mm diameter and 0.5% slope;
- An above ground OSD system consisting of 100m$^3$ storage is located in the car park;
- Grass swales form the overland flow paths to cater for stormwater flows for large storm events through the new works site;
- Water quality management, comprising of a treatment train made up of:
  - Vegetated swales to encourage stormwater infiltration and biological uptake; and
  - Enviropod pit inserts for the removal of gross pollutants e.g. rubbish, coarse sediment, trash and debris.;
- Regular operation and maintenance program;
- Environmental Management Plan during the construction and post development phases for the school upgrade project.

This SMCP has been formulated to comply with the relevant industry standards and guidelines to address the stormwater quantity and quality issues for the proposed development site. All proposed options outlined in this report satisfy the basic concepts for stormwater management for the site and ensures proper management of water quantity and quality issues.
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Appendix B – PRM Calculations
Appendix C – DRAINS Modelling Results
1. Introduction

NSW Public Works has been engaged by Government Architects Office (GAO) to prepare a Stormwater Management Concept Plan (SMCP) in support of a Development Application for the proposed development of Lake Cathie Public School to satisfy the requirements stipulated by Port Macquarie-Hastings Council (Council). Refer to Figure 1 for locality of the site.

The site is located within the sub-division of Area 14 residential development by the St Vincent’s Foundation, also known as Rainbow Beach, Bonny Hills, which is still in the planning phase. Specifically, the Project and Concept Plan approvals for the precinct include the provision of 'end of line' type stormwater treatment facilities within the central vegetated corridor and Lake, which have been designed to cater for all anticipated development within the precinct including the school site as part of a wider water cycle management plan.

The basic philosophy underpinning this Stormwater Management Concept Plan has been to adopt a holistic approach to the management of stormwater quantity and quality issues arising from the proposed development incorporating Water Sensitive Urban Design (WSUD) principles. The piped stormwater drainage system will need to be designed with a capacity to cater for the 20 year ARI storm event and to provide long-term overland flow paths of sufficient capacity to carry major flows up to the 100 year ARI storm event under the major/ minor flow system concept as recommended in Australian Rainfall &Runoff (AR&R) and noted in Council’s policies.

It is also a requirement that On-Site Detention (OSD) and WSUD initiatives be designed and constructed to control stormwater runoff from the development site based on the principal of restricting post-development discharge to pre-development rates for all storm events up to and including the 100 year ARI event.

This report summarises conceptually, the design principles and planning objectives adopted for the stormwater quantity and quality management and will identify:

- Existing site conditions;
- Proposed development conditions;
- Additional stormwater drainage system components, e.g. pits, pipes and connection to the new subdivision drainage system;
- On Site Detention (OSD) requirements as a result of the proposed development;
- Outline possible options to address stormwater quantity and quality issues, to satisfy Council’s requirement for the Development Application (DA); and
- Outline maintenance schedule for the proposed drainage system.

This concept plan has been generally prepared in accordance with:

- AS/NZS 3500, Australian/New Zealand Standard: Plumbing and Stormwater, 2003;
- CSIRO, Urban Stormwater: Best Practice Environmental Management Guidelines, Ch.5 – Water Sensitive Urban Design, 1999;
- Institution of Engineers Australia, Australian Rainfall and Runoff, Volumes I and II, IEAust, Canberra (AR&R), 1997;
- Landcom’s Managing Urban Stormwater, Soils and Construction, 2004;
- Port Macquarie-Hastings Council, Development Control Plans 2005;

It should be noted that the drawings and strategies developed for this report are intended for conceptual purposes in principle. Details provided are subject to adjustment/modifications as the design is being developed in conjunction with other works carried out for the final detail design phase.
2. Method of Approach

The methodology adopted for this stormwater management concept plan comprises of the following steps:

- **Review of available data, maps and plans including:**
  - Review of existing site survey plans;
  - Review of development application package “Cardno, Rainbow Beach, Bonny Hills - Lake Cathie Primary School Site civil and Subdivision works” April 2013.
  - Review of proposed architectural plans and relevant development plans;
  - Estimation of upstream catchment characteristics and using aerial photography;
  - Catchment delineation.

- **Carry out hydrologic water quantity modelling using DRAINS (Watercom Pty Ltd, 2012) for the stormwater pit and pipe drainage system:**
  - Estimate peak flow rates generated from the delineated catchment for the existing conditions for the 20 and 100 year ARI storm events;
  - Estimate peak flow rates generated from the delineated catchment for the proposed conditions for the 20 and 100 year ARI storm events;

- **Verification of hydrologic modelling results using the Probabilistic Rational Method (PRM) in accordance with AR&R 1997 for the 20 and 100 year ARI storm events;**

- **Assess the On Site Detention (OSD) requirements including Site Storage Requirements (SSR) and Permissible Site Discharge (PSD) in accordance with Council’s Development Design Specifications and OSD Policy:**
  - Carry out hydrologic water quantity modelling using Council’s OSD calculation sheet and DRAINS (Watercom Pty Ltd, 2012) to determine OSD requirements;
  - Verification of OSD modelling results using the Probabilistic Rational Method (PRM) in accordance with AR&R.

