THE HILLS SHIRE COUNCIL

DESIGN GUIDELINES SUBDIVISION/DEVELOPMENTS

FORWORD

This design manual has been prepared to provide engineering guidelines for the subdivision and development of land and to facilitate the efficient processing of engineering plan submissions for subdivisions and developments. Applicants should be aware that each development is required to be treated on its merits and that approval is dependant on the overall impact of the development and not solely on compliance with minimal engineering standards.

The manual aims to set standards in order that infrastructure associated with any development is designed to be serviceable, maintainable and meet community expectations.

Nothing in this manual is to be construed as limiting, in any way, Council's rights to impose differing conditions when approving development proposals, nor limiting the discretion of Council's Manager – Subdivision and Development Certification or their nominated representative to vary any necessary engineering requirements in respect of a particular development, having regard to good engineering practice.

Section 1 of this manual outlines Council's general engineering procedures in regard to the subdivision and development of land. The remaining sections contain detailed engineering requirements in regard to engineering drawings, road and drainage designs, and miscellaneous details.

GLOSSARY

Council	The Hills Shire Council as represented by its employees
Manager	Manager – Subdivision and Development Certification
Consent	Notice of Determination giving Subdivision, Development or Building Approvals
Council's Engineer	Person carrying out inspections or checking engineering details for Council
Applicant	Any person/s, company or entity representing the Developer for the purpose of carrying out works in association with a Subdivision, Development or Building
Surveyor	Registered Surveyor
Site	Area of land being developed by Subdivision, Development or Building Approvals
RTA	Roads and Traffic Authority, NSW
E.P.A.	Environmental Protection Authority
N.A.T.A.	National Association of Accredited Testing Authorities
W.A.E.	Works as Executed Plan
ARI	Average Recurrence Interval
AR&R (1998)	Australian Rainfall and Run-off (1998)
UPVC	Unplasticied polyvinal chloride compounds (referring to pipe)
VCP	Vitrified Clay Pipe
RHS	Rectangular Hollow Section
FRC	Fibre Reinforced Cement
RCP	Reinforced Concrete Pipe
PSD	Permissible Site Discharge
SSR	Site Storage Requirement
1:6 (V:H)	Slope of 1 vertical to 6 horizontal
AS	Australian Standards published by the Standards Association of Australia and being current at time of application
EP&A Act	Environmental Planning and Assessment Act 1979, as amended
OH&S	Occupational Health & Safety
DWE	Department of Water and Energy
OSD	On-site Stormwater Detention
WSUD	Water Sensitive Urban Design

DESIGN GUIDELINES FOR SUBDIVISIONS/DEVELOPMENTS

INDEX

GENERAL PROCEDURES

1.1 Scope

This section of the Engineering Guidelines sets out Council's general procedures and practices in respect of engineering requirements for subdivision and development of land within the shire.

1.2 Aim

To provide the Applicant with an outline of Council's engineering procedures for subdivisions and developments.

1.3 Process for the Applicant

When development consent has been granted the Applicant should:

- **Read the consent** – where you are unsure of the meaning or extent of any condition contact Council and seek clarification (Development Application No. will assist in your enquiries).
  Note: Construction Certificates cannot be issued until all Pre-Construction Certificate requirements / conditions of the Development Consent have been satisfied.

- **Engage an Engineering Consultant/Project Manager** – satisfy yourself that the client has the required expertise.

- **Give the Consultant a copy of the whole consent**, together with any approved plans or other documents.

- **Let the Consultant work for you** – Council's Engineer will have only one contact with whom correspondence relating to the technical aspect of the development will be exchanged.

- **Engineering plans are prepared by the Consultant** – the consultant is to arrange survey and engineering designs that will fulfil the conditions of the consent. These plans, when approved, will be used by the contractor to construct works.

- **Lodge the Engineering Plans and Assessment Fee**, together with any other fees / documents / information required to satisfy the conditions of the consent. Council's Engineer will check the engineering plans to ensure compliance with conditions of consent and other Council requirements.

- **Engineering plans returned to the Consultant for amendment (if required)** – the Consultant will be advised if any amendments are required to the Engineering Plans, and if any other outstanding items are required prior to the release of approved Engineering Plans.

- **Engineering plans re-lodged with Council** – the Consultant should have carried out all the amendments required by Council. If the Consultant needs clarification of any requirements, Council's Engineers are available for discussion. The Consultant must ensure that Council's "Red Mark Up" Plan (showing required corrections) is

returned to Council with the amended plans. This will expedite their assessment.

- **Approval of the Engineering Plans** – when Council is satisfied that the engineering plans will enable work to be constructed, the plans are approved and released in accordance with the consent conditions.

- **Construction** – The Consultant will engage a contractor to carry out the works in accordance with the approved plans, conditions consent and Council's Works Specification – Subdivisions/Developments.

- **Inspecting the works** – Council's Engineer will inspect the work to ensure the Contractor carries the work out in accordance with the approved plans and with Council's "Works Specification – Subdivisions/Developments".

- **Lodge the Works-As-Executed**, together with any compliance certificates, prior to requesting the final inspection.

- **Preliminary Final Inspection** – Council's Engineer is to be requested to inspect the works when the Applicant believes that all works are complete. The Applicant will be advised of any defects required to be rectified. Council's Engineer is to be advised when all the defects have been rectified to carry out the final inspection.

- **Check the Conditions of Consent** – Before requesting the issue of a Subdivision Certificate (in the case of subdivisions) or in the other cases prior to the issue of an Occupation Certificate for the development, the development consent must be checked in detail. The Consultant/Applicant must ensure all conditions have been satisfied including, but not limited to:

    - Compliance with all engineering conditions required by the Development Consent,
    - Payment of fees and contributions,
    - Lodgement of certificates required by the Works Specification,
    - Lodgement of a Works-As-Executed Plan, and
    - Lodgement of Hydraulic & Structural certificates.

- **Issue of Subdivision Certificate/Occupation Certificate** – When all conditions have been complied with, including payment of all fees and contributions, Council's Engineer will recommend the release of the final plan of subdivision and have the documents prepared for Council's signature. The documents will then be sent for signature and the Applicant will be contacted when they are ready to be picked up.

- **Liability Period** – The liability period shall be in accordance with Chapter 13 of Council's Works Specification – Subdivisions / Developments for all civil works becoming (or existing as) a Council asset.

1.4 Engineering Survey

The engineering survey shall be carried out using the ISG co-ordinate reference system and all levels shall be on Australian Height Datum (A.H.D.). The Manager's approval shall be obtained if another datum is to be adopted.

The survey shall accurately show the landform to facilitate the best possible design and construction of roadworks and drainage consistent with minimum interference to the existing amenity of the area.

Bench Marks shall be established at intervals not greater than 600 metres and are to be placed where they will not be disturbed. This requirement may be waived by the Manager where State Survey Marks exist.

1.5 Engineering Construction Certificate

Engineering plans are to be submitted to Council for approval together with an application form and the appropriate fee. Initially one (1) set of plans is to be submitted for checking by Council's Engineer, followed by a further three (3) sets on completion of any amendments required by Council. Two (2) sets of approved plans will be returned to the applicant with a letter of approval.

The preparation of engineering drawings for developments and subdivision shall be carried out in accordance with Section 2 – Engineering Drawings.

The civil engineering drawings will be checked by Council's Engineers for compliance with these guidelines. It is the responsibility of the Consultant to ensure that the designs, calculations and specifications comply with Consent Conditions, Engineering Guidelines, relevant Australian Standards and other Council documents. Approval of the drawings does not relieve the Applicant from rectifying any errors or omissions which become evident during construction or the liability period.

The Applicant is required to comply with the Council's current standards and if works have not substantially commenced within two (2) years of the date of the endorsed approval, the Manager may require that revised engineering drawings, calculations and specifications be submitted for a renewed approval.

1.6 Persons Qualified

Council requires that design plans be prepared to Council's standards by a person, either holding qualifications acceptable for Corporate Membership of the Institution of Engineers, Australia, or approved by the Manager and/or who has proven experience in the preparation of plans and specifications for land development.

1.7 Consultation

Designers are encouraged to consult with Council and other relevant authorities during the preparation of design plans.

1.8 Inspection of Works

The whole of the road and drainage works and any other works that will become Council's Asset, which the Developer is required to carry out in respect of a development, are to be inspected by Council's Engineers in accordance with Council's Work Specification – Subdivisions / Developments.

Internal civil engineering works for a development (apart from subdivisions) are the responsibility of the Developer who is to ensure compliance with Council's requirements.

A separate application shall be submitted to Council in respect of gutter and footpath crossings and inspections will be arranged with Council's Engineer.

1.9 Tree Preservation

Applicants are advised that NO trees shall be removed without Council's permission. The Applicant shall provide a tree survey plan detailing the trees to be retained and clearly defining any trees proposed for removal.

The following Tree Management provision applies to the Shire:

The Hills Shire Council Tree and Bushland Management provision is covered by Cause 27 of The Hills Shire Council Local Environmental Plan 2005.

Council may require Applicants to lodge a Tree Bond to ensure trees are not damaged or removed during the construction of works.

All trees to be retained are to be protected by paraweb fencing, firmly staked four (4) metres from the trunk of the tree. This fencing is to be erected prior to the commencement of any site works and is to be maintained in position for the duration of the works. The area within the dripline of the tree should not be used for the stockpiling of new or demolition material nor for vehicular or pedestrian convenience or uses that would compact the soil in the area.

1.10 Street Trees

Street Trees and tree guards are to be provided to all developments, where new road construction is required, in accordance with Council's Development Control Plan for Landscaping and Council's Tree Management Guidelines.

1.11 Erosion and Sedimentation Control

All developments, where the site is disturbed, shall provide Erosion and Sedimentation Control in accordance with the requirements of the

Department of Water and Energy, the Environment Protection Authority and Council.

Soil and Water Management plans shall be prepared in accordance with the Department of Environment and Conservation Guidelines, Landcom's "Managing Urban Stormwater – Soil and Conservation – Volume 1" 4th Edition (2004) and form part of the engineering drawings.

1.12 Road Safety Audit and OH&S Requirements

Consultants preparing Engineering Plans must carry out a road safety audit of the site, drawings and associated documents to ensure that all the requirements as set out in Austroad's "Road Safety Audit" Manual, Second Edition 2002, have been satisfied.

1.13 Engineering Fees

Tables 1.1 and 1.2 show typical engineering fees applicable to developments:

Engineering Fees for Subdivisions	
Engineering Construction Certificate fee and Long Service Levy payment (where applicable)	Paid prior to release of approved plans
Inspection fee for Road & Drainage Works	Paid prior to release of the final plan of subdivision
Bond assessment fee	Paid prior to assessment for release of the final plan of subdivision
Final release of plan of subdivision fee	Paid prior to assessment for release of the final plan of subdivision.

Table 1.1 - Engineering Fees for Subdivisions

Engineering Fees for Developments	
Engineering plan assessment fee	Paid prior to release of approved engineering plans
Inspection Fee for Road & Drainage	Paid prior to final approval
Bond assessment fee	Paid prior to final approval

Table 1.2 – Engineering Fees for Developments

All fees are reviewed regularly and the amount payable will be at the rate applicable at the date of assessment of engineering drawings, or the release of the final plan of subdivision, which shall be in accordance with Council's Schedule of Fees and Charges.

1.14 Works-As-Executed (W.A.E) Plans

Following the completion of engineering works of a subdivision or development, "Work-As-Executed" plans are required to be prepared by a Registered Surveyor or "Persons Qualified" (See Section 1.6) and forwarded to Council prior to the final inspection. A copy of the approved

detailed design must underlay the works as executed plan so clearly show any differences between the design and constructed works. The notation/ terminology used must be clear and consistent too. For bonded/ outstanding work the works as executed plan must reflect the actual work completed. Depending on the nature and scope of the bonded/ outstanding work a further works as executed plan may be required later, when that work is completed.

The WAE plans must show the matters as detailed in Section 2.21 – Engineering Drawings, of this guide.

1.15 Certificates

Prior to issue of a Subdivision Certificate, Occupation Certificate or upon completion of works, the following Certificates and Plans must be lodged:

Compaction Certificates

The final submission requires lodgement of the road pavement compaction certificates for all stages of the road pavement construction, lot filling and lot classification which have been prepared by a N.A.T.A. laboratory.

Compaction certificates and a lot fill diagram must also be provided where lots have been filled. The diagram will apply to all lots that have been filled in excess of 250mm. Two (2) copies shall be provided.

Easement Certificates

The final submission requires lodgement of the Surveyor's Certificate. This is to certify that all pipes and drainage structures are located within the proposed drainage easements.

Material Compliance Certificates

Material Compliance Certificates for all road pavement materials will be required to be submitted prior to issue of the Subdivision Certificate or upon completion of the works.

Engineers Certificate

Where structural work has been undertaken on a project a certificate from a Registered Engineer must be lodged certifying the adequacy of the structure for the imposed loads.

For OSD systems, a Hydraulic Certificate from "Persons Qualified" (See Section 1.6) shall be lodged with Council certifying that the system will function hydraulically as per design requirements.

Miscellaneous Certificates

The following certificates are required prior to the release of the final plan of subdivision or occupation certificate:

1. Kerb and gutter concrete core test results,

2. CCTV recording and report of the road drainage system,

3. Certification that the road pavement has been constructed in accordance with the approved design, and

4. Geotechnical reports as requires by the Subdivision / Development Consent.

1.16 Contributions

Section 94 Contributions are required in accordance with Section 94 of the Environmental Planning and Assessment Act, 1979, to provide for the increased demand for public amenities and services resulting from developments. Where a Section 94 Contribution is required to be paid, the amount payable will be at the rate applicable at the time of payment prior to release of the final plan of subdivision in accordance with advice issued with the consent.

For developments, Section 94 Contributions are payable prior to issue of the Construction Certificate at the rate applicable of the time of payment.

In lieu of the provision of Street Trees, council may accept a contribution based on one (1) tree per seven (7) metres of road frontage to be paid prior to assessment of the final plan of subdivision or prior to the final approval in the case of developments. The amount payable will be at the rate applicable at the time of payment in accordance with council's Schedule of Fees and Charges.

1.17 Bonds

All developments requiring infrastructure works shall provide a Maintenance Bond to Council, in the form of a cash bond or an unconditional bank guarantee, in the amount of 5.0% of the whole of the infrastructure works, with a minimum period of twelve (12) months from the date of release of the final plan of subdivision or the date of final clearance of the works for other developments. Any failure of the works within this period will lead to the call-up of all or part of the security to enable remedial works to be undertaken by Council.

For developments, other than subdivisions, Council also requires the submission of a cash bond or unconditional bank guarantee for outstanding works. The amount of such bond will be assessed upon submission of satisfactory engineering plans.

Council may also give favourable consideration to accept a suitable cash bond or unconditional bank guarantee from the Applicant where it is impractical to complete certain aspects of the infrastructure work or where it is necessary to defer construction until building activities have been substantially completed.

Upon written request from the Applicant and satisfactory completion of the maintenance period, or the works (whichever the case), the bond, or any amount remaining, will be released by Council.

ENGINEERING DRAWINGS

2.1 Scope

This section of the Design Guidelines sets out Council's general requirements for the preparation of Engineering Drawings.

2.2 Aim

To provide comprehensive details to facilitate the assessment of plans and construction of works in a safe, efficient and effective manner.

Also to ensure that Engineering Drawings provide sufficient information in a consistent format to allow Council to maintain a permanent record of subdivision and development works.

2.3 General Requirements

All engineering drawings are to ensure that all relevant conditions of consent have been addressed by the details shown. Drawings are to be submitted on standard size drawing sheets.