- **Proposed concept options to address stormwater quantity and quality issues to satisfy Council requirements including:**
  - Preliminary sizing of the new stormwater pit and pipe drainage system;
  - Preliminary sizing of the OSD system;
  - Propose stormwater treatment and stormwater harvesting measures by applying WSUD principles;
  - Outline maintenance schedule for the proposed drainage system; and
  - Preparation of Erosion and Sediment Control plan for the pre-development construction and on-going phases.
3. Available Data

3.1 Mapping
Available maps and plans of reference have been obtained and used in this study. Relevant maps and plans have been obtained from the Council, St Vincent’s Foundation, NSW Public Works Survey Group and NSW Department of Land & Property Information.

3.2 Survey Datum
Existing site survey and cadastral plans have been obtained from the field work carried out by NSW Public Works Survey Group and NSW Department of Land & Property Information. All survey data relate to the Map Grid of Australia (MGA 56) and all levels used in this report relate to the Australian Height Datum (AHD). Refer to Figure 2 for Existing Site Survey.

3.3 Design Storms
Typical design storm temporal patterns and associated rainfall intensities have been obtained from AR&R for input into the DRAINS model and the Probabilistic Rational Method (PRM). A copy of the IFD Chart has been included in Appendix A. The effects of all storm durations have been examined in accordance with Council's Development Design criteria.

3.4 Ponding Depths
The following ponding depths have been adopted from Council’s guidelines for the OSD requirements as part of this Stormwater Management Concept Plan in the interests of safety amenity.

<table>
<thead>
<tr>
<th>Use</th>
<th>Maximum Depth Adopted (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape and Sports Fields</td>
<td>0.5</td>
</tr>
<tr>
<td>Other Impervious area without vehicle access</td>
<td>0.18</td>
</tr>
<tr>
<td>Car Parking Areas</td>
<td>0.15</td>
</tr>
</tbody>
</table>

3.5 Downstream Receiving System
Stormwater from the proposed school site would discharge to the south-east boundary of the school site, then into the sub-division pipe/pit/open channel drainage system and ultimately to the Ocean, as specified in “Site Services Assessment for Lake Cathie/Bonny Hills School Site – NSW Public Works, 2011”.

3.6 Freeboard
Freeboard is a term used to describe a factor of safety expressed in metres above a design flood level for flood protective or control works. A freeboard is intended to allow for the uncertainties in analysis, design and construction. Therefore, the building can be constructed with confidence since the risk of a flooded structure has been greatly reduced.

Council has stipulated that developments will not be permitted within known floodways unless it can be proven that the development will not be affected by floodwaters nor will the development cause flooding both upstream or downstream of the proposed development site.

Council’s freeboard requirements are as follow:-
- Surcharge and overland flow routes shall have 0.3m freeboard between the 100 year level and habitable floor level and entrances to underground car parks.
- Major channels shall have 0.5m freeboard between the 100 year level and habitable floor level and entrances to underground car parks.
• For flood liable areas the freeboard to floor levels of dwellings and structures shall be in accordance with council’s flood policy.

3.7 **Habitable Floor Level**

There is no mainstream or back-water flood related development controls applied to the school. Therefore, the Habitable Floor Level (HFL) of the new buildings for the proposed works on the site will need to be located as a minimum at the adjacent road level plus a minimum of 0.3m freeboard.
4. Water Quantity Modelling

4.1 General
The site is located within the new sub-division of Area 14 residential development, also known as Rainbow Beach, Bonny Hills.

Specifically, the project and concept plan approvals for the precinct include the provision of 'end of line' type stormwater storage and treatment facilities within the central vegetated corridor and Lake, which have been designed to cater for all anticipated development within the precinct including the school site as part of a wider water cycle management plan. Refer to Figure 7 for the Concept Rainbow Beach Residential Development Masterplan.

OSD is not specifically required for the proposed school site as it has already been intended to be provided in the downstream infrastructure as part of the total water cycle management site for the subdivision works development. As we understand, the modelling to date has been undertake on the basis that the School is to be 70% impervious which is very conservative.

The new piped stormwater drainage system will need to be designed with a capacity to cater for the 20 year ARI storm event and to provide long-term overland flow paths of sufficient capacity to carry major flows up to the 100 year ARI storm event under the major/ minor flow concept as recommended by AR&R (1997).

Stormwater from the proposed school site would discharge from the south-east boundary to surface flow channels and ultimately to the Ocean, as specified in “Site Services Assessment for Lake Cathie/Bony Hills School Site – NSW Public Works, 2011”.

4.2 Catchment Area and Characteristics
The proposed development is undertaken on a “green field site” with no or limited existing infrastructure.

The catchment area for the school sit has been delineated based on available survey data and plans. Catchment boundaries developed have been based on estimation of site grades and proposed new drainage infrastructure locations. Verification of site specific information pertaining to the development's pervious and impervious fractions has been estimated based on proposed school building prepared by GAO. Due to the natural topography of the site, the proposed school site will not be affected by the upstream catchment runoff.

Characteristics of the pre-development and post development catchment areas have been estimated based on literature review.

The proposed school site catchment is bounded by Ocean Drive to the North, and a new proposed drainage easement which gently slopes to the south east. This local school catchment covers an area of approximately 3.96 ha. The topography of the site within the study area has slopes of about 1.25% and dips towards the south east corner.

Under ordinary conditions, stormwater runoff from the proposed school site drains into the southern adjacent land downstream.

The existing condition and proposed works on the site are shown at Figures 2 and 3 respectively.

4.3 Local Drainage System
As there is no formal drainage system on site, all of the stormwater runoff and overland flows generated from the existing “green field site” would drain as per natural contour shown at Figure 2.
4.4 Catchment Hydrology

The hydrology has been carried out in accordance to Australian Rainfall and Runoff (AR&R), 1997. Available regional parameters, rainfall statistics and research data have been obtained from Council’s DCP.

The methodology adopted for this study consists of carrying out hydrologic modelling using the Probabilistic Rational Method (PRM) and DRAINS computer model to estimate the peak flow rates generated from the site from the effects of all storms in determining the designs for the new stormwater drainage system and On-Site Detention (OSD) requirements.

The OSD has been designed and constructed to control stormwater runoff from the proposed new works on the school site such that peak stormwater discharges from the site does not exceed pre-development stormwater discharges. The piped stormwater system is to be designed with a capacity to cater for the 20 year ARI storm event and to provide overland flow paths to cater for the 100 year ARI storm event.

4.5 Catchment Areas

Due to the natural topography of the site, the proposed school site will not be affected by the upstream catchment runoff. A catchment area of 3.96 ha has been considered in this stormwater study. Table 4-1 summarises the pervious and impervious sub-catchment areas for the pre and post development conditions.

Figure 3 depicts the proposed works on the site, which consists of new buildings, new car parks and driveways, games court area, site access and new landscaped areas. The proposed development also includes additional stormwater drainage pits and pipes, grass swales, and an OSD system to satisfy Council’s DCP requirements.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Impervious Area (ha.)</th>
<th>Pervious Area (ha.)</th>
<th>Total Area (ha.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-development</td>
<td>0.20</td>
<td>3.76</td>
<td>3.96</td>
</tr>
<tr>
<td>Post-development</td>
<td>0.70</td>
<td>3.26</td>
<td>3.96</td>
</tr>
</tbody>
</table>

Our assessment shows that the proposed works will create a total increase of approximately 0.5 ha in impervious area on the proposed school development site.

4.6 Probabilistic Rational Method

The Probabilistic Rational Method (PRM) has been used to provide preliminary estimates for the peak stormwater flows from the school for the existing and post development site conditions for the 20 and 100 year ARI storm events. Refer to Appendix B for PRM calculation.

4.7 DRAINS Modelling

DRAINS is a computer program which simulates runoff hydrographs at defined points through a watershed for a set of catchment conditions and specified rainfall events.

The DRAINS computer model has been setup to conceptualise the stormwater pit and pipe drainage system and overland flow paths to cater for the estimated peak flow rates generated from the catchment for the 20 and 100 year ARI storm events respectively, and to provide parameters in determining OSD requirements.

The DRAINS model has been setup in accordance with Council’s Development Design Specifications. Refer to Table 4-2 for DRAINS modelling parameters.
Table 4-2 - DRAINS Modelling Parameters

<table>
<thead>
<tr>
<th>Description of DRAINS Parameter</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved (impervious) area depression storage (mm)</td>
<td>1</td>
</tr>
<tr>
<td>Grass (pervious) area depression storage (mm)</td>
<td>1</td>
</tr>
<tr>
<td>ILSAX soil type</td>
<td>5</td>
</tr>
<tr>
<td>Antecedent Moisture Condition (ARI = 1-10 years)</td>
<td>2.5</td>
</tr>
<tr>
<td>Antecedent Moisture Condition (ARI = 20 years)</td>
<td>3</td>
</tr>
<tr>
<td>Antecedent Moisture Condition (ARI = 100 years)</td>
<td>3.5</td>
</tr>
<tr>
<td>Reinforced Concrete Pipe – Colebrook White 'k'</td>
<td>0.3</td>
</tr>
</tbody>
</table>

4.8 Modelling Results – Stormwater Drainage System

Tables 4-3 and 4-4 below summarises the stormwater drainage system modelling results obtained from the PRM and DRAINS modelling for the pre-development and post development scenarios respectively. Refer to Appendix B for detailed PRM calculations and Appendix C for DRAINS modelling results.