Four (4) sets of the engineering drawings are to be submitted, two (2) sets, endorsed with Council's approval, will be returned to the Applicant.

2.4 Title Blocks

All Engineering Drawings submitted to Council for approval are to have a title block showing the following:

- Applicants Name
- Consultants Name, Address, Phone Number and Contact Name
- Drawing Number, Sheet Number and Amendment Number
- Schedule showing Date and Nature of Amendments
- Site Address, including Lot and Deposited Plan (DP) Number
- Council's Application Number
- Stage Number
- Drawing Title
- Scale with Scale Bar
- Signature of Authorized Person (see Section 1.6)

2.5 Road and Drainage Drawings

Plans for Road and Drainage works shall be presented to Council generally in the following format:

- Title Sheet
- Detailed Plan(s)
- Road Longitudinal Section(s)
- Road Cross Sections
- Typical Road Cross Section(s)
- Kerb Return Details
- Traffic Calming Devices, Pathways, Cycleways and Other Miscellaneous Road Details

- Drainage Catchment Plan
- Drainage Calculations
- Drainage Longitudinal Section(s)
- Other Drainage Details
- Erosion and Sediment Control Measures
- Traffic Control Measures

2.6 On-site Storage Detention Drawings

Engineering drawings showing on-site stormwater detention details for developments shall generally include the following:

- Catchment Plan showing contours, area of site effected and area of site not collected.
- Drainage design summary in format of that shown in the Upper Parramatta River Catchment Trust's On-site Stormwater Detention Handbook.
- Calculations to confirm volumes and pipe sizes.
- Detail Plan and sections (see Section 2.17)
- Design Levels for top water/overflow; inverts of all drainage pits, pipelines and storage areas; overflow weir; centreline of orifice; surface of all drainage pits; and surfaces designed to detail and direct stormwater.
- Dimensions of storage areas, drainage pits, overflow weirs, maximum head, high early discharge head and depth of storage.

2.7 Title Sheet

The location of the Development shall be identified by lot, DP, street name and suburb and by clearly marking the site on a Locality Plan.

A layout plan shall be provided showing the layout of roads, road numbers, allotment layout (with lot numbers as per the approved plan of subdivision) and Bench Marks (to A.H.D.). The origin, nature and value of the datum used to establish the bench marks to be indicated, e.g. Permanent Mark or State Survey Mark and number. Where the plan shows layouts for the past or future stages, a bold and clearly defined stage border is to be shown. For small developments, where all of these details can be shown on the detail plan, the layout plan may be omitted.

The title sheet should also include construction notes and an index of the sheets provided in the set of drawings.

2.8 Detail Plan

Detail plans should include the following:

- North point.
- Lot details, including numbers, easements and any road widening.
- Existing contours extending beyond the boundary of the site for a distance sufficient to show any constraints.
- Existing natural features including trees, water courses, ditches, dams, mounds, etc. – these details are not to be limited to the site and are to include any feature which has an impact on the development.

- Existing constructed features including fences, kerb and gutter, pipes, pits, headwalls, road pavements, buildings, road furniture, etc. – these details are not to be limited to the site and are to include any feature which has an impact on the development.
- Existing services including sewer, water, telephone, gas, electricity, etc., together with all associated pits, poles and other structures.
- Road centrelines showing chainages, bearings, and intersection points.
- Pavement and footpath widths.
- Curve information including tangent point chainages, radii, arc and chord lengths, superelevation (if applicable).
- Edge of pavement where no kerb is constructed.
- Kerb return numbers.
- Location of proposed gutter crossings, footpaving, cycleways, pedestrian ramps and any required access driveways.
- Drainage pits including chainage, length and pit number.
- Pipeline locations including pipe size, type and class.
- Cut and fill areas clearly identifying depths.
- Extent of proposed works.
- Subsoil Drains.

2.9 Road Long Sections

Road long sections should include the following:

- Road Number.
- Centreline chainage.
- Existing centreline surface level.
- Design centreline level (seal level).
- Design grades.
- Length of vertical curves.
- Chainage and levels at grade intersection points and vertical curve tangent points.
- Extended levels and grading to depict future works and / or match to existing roads (min 60m).

2.10 Road Cross Sections

A cross section for each centreline chainage (typically 15 metre intervals), with additional cross sections as required, should include the following:

- Road number.
- Centreline Chainage.
- Existing surface levels, extending beyond any proposed batters.
- Design surface levels.
- Offset distances to centreline.
- Crossfalls, batter slopes and dimensions, where these differ to that shown on the typical section.

2.11 Typical Road Cross Sections

A typical cross section shall be provided for each road as additional detail on at least one cross section on each sheet of road cross sections OR alternatively, may be provided separately as a set of typical cross sections. Where typical cross sections are provided separately to the road cross sections, general details shall comply with section 2.10. The additional detail for a typical road cross section should include the following:

- Road reserve width (existing and proposed).
- Road width between face of kerbs, or where no kerb is constructed, pavement and shoulder widths.
- Location and width of any proposed concrete footpaving or cycle paths.
- Kerb and gutter type.
- Grades/slopes of pavements, footpaths and batters, with offsets to changes of grade.
- Type and thickness of surfacing.
- Thickness of pavement, using Council's minimum pavement thickness and a note advertising that pavement thicknesses are to be designed in accordance with Council's Works Specification – Subdivision/Developments by a N.A.T.A. registered geotechnical consultant.

2.12 Kerb Return Details

Plans showing kerb returns at intersections, junctions and turning heads should include the following:

- Design kerb levels at tangent points, quarter points, high and low points, and wherever necessary to ensure accurate construction.
- Contours for pavement design.
- Kerb radius.
- Vertical curve design.
- Kerb return numbers.
- Kerb chainage and where appropriate centreline chainage.
- High and Low points.

Cul-de-sac head details shall be provided generally in accordance with the abovementioned requirements.

2.13 Traffic Calming Devices, Pathways, Cycleways and Other Miscellaneous Details

Plans showing traffic calming devices should show design levels, design contours, signposting and line marking. Pathways, cycleways and other miscellaneous road details should be shown clearly on typical sections.

2.14 Drainage Catchment Plan

A plan showing all internal and external catchments effecting the development and their breakdown into sub-catchments should include the following:

- Road Numbers.
- Existing and proposed property and road boundaries.
- All catchments / sub-catchments labelled according to the drainage calculation sheet.
- Catchment / sub-catchment boundaries indicated by a bold line.
- Proposed / existing contours at a suitable interval.
- Direction of waterflow along the flow paths of the longest times of concentration.
- Any features that may effect catchment boundaries.
- Drainage lines and pit numbers.
- Areas of all catchment / sub-catchments.

2.15 Drainage Calculations

A comprehensive drainage calculation table is to be provided complete with all hydrological and hydraulic data in the format shown in Section 4 – Drainage Design or other format approved by the Manager.

2.16 Drainage Longitudinal Sections

A longitudinal section of each drainage pipeline is to be shown including the following information on each:

- Chainages.
- Existing and finished surface levels.
- Design invert levels.
- Drainage pits (including numbering).
- Drainage line numbers.
- Grade, diameter, class and material of each pipe section.
- Hydraulic grade lines and levels.
- Pipe flows and capacities.

2.17 Other Drainage Details

Details of the following are to be provided on a drainage detail plan where not shown on the roadworks detailed plan:

- Details of the pipe junctions.
- Full details, including reinforcing, of non standard structures.
- Invert levels, surface levels and locations of all drainage structures.
- Pipe details.
- Length of lintels.
- Pit Schedule.

Where open drains are designed additional details shall be provided including the following:

- Cross sections (usually 15 metre intervals)
- Details of drop structures, energy dissipators, gross pollutant traps, etc. (plan and sectional view).
- All natural creeks are to be retained and any works must comply with the requirements of DWE.