Table 4-3 Peak Flow Estimates for Pre-Development Condition (without OSD)

<table>
<thead>
<tr>
<th>Design Storm (ARI)</th>
<th>Estimate Peak Flow (m³/s)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRM</td>
<td>DRAINS</td>
<td></td>
</tr>
<tr>
<td>20 year</td>
<td>1.01</td>
<td>0.92</td>
</tr>
<tr>
<td>100 year</td>
<td>1.60</td>
<td>1.52</td>
</tr>
</tbody>
</table>

Refer to Appendix D and Appendix E for PRM and DRAINS calculation respectively.

Table 4-4 Peak Flow Estimates for Post Development Condition (without OSD)

<table>
<thead>
<tr>
<th>Design Storm (ARI)</th>
<th>Estimate Peak Flow (m³/s)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRM</td>
<td>DRAINS</td>
<td></td>
</tr>
<tr>
<td>20 year</td>
<td>1.04</td>
<td>0.95</td>
</tr>
<tr>
<td>100 year</td>
<td>1.65</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Refer to Appendix B and Appendix C for PRM and DRAINS calculation respectively.

The results from the modelling have been verified by comparing the peak discharge values computed against those estimated using the PRM for the 20 and 100 year ARI storm events. Difference between the peak discharge values are within the 20% confidence level, thus the model is considered acceptable in accordance with AR&R (1997) requirements.

4.9 On-Site Detention (OSD) System Modelling Results

On-site Detention (OSD) is not specifically required for the proposed school site as it has already been intended to be provided in the downstream infrastructure as part of the total water cycle management of new subdivision works.

However, as the school development is likely to proceed prior to the downstream and surrounding subdivision works, a temporary OSD would be required to cater for the additional stormwater runoff generated from the proposed new school site.

OSD involves temporary storage and controlled releases of stormwater generated from the proposed works, with benefits for downstream residents in small rainfall and large storm events. OSD system must be properly maintained to ensure that stormwater flows from the site are regulated for the life of the development.

Council does not provide site specific detention requirements, rather the OSD requirements are based around the principle of restricting post-development discharge to pre-development rates for all storm events up to and including the 100 year ARI storm event. Hydrological modelling for the
OSD system, as a result of the increase in impervious areas for the 100 year ARI storm has been carried out using DRAINS. Refer to Table 4-5 and Appendix C for DRAINS results.

The results from the DRAINS model have been compared and verified using the PRM. The OSD requirements calculated have been summarised in Table 4-6 below.

**Table 4-5 Peak Flow Estimates for Post Development Condition**

<table>
<thead>
<tr>
<th>Design Storm (ARI)</th>
<th>Pre-Development</th>
<th>Post Development</th>
<th>Post Development with OSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 year</td>
<td>1.52</td>
<td>1.56</td>
<td>1.51</td>
</tr>
</tbody>
</table>

**Table 4-6 OSD Requirements Summary**

<table>
<thead>
<tr>
<th>OSD System</th>
<th>Storage Volume Required (m³)</th>
<th>Orifice Plate Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSD - (Car park)</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

Notes: *Refer to Figure 6 for Cumulative Storage Curve.

Therefore a temporary OSD system with a storage of 100 m³ has been provided in the car park as shown at Figure 4.
5. Water Quality Modelling

Discussions with Council Stormwater Engineer Mark Edenborough have confirmed that a Model for Urban Stormwater Improvement Conceptualisation (MUSIC) model would not be required for the DA submission. It is understood that water quality modelling of the entire new subdivision Area 14 precinct has been carried out during the planning phase which includes the proposed Lake Cathie Public School development site.

However, as the school development is likely to proceed prior to the downstream surrounding subdivision works, an interim/temporary stormwater quality infrastructure consisting of a treatment train will be installed and constructed to prevent environmental degradation and minimise risks to water quality objectives in the short term. Refer to Figures 4 and 5 for proposed stormwater treatment measures details.
6. Stormwater Management Plan

6.1 General

Council has indicated that depending on the timing of the school construction relative to the other developments in the new sub-division of Area 14, temporary stormwater management measures may be required. Therefore, an interim/temporary detention system and WSUD initiatives including stormwater harvesting would be installed and constructed on the school site to prevent environmental degradation and to minimise risks in the meantime.

The primary objective of the stormwater management strategy proposed is to achieve minimal detrimental impact on the downstream surrounds as a result of stormwater flow rate, runoff volume and quality. The objectives have been achieved by the adoption of a series of integrated strategies, e.g.:

- Control runoff volumes and flows from the proposed development site;
- Control storm water flows on the site and manage the discharge rates in accordance with specified criteria outlined;
- To maximise the potential for stormwater infiltration as a means of disposal and quality improvement;
- Encourage stormwater harvesting and reuse opportunities by applying WSUD principles to reduce potable demands;
- Minimise pollutant loads generated by the proposed development site; and
- Carry out source control treatment to reduce pollutant loads emanating from the proposed development site.

Stormwater management also involves regular inspections and maintenance of stormwater drainage systems. In general, to sustain an effective stormwater drainage system, cleaning and maintenance operations should be carried out once every month or after every storm event greater than 10 mm or more frequently if the system becomes clogged. Overland flow paths, grass swales, OSD and discharge controls, including the rainwater tanks will need to be inspected on a regular basis.

The drainage infrastructure will consist of a combination of stormwater pipe/pit drainage system, grass swale, and on-site detention storage. The site area will be graded to fall towards the outlet located at the southeast corner of the site. Pipes and inlets forming the stormwater drainage system have been designed and duplicated where considered necessary to minimise risk of blockage at critical points. The on-site detention storage has been designed to cater for storm events up to the 100 year ARI and shall slowly release stored flows back to the downstream drainage system.

The section below outlines the nature and scale of the proposed development together with specific components on stormwater management and pollution control strategy. Stormwater runoff quality from the car parks/driveways will be directed into enviropods and grass swales for treatment as per WSUD principles, summarised in Table 6.1. Refer to Figures 4 and 5 for details.
### Table 6.1 - Proposed Pollutant Treatments

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Treatment Objective</th>
<th>Proposed Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspended solids</td>
<td>80% retention of the average annual load</td>
<td>Enviropods and Grass swale</td>
</tr>
<tr>
<td>Total Phosphorous</td>
<td>45% retention of the average annual load</td>
<td>Grass swale</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>45% retention of the average annual load</td>
<td>Grass Swale</td>
</tr>
<tr>
<td>Litter</td>
<td>Retention of litter greater than 5mm for flows up to 100% of the 3 month ARI peak flow</td>
<td>Enviropod</td>
</tr>
<tr>
<td>Coarse sediment</td>
<td>Retention of sediment coarser than 0.125mm for flows up to 100% of the 3 month ARI peak flow</td>
<td>Enviropod</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>In areas with concentrated hydrocarbon deposition, no visible oils for flows up to the 3 month ARI peak flow</td>
<td>Enviropod</td>
</tr>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspended solids</td>
<td>Effective treatment of 90% of daily runoff events (e.g. &lt;4 month ARI). Effective treatment equates to a 50%ile suspended solid concentration of 50mg/L</td>
<td>Erosion &amp; Sediment Controls</td>
</tr>
<tr>
<td>Other pollutants</td>
<td>Limit the application, generation and migration of toxic substances to the maximum extent practicable</td>
<td>Erosion &amp; Sediment Controls</td>
</tr>
</tbody>
</table>

### 6.2 Proposed Stormwater Management Plan

The proposed stormwater management components are summarised at Figure 4 with the respective component details at Figure 5.

#### 6.2.1 General

A gravity line stormwater collection, drainage system will be provided to dispose stormwater runoff from the proposed development site in accordance with the local authority requirements and as per specification below.

#### 6.2.2 Roof Water

Roof waters from the new buildings shall be collected via roof gutters, downpipes, etc and discharged into the nearest stormwater pit, for later discharge into the existing site stormwater drainage system.

#### 6.2.3 Stormwater Pit and Pipe Drainage System

The new stormwater pit and pipe drainage system has been designed to cater for the 20 year ARI storm event with a minimum 300 mm pipe diameter to be adopted. The pipe system has also been designed to ensure that the ponding depth would not exceed the 150mm freeboard. The minimum pipe slope shall be 0.5% to promote self-cleansing velocities. However, most of the stormwater runoff and overland flows generated from the proposed works at the school site would drain into proposed Council’s stormwater drainage easement located toward the south-east of the site.

The minimum size of stormwater pits shall be 600 x 600mm, with medium duty grating and pit inserts such as Enviropods or equivalent are to be installed at the car park for stormwater treatment and to provide pollution control, e.g. prevent trash from blocking the pipes, OSD system, etc.

#### 6.2.4 Overland Flow Corridors

Proposed development remains unaffected by the upstream overland flows generated. Thus flood proofing measures is not required to cater for upstream overland flows.

Localised overland flow paths have been intended to pass through the site via a sheet flow profile as a result of minor site grading earthworks and provided within the school site via grass swales and concrete v-drains to cater for large storm events e.g. 100 year ARI and up. The velocity - depth ratio for the overland flow paths, grass swales and any open channels have been designed to encompass values of less than 0.4 m²/s in a large storm event. This criterion relates to public safety as a higher value would present a hazard during large storm events.
The hazard rating can generally be summarised as following:-

- Low hazard where the product of velocity and flow depth is - < 0.4 m²/s.
- Medium hazard where the product of velocity and flow depth is - from 0.4 to 1 m²/s.

However, to prevent pedestrians being swept along streets and other overland flow paths during major storm events, the product of velocities and depths in streets and major flow paths generally shall not exceed 0.4m²/s. This limit is based on experimental studies of stability of children by Foster and Cox (1973). Where vehicles alone are affected, a higher depth-velocity product, 0.6 or 0.7m²/s depending on vehicle size, is appropriate. The stability of vehicles in lateral and longitudinal flows has been investigated by Gordon and Stone (1973).