Where detention basins are required, full construction details shall be provided including the following:

- Plan view.
- Sectional views.
- Details of basin wall construction.
- Details of outlet structures.
- Extent of storage.
- Maximum storage level.
- Extent and nature of any landscaping.

2.18 Erosion and Sedimentation Control Measures

A plan shall be provided showing relevant site characteristics and design criteria of erosion and sediment controls and should include the following:

- Existing and design contours.
- Existing site drainage and vegetation.
- Limit of clearing, grading and filling.
- Grades / slopes of site.
- Critical natural areas (natural watercourses, swamps, cliffs, etc.)
- Location of topsoil stockpiles, roads and all impervious surfaces.
- Distance to nearest natural watercourse or drainage line.
- Catchment area boundaries.
- Sediment basin calculations.
- Erosion and sediment controls, including diversions.
- Construction / revegetation notes.
- Outline of program for maintenance of erosion and sediment controls.
- Temporary construction exits.

2.19 Traffic Control Measures

A plan shall be provided showing traffic control measures for each stage of a proposed development and should include the following:

- Diversion of Pedestrians
- Delineation of temporary traffic paths.
- Position of warning devices.
- After hours traffic arrangements.
- Instructions for the installation, operation, between stage rearrangements, and removal of traffic control devices.

Temporary road closures requiring detour onto an alternate route must make a separate formal application to Council's Traffic and Transport

Team for approval by the General Manager. Further information regarding this process is available from Council's website.

2.20 Traffic Regulation (Permanent)

A plan shall be prepared and submitted to Council for approval showing all permanent traffic regulatory and warning devices including but not limited to linemarking (edge lines, centre lines and holding lines), painted line arrows, school zone signs and pavement markings, curve warning signs, keep left signs, parking restrictions, speed limit signs, bus zones and any other warning signs as required by the development consent or relevant Australian Standard.

2.21 Work-As-Executed Plans

Following the completion of engineering works in a subdivision or development, Work-As-Executed plans are required to be prepared by a Registered Surveyor or "Persons Qualified" (see Section 1.6) and forwarded to Council prior to the final inspection. The plans should include the following:

- Certification that all works have been completed generally in accordance with the approved plans.
- Any departures from the approved plans.
- Any additional work that has been undertaken.
- Stripped and Finished levels (see Section 2.21)
- Length of lintels and pit types shown on plan and long sections.
- Location of water and electricity conduits.
- Location of flushing points and subsoil drains.
- Location of start and end of construction.
- Top of kerb levels shown in cross sections and kerb return details.
- Footpath levels at boundary shown on cross sections.
- Road centreline levels shown on long and cross sections.
- Invert of pipes at pits.
- Location of gutter crossings.
- Width of road and footpath at 100 metre intervals.
- Location and details of Permanent Marks (PM's) and State Survey Marks (SSM's).
- Flood levels

2.22 Lot Filling

Council requires all areas of the site, subject to filling, to be identified on the engineering plans, submitted for approval and should include the following:

- Road numbers and road names.
- Road reserve boundaries.
- Allotment layout, including easements and lots numbered in accordance with the final plan of subdivision.
- Extent of fill.
- Fill area hatched, and hatching shown in a legend as filled area.
- Stripped and finished levels.
- Contours.
- Certification of the plan by Registered Surveyor.

All imported fill material to be used must be tested and certified to be Excavated Natural Material (ENM).

Compaction shall be in accordance with Section 4.9 of Council's Works Specifications Subdivision / Developments – Placement and Compaction of Fill.

Each Residential Lot, whether filled or not, shall be classified in terms of the listed classes contained with Table 2.1 of the Australian Standard for Residential Slabs and Footings (AS 2870). The lot classification shall be prepared by a N.A.T.A. registered geotechnical consultant.

Any lot identified as a Class outside of the classes listed within Table 2.1 of AS2870, will not be accepted by Council without prior approval and will be required to address any matters as required/requested by Council.

No allotment filling is to be placed against existing allotment boundaries. Where approval is obtained to extend fill into adjoining properties (written consent required), satisfactory arrangements must be made for the grading of the fill onto the land without ponding.

Revegetation must be applied immediately on completion of the site filling – regrading works.

The minimum lot grading shall be 1% and 100mm of topsoil must be placed over all filled land and graded to ensure no ponding of water.

2.23 Sheet Sizes

Sheet sizes should not be mixed within the same set of plans and shall be limited to the following:

- A1 - 841 x 594 - Road and Drainage Works
- A2 - 594 x 420 - Minor Engineering Details
- A3 - 420 x 297 - Minor Engineering Details
- A4 - 297 x 210 - Minor Engineering Details

2.24 Scales

Scales used for all plans should be those recommended by the Standards Association and Austroads as follows:

- 1:1, 1:2 and 1:5 and multiples of 10 of these scales.
- 1:25 and 1:125 and multiples of 10 are not preferred but may be accepted.

The following scales are suggested for particular uses but may be varied as appropriate to the works concerned:

- Engineering Detail Plan - 1:1000 or 1:500
- Longitudinal Section - 1:1000 or 1:500 (Horizontal)
  1:100 or 1:50 (vertical)
- Cross Section - 1:100
- Intersection Details - 1:1250, 1:200 or 1:100

- Layout Plan - 1:500, 1:1000,1:2000 or 1:4000
- Catchment Plan - 1:500, 1:1000,1:2000 or 1:4000
- Locality Plan - 1:500, 1:1000,1:2000 or 1:4000

2.25 Dimensions

Linear dimensions on all engineering plans shall be in metres, with the exception of detail plans which may be in millimeters. Methods of dimensioning will be in accordance with the current Australian Standard.

Chainages shall be expressed to the nearest 0.01m, levels shall be reduced to Australian Height Datum (AHD) and expressed to the nearest 0.005m (except Bench Marks, PM's and SSM's which will be expressed to the nearest 0.001m).

ROAD DESIGN

3.1 Scope

This section of the manual sets out Council's requirements for the design of urban and rural roads. It is in no way a comprehensive manual and it is intended to be read in conjunction with and as supplement to:

- AUSTROADS – Guide to Traffic Engineering Practice, Parts 1-15;
- AUSTROADS – Rural Road Design, Guide to the Geometric Design of Rural Roads;
- AUSTROADS – Pavement Design, Guide to the Structural Design of Road Pavements;
- ARRB, Transport Research Sealed Local Roads Manual – Guidelines to Good Practice for the Construction, Maintenance and Rehabilitation of Pavements;
- AMCORD – A National Resource Document for Residential Development;
- Department of Housing Road Manual;
- Roads and Traffic Authority Road design Guide; and
- Council's relevant Development Control Plans.
- Infrastructure, Planning and Natural Resources – Roads and Salinity

3.2 Aim

The design and construction of a road system that provides the following:

- a high level of safety for all users;
- acceptable levels of amenity and protection from the impact of traffic;
- a reasonable level of convenience for all users; and
- economy of construction and maintenance.

3.3 Planning Standards

The road layout and width must conform to that shown on any relevant Development Control Plan. The precise location of any proposed roads are subject to the detailed site assessment carried out during the subdivision application process. In areas not covered by a Development Control Plan the layout and width will be determined by Council on their merits.

3.4 Design Speed

Design speed is the speed applied to the design of a road's geometric elements to create and maintain a speed environment for 85% of drivers.

Generally the following design speeds should be adopted:

Cul-de-sac, Access Streets and Community Title Roads	30km/h
Local Streets	50km/h
Collector and Sub-Arterial Roads	60km/h

A speed limit of 60 km/h should be used for calculating design values which depend on speed. Vehicular speeds are limited by road intersections as well as changes in vertical and horizontal alignment. The adopted design speed may be reduced with Council approval.

3.5 Sight Distance

Refer to the RTA Design Guide Section 2.1.