6.2.5 Grass Swales

Grass swales at a minimum 0.5% slope have been proposed along the boundary of the proposed new works to capture and convey localised overland flows. Runoff from the proposed works site has been diverted into grass swales through direct surface runoff to promote stormwater treatment. The treatment system operates by filtering surface flows through surface vegetation and then percolating runoff through fine filtration, extended detention and biological uptake, which are particularly efficient at removing nutrients.

6.2.6 Enviropod Pit Inserts

Enviropod pit inserts has been proposed to control gross pollutants which enter the local stormwater system. Source control system such as these pit inserts will enable the removal of gross pollutants, such as coarse sediments, trash, litter and grease & oils. All gross pollutant, debris and sludge trapped in the Enviropods will need to be removed by as part of the regular maintenance program and disposed off in an appropriate landfill. Refer to Figure 5 for details.

6.2.7 OSD System & Discharge Control Pit

Provisions for an above ground OSD storage has been proposed within the car park. 100m³ storage has been proposed in accordance with Council requirements. An orifice control plate and a screen mesh are also required for the OSD system. The orifice has been designed to maintain the Permissible Site Discharge (PSD) and shall be protected from blockage and the like by an approved mesh screen.

6.2.8 Rainwater Tanks

Provision for a rainwater tank system is optional but strongly recommended for the proposed school development. A rainwater tank system is beneficial in that it reduces the potable water consumption, thus allowing the harvesting and reuse of stormwater onsite, and this assists in reducing the amount of post development site discharge.

Tank water shall be utilised as a non-potable supply for the building and for other secondary reuse purposes such as toilet flushing, irrigation of playing fields, etc. The waters collected can be treated to potable quality by UV Disinfection. Overflow from the rainwater tanks shall be directed to the stormwater system.

6.2.9 Summary of Stormwater Site Drainage Plan

In summary, to satisfy Council’s requirements, the proposed stormwater drainage system will comprise of the following components;

- New stormwater pit and pipe drainage system to convey the stormwater flows through the proposed works site. The pipes used have a minimum size of 300mm diameter and 0.5% slope;
- An above ground OSD system consisting of 100m³ storage is located in the car park;
- Grass swales form the overland flow paths to cater for stormwater flows for large storm events through the new works site;
- Water quality management, comprising of a treatment train made up of:
  - Vegetated swales to encourage stormwater infiltration and biological uptake; and
  - Enviropod pit inserts for the removal of gross pollutants e.g. rubbish, coarse sediment, trash and debris.;
- Regular operation and maintenance program;
- Environmental Management Plan during the construction and post development phases for the school upgrade project.

6.3 Maintenance Schedule and Time

Suggested stormwater drainage maintenance schedule is given in Table 6.2. All maintenance works carried out including volumes of trash, debris and sediment/grit removed should be recorded.

<table>
<thead>
<tr>
<th>Item</th>
<th>Frequency of Inspection</th>
<th>Frequency of Cleaning</th>
<th>Method of Cleaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pits and pipes in the drainage system</td>
<td>Weekly or after every storm event greater than 10 mm</td>
<td>Monthly</td>
<td>Manually</td>
</tr>
<tr>
<td>Swales &amp; Bio-retention trenches</td>
<td>Weekly or after every storm event greater than 10 mm*</td>
<td>Monthly**</td>
<td>Manually</td>
</tr>
<tr>
<td>Enviropod GPTs</td>
<td>Weekly or after every storm event greater than 10 mm*</td>
<td>Monthly**</td>
<td>Manually remove the litter nylon bag and replace with a cleaned bag or nylon bag</td>
</tr>
<tr>
<td>Screen Mesh</td>
<td>Weekly*</td>
<td>Monthly**</td>
<td>Sweep screen with broom and clean water</td>
</tr>
<tr>
<td>Rainwater Tanks</td>
<td>Quarterly</td>
<td>Yearly***</td>
<td>Using Supersucker/Grit removal plant</td>
</tr>
<tr>
<td>OSD storage facility in the car park including the Discharge Control Pit</td>
<td>Weekly or after every storm event greater than 10 mm*</td>
<td>Monthly**</td>
<td>Manually</td>
</tr>
</tbody>
</table>

[Notes: * - Should be cleaned if required at the inspection; ** - frequency period may be adjusted at the end of first year; *** - Frequency may be increased at the end of first year]

An Operations and Maintenance program will need to be designed so as to satisfy Council’s and the Work Health & Safety requirements.
7. Environmental Management Plan

7.1 General

This section outlines the requirement for management of stormwater during the construction and post development phases for the new school project. The details provided below, are based on the currently available soils, stormwater and groundwater information for the site. These provide the basis for an Erosion and Sedimentation Control Plan (ESCP).