The *Absolute Minimum* sight distance is that required for a driver to observe an object on the road surface ahead, and to stop the vehicle before reaching the object. This sight distance shall be available at every point on every road and at intersections to provide sufficient distance for an approaching vehicle to stop before an obstruction in the roadway at the intersection, using the approved design speed. Table 3.1 gives the appropriate value of sight distance for various speeds.

Target Speed (km/h)	**Sight Distance (m)**
15	5
30	20
40	30
50	40
60	55

Table 3.1 – Absolute Minimum Sight Distances (AMCORD)

The *Desirable Minimum* sight distance for two-way roads is that required for the drivers of two opposing vehicles to see each other in time to stop before collision. Table 3.2 gives the appropriate value of sight distance for various vehicle speeds. This distance shall be provided at the intersections to provide sufficient distance for a vehicle stopped in the side road, at the alignment of the through road, to start and turn safely onto the through road, and wherever else possible.

Target Speed (km/h)	**Sight Distance (m)**
15	10
30	40
40	60
50	80
60	110

Table 3.2 – Desirable Minimum Sight Distances

Where sight distance available on a two way rural road is less than the Desirable Minimum, pavement markings restricting overtaking shall be provided, together with appropriate widening of the shoulder if considered necessary by Council's Engineer.

3.6 Horizontal Alignment

Drivers react to restrictive horizontal alignment by slowing to an appropriate speed, hence the desired maximum Design Speed is maintained by deliberately designing a restrictive horizontal alignment.

The horizontal alignment of a road is to be generally in accordance with Council's relevant Development Control Plan.

The minimum horizontal deflection angle for which a curve is needed is 1.0 degree. Where possible the radii of the curve shall be maximized to reduced the necessity for centreline shift and widening of the carriageway. The minimum radii for various deflection angles shall be in accordance with Table 3.3.

Deflection Angle (Degrees)	Minimum Radius (m)
75°	20
60°	33
40°	65
30°	75
20°	100

Table 3.3 – Minimum Curve Radii

3.7 Transitions and Widening on Curves

All curves of less than 180 metres radius shall be widened and provided with plan transition at the junctions with the tangents. This applies particularly to curves which tend to reduce the speed of traffic flow and those with crests within their length.

3.8 Longitudinal Gradient

Longitudinal grades shall generally be in accordance with Table 3.4.

Road Type	Desirable Minimum (%)	Absolute Minimum (%)	Desirable Maximum (%)	*Absolute Maximum (%)
Sub-arterial	1.0	0.7	6.0	8.0
Collector/Industrial	1.0	0.7	6.0	10.0
Access/Local	1.0	0.7	12.0	16.0
Rural	1.0	0.7	12.0	16.0

** Absolute maximum of 6% where water sensitive urban design swales are proposed.*
Table 3.4 – Minimal / Maximum Longitudinal Grades

At intersections, the longitudinal grade of the side road, within 6.0 metres of the through road, should not exceed 5.0%. The longitudinal grade at the head of cul-de-sacs should also not exceed 5.0%.

Where the topography makes it difficult to provide a road location to conform to the required grades, the lengths over which these grades apply will then become a consideration, and any variations will be at the discretion of the Manager.

3.9 Vertical Curves

Vertical Curves of the form of simple parabolas shall be provided at all changes of grade exceeding the following:

- Access, Local and Collector 1.0%
- Rural and Sub-arterial 0.6%

Where the change of grade is less than that shown above, the centerline grading shall be "eased" over a symmetrically located distance of 10 metres. This distance may be reduced to 5 metres for cul-de-sacs, access streets and community title roads.

Every effort should be made to provide vertical curves as long as possible for improved appearance, however, surface drainage should be maintained in proximity to sag points. The design of vertical curves shall be in accordance with the RTA Design Guide and the following:

- A minimum design speed of 60 km/h shall be adopted even if the horizontal alignment is not satisfactory for that speed.
- The *minimum* length of a *crest vertical curve* is governed by sight distance requirements.
- The *desirable minimum* length of a *sag vertical curve* is that providing minimum headlight sight distance and this length should be provided wherever possible.
- The *absolute minimum* length of a *sag vertical curve* is based on the consideration of riding comfortably and shall be such that the maximum vertical acceleration is 0.1G.
- In addition to the minimum length requirements mentioned above, from a consideration of appearance the minimum length of a vertical curve in urban areas shall not be less than that shown in Table 3.5.

Road Type	General Minimum Curve Length (m)	Minimum Curve Length at Road Junctions (m)
Access/Local Streets	25	6
Collector Streets	32	12
Sub-arterial/Rural	50	20

Table 3.5 – Minimal Vertical Curve Lengths

- The use of short sections of straight grade between vertical curves is undesirable for appearance and should be avoided.
- The tangent point of a vertical curve in the side road should be located at, or behind, the kerb line through the road.
- Vertical Curves on kerb returns must be treated in such a manner as to make construction practical.

3.10 Super-Elevation

Where super-elevation is considered necessary, the design shall be carried out in accordance with the R.T.A Road Design Guide adopting maximum values of 4.0% in urban areas and 7.0% in rural areas.

3.11 Carriageway Crossfall

The normal cross-fall of pavement and shoulders on a straight alignment shall be in accordance with Table 3.6.

Surface Type	Road Cross-fall (%)	Shoulder Cross-fall (%)
Concrete	2.0-3.0	2.0-3.0
Asphaltic Concrete	2.5-3.0	2.5-3.0
Sprayed Seal	3.0-4.0	3.0-4.0
Unsealed	-	4.0-5.0

Table 3.6 – Normal Cross-fall

There are many controls in urban areas which may force departures from the above values, should it be necessary to increase or decrease cross-falls the variances should be within 1.0% of the above values.

3.12 Pavement Design

A formal pavement design shall be prepared by a registered N.A.T.A. laboratory based on sampling and testing of the subgrade materials from the site. Details of the pavement design and results of sub-grade testing (including 4 day soaked CBR's) are to be submitted to Council for approval prior to commencement of pavement construction. The Design shall be based on Traffic Loading Criteria specified in the Consent for the proposed works, which is based on the Design Traffic Loadings shown in Table 3.7.

Road Type	Design Traffic Loading	AADT
Access/Local	5×10^5	500 - 2000
Collector	1×10^6	2000 – 4000
Sub-Arterial/Enhanced Collector	5×10^6	4000 - 10000
Commercial/Light Industrial	1×10^7	
Heavy Industrial	5×10^7	
Rural	5×10^5	
Cul-de-sacs/Private Community Title	2×10^5	0-500

Table 3.7 – Design Traffic Loadings

The minimum unbound granular pavement thickness for urban and rural roads shall be 300 mm, consisting of 150 mm thick sub-base and 150 mm thick base. A two coat hot bitumen seal (10mm & 14mm aggregate)

shall be provided with a 40mm minimum thick asphaltic concrete wearing course for urban roads.

The pavement for roundabouts shall consist of deeplift asphaltic concrete placed on 150 mm rolled concrete (5 MPa) to the requirements of the Manager.

Rural cul-de-sacs shall be provided with a 25 mm minimum thick asphaltic concrete wearing course at the head of cul-de-sac to the tangent points.

3.13 Kerb and Gutter

Concrete kerb and gutter shall be provided on both sides of urban roads and other roads at the discretion of the Manager. Concrete kerb and gutter shall be provided in accordance with Table 3.8 or the relevant Development Control Plan.

Road Type/Location	Kerb and Gutter Type
Local/Access	Roll Kerb and Gutter
Collector	Roll Kerb and Gutter
Sub-Arterial	150 mm Integral Kerb and Gutter
Commercial/Industrial	150 mm Integral Kerb and Gutter
Adjacent to Public Open Space	150 mm Integral Kerb and Gutter
Roundabout Kerb Returns	150 mm Integral Kerb and Gutter

Table 3.8 – Kerb and Gutter Types

For infill development, or where new kerb and gutter joins existing works, the kerb and gutter type shall match the existing unless otherwise specified.

Pedestrian ramps shall be provided at intersections to Council's Engineers requirements in accordance with Council's Works Specification – Subdivisions/Developments.

3.14 Footpath Crossfall

Footpath areas shall be sloped towards the road so that water does not drain into adjoining properties. A desirable grade of 3.0% shall be provided, with a maximum grade of 4.0% and a minimum grade of 2.0%. Where properties bound sub-arterial / arterial roads, additional mounding may be required within the footpath area for sound attenuation purposes.

3.15 Berms

Berms shall extend 0.5 metres in cut or fill beyond the property boundary at the same grade as the footpath.

3.16 Batters

Batters shall be designed at stable slopes at the edge of the berm in accordance with Table 3.9.

Batter Type	Desirable Maximum Slope (V:H)	Absolute Maximum Slope (V:H)
Earth	1:4	1:2
Rock	1:0.5	1:0.25

Table 3.9 – Maximum Batter Slopes

The abovementioned slopes for rock batters refer only to cut batters in solid rock with a few clay bands.
Where the abovementioned slopes cannot be reasonably attained, variances may be permitted subject to approval being obtained from the Manager.

The need for constructing retaining walls should be avoided wherever possible. Should a retaining wall be necessary the Developer must provide full engineering details of the proposed structure, including elevation, typical cross-section and structural certification.

3.17 Intersections

The design of intersections or junctions shall be in accordance with AUSTROADS – guide to Traffic Engineering Practice, PART 5, Intersections at Grade; R.T.A. Road Design Guide; and/or the requirements of the Manager.

Intersections should generally be located so that streets intersect at right angles and at not less than 70°. Adequate stopping and sight distances should be provided on each of the approach legs of an intersection and for any horizontal or vertical curves.

- Splay corners shall be provided at all intersections.
  4m x 4m – Access Streets to Collector Roads
  5m x 5m – Enhanced Collector to Heavy Industrial Roads and Rural Roads.

Turning movements shall be accommodated by using AUSTROADS Design Vehicles and Turning Templates as follows:

- For turning movements involving collector streets, the "design semi-trailer" with turning path radius 12.5 metres shall be used to enable turns to be made in a single forward movement.
- For turning movements involving access streets and collector streets, the "design single unit" truck with turning path radius 12.0 metres shall be used to enable turns to be made in a single forward movement.
- For turning movements on access streets, the "design car" with turning path radius 7.5 metres shall be used.

3.18 Kerb Returns

The general design of a kerb return shall be by dividing the kerb return into quarters between tangent points and using two vertical curves to achieve a smooth profile. The radii for kerb returns shall generally be in accordance with Table 3.10.

Road Type	Minimum Kerb Return Radii (m)	Minimum Cul-De-Sac Kerb Radii (m)
Residential	7.5	9.5
Industrial	12	13.5

Table 3.10 – Minimum Radii of Kerb Returns

Any variation to the above radii shall be approved by the Manager and should accommodate the intended vehicular movement using AUSTROADS Design Vehicles and Turning Templates.

On bus routes the geometry of kerb returns may be varied to allow for the turning circle of larger vehicles.

Generally the profile shall be designed by adopting the grades of the approach and exit kerbs to the return, by quartering the length of the return and by computing kerb levels adopting two vertical curves as required.

As far as practicable low points within the kerb return shall be avoided to eliminate the use of pits with curved lintels.

3.19 Cul-De-Sac Head Kerb Grading

The design kerb levels at the head of a cul-de-sac shall also be detailed in plan using a scale of 1:200.

The longitudinal profile of the kerb and gutter of the cul-de-sac head shall be based on the adoption, as far as practicable of the standard 3% carriageway crossfall at critical points in the arc length with easing of changes in grade by designed vertical curves as required.

The minimum acceptable crossfall is 1.5% while the maximum allowable crossfall is 8%.

It will be necessary to give special consideration to the design of kerb longitudinal profiles for a cul-de-sac draining to the head. Drainage of the low point in the head shall be provided via pipelines within pathways. It is essential that provision be made for overland flow for events which exceed pipeline capacity or to allow for blockages of the downstream line.

3.20 Roundabouts

The design of roundabouts shall be in accordance with AUSTROADS – Guide to Traffic Engineering Practice, PART 6, Roundabouts and shall be approved by the Council and / or the Roads and Traffic Authority.

3.21 Traffic Calming Devices

The design of traffic calming devices shall be in accordance with AUSTROADS – Guide to Traffic Engineering Practice, PART 10, Local Area Traffic Management and shall be approved by the Council.

DRAINAGE DESIGN

4.1 Scope

This section of the manual sets out Council's requirements for the design of stormwater drainage for urban and rural areas. It is in no way a comprehensive design manual and it is intended to be read in conjunction with and as a supplement to the 1998 edition of Australian Rainfall and Run-off (AR&R), Australian Runoff Quality (ARQ) 2006, Water Sensitive Urban Design (WSUD) Technical Guidelines for Western Sydney and On-Site Stormwater Detention Handbook (latest edition). Many of the principles have been adopted from the Queensland Urban Drainage Manual.

4.2 Aim

The design and construction of a drainage system that provides the following:

- a high level of safety for all users;
- acceptable levels of amenity and protection from the impact of flooding;
- economy of construction and maintenance.
- the protection of downstream environments.

4.3 General Requirements

All drainage, whether internal or external to the site, relevant or reasonably required in respect of the proposed development shall be provided to Council's requirements at the Applicant's cost.

A stormwater drainage system shall be provided in accordance with the "major/minor" system concept set out in Chapter 14 of the AR&R (1998); that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm run-off events while "minor" system shall be capable of carrying and controlling flows from frequent storm run-off events.

In general, drainage works will be constructed by the Applicant in accordance with the following:

<u>Drainage in Urban Areas</u>

Minor System

- Kerb and gutter shall be provided on both sides of all roads except where the relevant Development Control Plan advises otherwise.
- Kerb inlets shall be provided at locations such that the flow in the gutter does not exceed the specified limits.
- Inter-allotment drainage shall be provided at the lowest point of all allotments together with the creation of an easement over all downstream pipework to the legal point of discharge.
- Full piped drainage from all kerb inlets and other inlets shall be provided to the boundary of the subdivision, or approved point of discharge, unless otherwise approved by the Manager.

Major System

- An overland flow system shall be provided for run-off in excess of the capacity of the pipe system, such that the design flow is carried through the subdivision or development clear of, and with the required freeboard to allotments.
- Overland flow paths will not be permitted within urban allotments, unless otherwise approved by the Manager.

Drainage in Rural Areas

Minor System

- Pipe or concrete box culverts, bridges or concrete causeways shall be provided at road crossings over natural watercourses to the limits of the road formation. Where services are underground then these services shall be carried over the structure in a services corridor approved by the Manager. Cross drainage design shall take into account the possible blockage caused by debris load from the catchment.
- Table drains and surface inlet pits shall be provided on the cut side of roads, within the road reserve, together with stone pitching or concrete lining where required for scour protection.

Major System

- An overland flow system shall be provided for run-off in excess of the capacity of the pipe system, such that the design flow is carried through the subdivision or development clear of, and with the required freeboard, to building platforms.

4.4 Lawful Point of Discharge

Urban development generally modifies the naturally occurring drainage regime by increasing the volume and rate of run-off, sometimes diverting flow between natural catchments, modifying existing flow paths and concentrating flow along drainage paths and at outlets. These changes may affect the safety, amenity and enjoyments of persons and property and may result in legal disputes.

Legal problems arising from the planning and proposed construction of the drainage works need to be negotiated and resolved with adjoining owners, and any other landowners who could be detrimentally affected, before approval of the works can be granted by Council. In this regard, Council will require that a *lawful point of discharge* exists prior to approval of development.

In order to determine whether a lawful point of discharge exists at a particular location the following two points must be satisfied:

a) That the location of the discharge is under the lawful control of Council or other statutory authority from whose permission to discharge has been received. This will include drainage reserve, road reserve, or stormwater drainage easements; and

b) That in discharging in that location, the discharge will not cause an actionable nuisance (i.e. a nuisance for which the current or some future

neighboring proprietor may bring an action or claim for damages arising out of the nuisance).