The ESCP will form a key component of the temporary works required to maintain the quality of stormwater and groundwater during pre-development and construction stages. Details of the proposed ESCP will need to be submitted to Council for approval prior to commencement of each stage of construction. The ESCP will be developed in parallel with the preparation of the detailed engineering drawings. This process will ensure that the level of detail available for the design of the ESCP is compatible with and complimentary to that included in the engineering drawings. The proposed plan will be prepared by suitably qualified and experienced consultant and will include:-

- locality of site, a north point and scale;
- existing contours of the site including direction of fall;
- location of significant natural features requiring special planning or management including waters, flood plain, seasonal wet areas, areas prone to ponding - waterlogging, unstable slopes, etc.;
- nature and extent of earthworks including cut and fill and road works and retaining walls.
- location of all soil and material stockpiles;
- location of site access and other impervious areas;
- location and type of proposed erosion and sediment control measures;
- site rehabilitation proposal, including final contours;
- time of placement of sediment control works;
- staging of works and maintenance schedule;
- all water draining from impervious surface within the site (including roofs, driveways, park area and roadways) shall be collected and drained to sediment collection sumps prior to discharging from the site;
- All surface water outlets shall be discharge at non-erosive velocities (i.e. less than 2m/s) in not less than 20 year, time of concentration event.

7.2 Overview of Erosion and Sediment Control Measures

Construction activities generate the potential for erosion and sediment movement during and after rainfall. To control the potential for erosion and sediment movement the following measures will be utilised on the proposed development site for each stage of the development:-

- preparation of a comprehensive ESCP for the site taking account of soil characteristics
- staging of construction activities to ensure that the works program takes account of all measures necessary to control erosion on the site.
- minimisation of disturbed areas. Only those areas directly required for construction will be disturbed. Construction boundaries will be marked and no activity permitted outside these designed areas. Disturbed areas will be rehabilitated quickly.
- installation of temporary sediment and erosion control measures prior to commencement of construction operations
- diversion of clean water from undisturbed areas around working areas
• maintenance of sediment control structures, particularly after rainfall, to ensure their efficiency until their catchment areas are fully stabilised.

A diverse range of storm water management, erosion and sediment control measures will need to be installed on the proposed development site. A selection of measures considered suitable is included below. The implementation of any specific measures is generally dependant on the degree of storm water management or sediment control required for the area in question. In most situations several measures would be used in conjunction to achieve the desired result. The combination of measures to be used would be identified during the preparation of the ESCP for each stage of the development.

7.2.1 Temporary Drains
Temporary drains and diversion banks will be designed to maintain non-erosive velocities and direct runoff to temporary sediment trapping structures or divert clean runoff to stabilised outlets. Temporary drains are generally short-term controls and required alterations on a frequent basis during construction. Where required catch and diversion drains will be located upstream of working areas to divert clean runoff around the construction site.

7.2.2 Sediment Filters
Sediment filters will be used to filter sheet flow from small drainage areas of the site. The sediment filter consists of:-

• sediment fences along the contour below the construction areas
• straw bale sediment filters in the overland flow path (i.e. roads) to trap sediment.
• they will be located at points with significant disturbed drainage area to optimise their use

7.2.3 Sediment Basins
Sediment basins will consist of a dam or barrier designed to intercept sediment laden runoff and retain the sediment. They will be located on drainage lines below a construction site. Sediment basins will be used to trap sediment from large drainage areas of the site and where concentrate flow exists. Sediment basins will be designed to drain slowly.

7.2.4 Revegetation
The staging of construction works will allow progressive revegetation and hence minimisation of disturbed areas. Specific grasses, mulches and mats for rapid revegetation and establishment of disturbed areas will be used when and if required at strategic locations, such as long batters.

7.2.5 Dust control
Dust control will be implemented during construction by keeping disturbed areas moist by spraying from water carts. Erosion of disturbed areas by high winds will be controlled with the use of porous barrier fence around the boundaries where existing fencing or features do not provide protection from these winds.

7.2.6 Construction Staging
To ensure erosion and sediment control during construction, a range of measures will be implemented in accordance with the construction staging.

7.2.7 Site Entry
Temporary construction entry/exit points will be used to prevent the most heavily travelled routes from becoming a source of sediment. Truck shaker ramps or washdowns and sediment traps will be incorporated at entry/exit points.

7.2.8 Soil Stockpiling
Soil stockpiles will be located away from drainage paths and in areas where surface water can be diverted and prevented from washing into the stockpiles. Sediment filter fences or barriers of coarse gravel in hessian or geotextile bags will be installed below stockpiles to prevent movement of soil material from the stockpiles.

Topsoil stockpiles will be seeded with a temporary cover crop after reshaping or alternatively covered with straw mulch held in position with nylon netting which will be pegged onto the stockpile to prevent the mulch blowing away.