Where the conditions of the first test have not been satisfied prior to development, it will be necessary to obtain a lawful point of discharge. This will usually be achieved by the creation of a drainage reserve, or where approved by the Manager, acquisition of a drainage easement over one or more downstream properties until the conditions of the second test have been met.

It should be noted that a natural watercourse may not necessarily constitute a lawful point of discharge, unless the requirements of the above two tests can be satisfied.

4.5 Flood Studies

Council may require the submission of a flood study in the following circumstances:

- To determine whether the proposed method of stormwater discharge would have a detrimental effect upon neighboring lands.
- To determine whether the existing or proposed stormwater discharge will have the potential to cause overland flood inundation problems on the property.

Where Council considers necessary, the Developer will be required to submit a flood study that calculates the 1:100 year Average Recurrence Interval flood level. The study shall be carried out by a qualified Civil Engineer or Surveyor with documented experience in hydraulic analysis. Design calculations submitted shall be accompanied by a catchment plan, showing contours, at the scale of 1:2000 or 1:4000, together with survey cross sections of the overland flow path.

The method of calculating flood/flow levels shall be to the requirements of the Manager. For minor flood studies Council prefers that the calculations be submitted on Council's form "A Simple Method for Estimation of Flow and Flood Levels in Easements" (See Appendix B)

4.6 Drainage Reserves/Easements

Where a natural open channel or similar overland flowpath exists in a proposed development, a drainage reserve shall be provided to contain the design flow within the actual drainage reserve area. The design and construction of the drainage reserve shall be in accordance with the relevant Development Control Plan and the minimum width shall be 5.0 metres.

Where stormwater drainage has been approved within allotments, a drainage easement shall be created or acquired. The width of easements benefiting Council shall be in accordance with Table 4.1 and the width of the inter-allotment drainage shall be in accordance with Table 4.2.

Drainage Width	Easement Width (m)
Stormwater system ≤ 1350	3.0
Stormwater system > 1350	Width of the system plus 2.0 metres

Table 4.1 – Minimum Easement Width for Council Drainage

Drainage Width	Easement Width (m)
Stormwater system ≤ 150	1.0
Stormwater system > 150	1.5

Table 4.2 – Minimum Easement Width for Inter-allotment Drainage

4.7 Hydrology

A number of methods are available for the determination of the flow rate, run-off, volume and catchment response. The following commonly used hydrological methods are acceptable to Council:

- *The Rational Method* – This method has been the most commonly used method for drainage design. It provides simple means for the assessment of design peak flow rate (peak discharge). The rational method is not recommended for the design of detention basins.
- *Time-Area Run-off Routing, eg. ILSAX* – ILSAX is a computer based model which involves the routing of the time-area relationship developed for the sub-catchments under consideration. It is suitable for use in urban catchments but requires calibration with available flow data. The Technical Note 7 in Chapter 14 of the AR&R (1998) provides an example of the use of ILSAX.
- *RAFTS* – This is a proprietary computer model based upon the Regional Stormwater Model (RSWM). It includes separate routing of impervious and pervious areas; sophisticated loss models; urban run-off modelling and detention basin design; and provision for river basin analysis.

Other hydrological models may be used as long as the requirements of AR&R (1998) are met. Council will require the submission of calculations in the format of that shown on Council's summary sheet for hydrological calculations (See Appendix C), together with details of all program inputs and outputs.

4.8 Design Average Recurrence Intervals (ARI)

For drainage design under the "major/minor" concept the ARI's shall be in accordance Table 4.3

Location	Minor System (Years)	Major System (Years)
General	10	100
Sag	20	100

Table 4.3 – Design Average Recurrence Intervals

An overland flow path will be provided for drainage systems even where the 100 year ARI flows can be maintained within the pipe system.

4.9 Time of Concentration

The time of concentration (t_c) of a catchment is defined as the time required for the stormwater run-off to flow from the most remote part (relative to time) of the catchment to its outlet.

In determining the time of concentration, the designer should assume that the catchments under construction are fully developed in accordance with the land use shown on the relevant Zoning Maps.

In a typical urban drainage system a designer will need to calculate the time of concentration for inlet location and pipe sizing. Regardless of the purpose of the time of concentration calculation, it will include one or a number of the following components:

- Overland or 'sheet' flow time.
- Roof to drainage system flow time.
- Gutter or channel flow time.
- Pipe flow time.

Where the flow path is through areas having different flow characteristics, the flow time of each portion of the flow path shall be calculated separately.

The *minimum time of concentration* should not be less than 5 minutes for the total flow travel time from any catchment to its point of entry into the drainage network. The *maximum time of concentration* in urban areas shall be 20 minutes unless sufficient evidence is provided to justify a greater time.

4.10 Rainfall Intensities

The Design Intensity-Frequency-Duration (IFD) Rainfall is required as input to the hydrological model used for the drainage design.

Table 4.4 provides the intensities for the Parramatta catchment area and Table 4.5 provides the intensities for the Hawkesbury catchment area.

Alternatively, the IFD Rainfall for the catchment under consideration may be derived in accordance with Chapter 2 (Volume 1) of AR&R (1998). The nine basic parameters read from the Maps in Volume 2 of AR&R (1998) shall be shown in the calculations submitted to Council unless the Bureau of Meteorology provides a polynomial relationship for the catchment.

Duration (min)	Average Storm Recurrence Interval						
	1 Year (mm/hr)	2 Year (mm/hr)	5 Year (mm/hr)	10 Year (mm/hr)	20 Year (mm/hr)	50 Year (mm/hr)	100 Year (mm/hr)
5	83.63	1.7.75	139.63	156.89	180.68	211.80	235.46
6	78.36	100.99	130.97	147.23	169.61	198.89	221.17
7	73.97	95.36	123.75	139.16	160.36	188.11	209.22
8	70.23	90.55	117.58	132.26	152.45	178.88	199.00
9	66.97	86.37	112.22	126.26	145.57	170.86	190.10
10	64.11	82.69	107.49	120.97	139.51	163.78	182.26
11	61.55	79.41	103.28	116.26	134.10	157.47	175.27
12	59.26	76.47	99.49	112.03	129.24	151.80	168.98
13	57.19	73.80	96.07	108.19	124.84	146.66	163.28
14	55.30	71.38	92.94	104.70	120.83	141.97	158.08
15	53.57	69.15	90.08	101.79	117.15	137.67	153.31
16	51.98	67.11	87.45	98.54	113.76	133.71	148.92
17	50.50	65.21	85.01	95.81	110.63	130.05	144.85
18	49.14	63.46	82.74	93.28	107.71	126.64	141.07
20	46.67	60.29	78.66	88.70	102.46	120.50	134.25
25	41.71	53.91	70.43	79.47	91.84	108.08	120.48
30	37.93	49.03	64.13	72.41	88.72	98.58	109.20
35	34.92	45.16	59.13	66.79	77.26	91.01	101.52
40	32.46	42.00	55.03	62.19	71.96	84.81	94.62
45	30.41	39.35	51.60	58.33	67.53	79.61	88.84
50	28.66	37.09	48.67	55.05	63.74	75.17	83.91
55	27.14	35.14	46.14	52.21	60.47	71.33	79.90
60	25.82	33.44	43.93	49.72	57.60	67.97	75.90
75	22.77	29.51	38.82	43.97	50.97	60.19	67.25
90	20.52	26.60	35.04	39.71	46.06	54.43	60.83