Excavated material that is temporarily stockpiled for later use as fill material will be stockpiled away from the topsoil material so that cross contamination does not occur. If this material is to
remain stockpiled for more than 10 days the stockpiles will be covered with tarpaulins or plastic sheeting to prevent rainfall washing the fine materials from the stockpiles. Excavated material stockpiles will also be protected from storm water run-on by diversion banks above the stockpiles and sediment filter fences below the stockpiles.

7.2.9 Site Management
Adequate and effective site management of the soil erosion and sediment control measures during the construction phase is essential. On the site it is intended to undertake a regular site audit of the soil erosion and sediment control measures by an independent organisation to ensure the requirements of the Stormwater Management Plan are implemented and maintained.

The responsibility for monitoring and reporting of the status of each erosion and sedimentation control measure is, for the most part, the responsibility of the contractor for each development stage.

7.2.10 Summary of Environmental Management Plan
Construction activities generate the potential for erosion and sediment movement during and after rainfall. Control measures are to be undertaken during the construction phase of the development to minimise the impact of soil erosion and sediment/nutrient pollution to the downstream environments. The following water and erosion/sediment control measures shall be provided as a minimum by the Contractor and will only be removed after the disturbed areas are stabilised and revegetated. These measures include:-

- straw bale or sandbag diversion bank above disturbed areas;
- sediment fence below the site;
- Temporary fencing;
- Temporary catch drains;
- Sediment/silt/hay-bale fences.
- temporary sediment basins;
- protection of the soil stockpile site;
- immediately turfing of tidied up areas after completion of construction activities;
- immediate connection of gutter and downpipes to the stormwater drainage system;
- regular and ongoing maintenance of all measures.

It is expected that site erosion control measures will be regularly inspected by the construction superintendent/inspectors as part of the implementation of Erosion and Sediment Control Policy.

The water and erosion/sediment control measures will be constructed during the early part of the construction phase and monitored during construction phase activities in accordance to “Managing Urban Stormwater, Soils and Construction” by Landcom (2004).
8. Conclusion

NSW Public Works has been engaged to prepare a Stormwater Management Concept Plan (SMCP) in support of a Development Application for the proposed development of Lake Cathie Public School to satisfy the requirements stipulated by Port Macquarie-Hastings Council (Council). The site is located within the new sub-division Area 14 residential development, also known as Rainbow Beach, Bonny Hills, which is still in the planning phase. Specifically, the Project and Concept Plan approvals for the precinct include the provision of ‘end of line’ type stormwater storage and treatment facilities within the central vegetated corridor and Lake, which have been designed to cater for all anticipated development within the precinct including the school site as part of a wider water cycle management plan.

The proposed stormwater management concept plan initiatives summarised in this report show that Council requirements can be satisfied to cater for the proposed new works on the school site located within Area 14 residential development.

This stormwater management concept plan has generally been designed in accordance with the relevant Council, industry standards and guidelines to address the stormwater quantity and quality issues on the proposed works. All proposed options outlined in this report satisfies the basic concepts for stormwater management including management of stormwater quantity and quality.

The key objectives of this Stormwater Management Concept Plan consists of the following:

- New stormwater pit and pipe drainage system to convey the stormwater flows through the proposed works site. The pipes used have a minimum size of 300mm diameter and 0.5% slope;
- An above ground OSD system consisting of 100m³ storage is located in the car park;
- Grass swales form the overland flow paths to cater for stormwater flows for large storm events through the new works site;
- Water quality management, comprising of a treatment train made up of:
  - Vegetated swales to encourage stormwater infiltration and biological uptake; and
  - Enviropod pit inserts for the removal of gross pollutants e.g. rubbish, coarse sediment, trash and debris.;
- Regular operation and maintenance program;
- Environmental Management Plan during the construction and post development phases for the school upgrade project.

The use of grass swales, enviropods and on-site detention systems provide a mixture of stormwater quantity and quality measures incorporating Water Sensitive Urban Design (WSUD) principles to manage and treat the stormwater runoff from the proposed new works located at the school site.

The stormwater management concept provided in this report has been based on desktop investigations with certain assumptions. Detailed site investigations, including field surveys, geotechnical work and detailed design work will need to be carried out to confirm the assumptions presented in this report.

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FIGURES

Figure 1 – Locality Plan
Figure 2 – Existing Site Survey
Figure 3 – Proposed Works on the School Site Plan
Figure 4 – Stormwater Management Concept Plan
Figure 5 – Typical Stormwater Management Details
Figure 6 – Cumulative Storage Curve
Figure 7 – Concept Rainbow Beach Residential Development Master Plan
Figure 1 – Locality Plan of Lake Cathie PS

Ocean Drive
Lake Cathie Public School
Bonny View Drive
Bonny Hill
To Sydney
To Lake Cathie
Figure 4 Stormwater Management Concept Plan

Figure 5 Typical Stormwater Management Concept Details
Figure 6 Cumulative Storage Curve

DC13105 – Lake Cathie Public School – Stormwater Management Concept Plan