Table 4.4 – Rainfall Intensity for the Parramatta Catchment

Duration (hr)	Average Storm Recurrence Interval						
	1 Year (mm/hr)	2 Year (mm/hr)	5 Year (mm/hr)	10 Year (mm/hr)	20 Year (mm/hr)	50 Year (mm/hr)	100 Year (mm/hr)
2	17.37	22.54	29.75	33.75	39.18	46.34	51.82
3	13.70	17.79	23.55	26.76	31.11	31.28	41.24
4	11.57	15.03	19.94	22.68	26.39	29.26	35.02
4.5	10.79	14.03	18.63	21.20	24.67	27.56	32.78
5	10.15	13.19	17.53	19.95	23.23	24.85	30.89
6	9.12	11.86	15.78	19.97	20.93	24.85	27.86
8	7.70	10.03	13.317	15.24	17.77	21.12	23.69
9	7.19	9.36	12.49	14.25	16.62	19.76	22.17
10	6.76	8.81	11.76	13.42	15.65	18.61	20.89
12	6.08	7.92	10.59	12.09	14.11	16.79	18.86
14	5.53	7.21	9.64	11.02	12.86	15.31	17.20
15	5.30	6.91	9.25	10.57	12.34	14.69	16.50
16	5.10	6.65	8.89	10.16	11.87	14.13	15.88
18	4.74	6.18	8.28	9.46	11.05	13.16	14.79
20	4.44	5.79	7.76	8.87	10.37	12.35	13.88
22	4.19	5.46	7.32	8.37	9.78	11.65	13.10
24	3.97	5.17	6.94	7.93	9.27	11.05	12.42
36	3.06	4.00	5.37	6.15	7.19	8.57	9.64
48	2.53	3.30	4.44	5.08	5.95	7.10	7.99
60	2.16	2.82	3.80	4.36	5.10	6.09	6.85
72	1.89	2.47	3.33	3.82	4.47	5.34	6.01

Table 4.4 Continued – Rainfall Intensity for the Parramatta Catchment

Duration (min)	Average Storm Recurrence Interval						
	1 Year (mm/hr)	2 Year (mm/hr)	5 Year (mm/hr)	10 Year (mm/hr)	20 Year (mm/hr)	50 Year (mm/hr)	100 Year (mm/hr)
5	79.76	102.36	130.81	147.22	169.01	197.45	219.06
6	74.73	95.90	122.52	137.88	158.27	184.88	205.10
7							
8							
9							
10	61.12	78.40	100.10	112.59	129.21	150.88	167.33
11							
12	56.49	72.46	92.49	104.02	119.35	139.35	154.53
13							
14							
15	51.06	65.49	83.55	93.95	107.78	125.81	139.50
16							
17							
18	46.83	60.05	76.59	86.11	98.11	115.29	127.82
20	44.48	57.03	72.73	81.76	93.77	109.44	121.33
24	40.58	52.03	66.33	74.55	85.50	99.76	110.59
30	36.13	46.32	59.02	66.32	76.04	88.71	98.32
35							
40							
45	28.96	37.11	47.25	53.07	60.82	70.93	78.59
50							
55							
60	24.59	31.50	40.08	45.00	51.57	60.12	66.60
75							
90	19.33	24.80	31.66	35.61	40.86	47.71	52.91

Table 4.5 – Rainfall Intensity for the Hawkesbury Catchment

Duration (hr)	Average Storm Recurrence Interval						
	1 Year (mm/hr)	2 Year (mm/hr)	5 Year (mm/hr)	10 Year (mm/hr)	20 Year (mm/hr)	50 Year (mm/hr)	100 Year (mm/hr)
2	16.25	20.86	26.69	30.05	34.52	40.35	44.78
3	12.68	16.29	20.92	23.60	27.14	31.78	35.31
4							
4.5	9.88	12.72	16.38	18.51	21.32	25.00	27.81
5							
6	8.28	10.67	13.77	15.58	17.97	21.10	23.48
8							
9	6.46	8.33	10.79	12.23	14.13	16.61	18.51
10							
12	5.42	7.00	9.08	10.31	11.92	14.03	15.65
14							
15							
16							
18	4.13	5.36	7.05	8.06	9.37	11.10	12.43
20							
22							
24	3.40	4.43	5.88	6.75	7.88	9.38	10.54
36	2.91	3.80	5.09	5.87	6.87	8.21	9.25
48	2.56	3.35	4.51	5.22	6.13	7.35	8.29
60	2.08	2.73	3.71	4.32	5.09	6.13	6.94
72	1.51	2.00	2.76	3.24	3.84	4.66	5.30

Table 4.5 Continued – Rainfall Intensity for the Hawkesbury Catchment

4.11 Run-off Coefficient

The coefficient of run-off (*C*) is the coefficient used in the Rational Method and is the ratio of the peak rate of run-off to the average rainfall intensity during the critical rainfall period for the catchment area under consideration. The value of *C* is a statistical composite not only for the infiltration and other losses, but also the effects of channel storage and initial loss.

The coefficient of run-off adopted shall account for the future development of the catchment in accordance with the land use shown on the relevant Zoning Maps.

Fraction impervious values shown in Table 4.6 have been adopted by Council from unpublished research by the Upper Parramatta River Catchment Trust. The coefficient of run-off values shown in Table 4.6 have been adopted by Council from the method presented in Section 14.5 of AR&R (1998).

Zoning	Example of Land Use	Impervious Fraction (%)
Rural (1a, 1b, 1c & 1d)	2, 10 & 40 hectare allotments	5
Residential (2a)	Medium density housing	80
Residential (2b)	Detached housing	80
Residential (2c)	Tourist villages	65
Residential (2d)	Residential with environmental protection	30
General & Special Business (3a & 3b)	Shops and offices	100
Light Industry 4b	Factory units, warehouses	90
Extractive Industry	Quarry	80
Special Uses (5a)	Schools, hospitals	50 (measure)
Public Open Space (6a)	Reserves, bushland	5
Private Open Space (8a)	Golf or bowling club	5 (measure)
National Parks & Reserves (8a)	Bushland	5
Business park (10a)	Business Park Estate	70

Table 4.6 – Fraction Impervious Values

Zoning	C1	C2	C5	C10	C20	C50	C100
Rural (1a, 1b, 1c & 1d)	0.36	0.38	0.43	0.45	0.47	0.52	0.54
Residential (2a)	0.64	0.68	0.77	0.81	0.85	0.93	0.97
Residential (2b)	0.37	0.39	0.44	0.46	0.49	0.53	0.56
Residential (2c)	0.37	0.39	0.44	0.46	0.48	0.53	0.55
Residential (2d)	0.42	0.44	0.50	0.52	0.55	0.60	0.63
General Business (3a)	0.72	0.77	0.86	0.90	0.95	1.0	1.0
Special Business (3b)	0.72	0.77	0.86	0.90	0.95	1.0	1.0
General & Light Industry (4a & 4b)	0.68	0.72	0.81	0.85	0.90	0.98	1.0
Extractive Industry (4d)	0.64	0.68	0.77	0.81	0.85	0.93	0.97
Special Uses (5a)	0.53	0.56	0.63	0.66	0.70	0.76	0.80
Public Open Space (6a)	0.36	0.38	0.43	0.45	0.47	0.52	0.54
Private Open Space (8a)	0.36	0.38	0.43	0.45	0.47	0.52	0.54
National Parks & Reserves (8a)	0.36	0.38	0.43	0.45	0.47	0.52	0.54
Business park (10a)	0.61	0.64	0.72	0.76	0.80	0.87	0.91

Table 4.7 – 'C' Values for the Parramatta Catchment Area

Zoning	C1	C2	C5	C10	C20	C50	C100
Rural (1a, 1b, 1c & 1d)	0.31	0.33	0.37	0.39	0.41	0.45	0.47
Residential (2a)	0.63	0.67	0.75	0.79	0.83	0.91	0.95
Residential (2b)	0.32	0.35	0.39	0.41	0.43	0.47	0.49
Residential (2c)	0.32	0.34	0.38	0.40	0.42	0.46	0.48
Residential (2d)	0.38	0.40	0.45	0.47	0.50	0.54	0.57
General Business (3a)	0.72	0.77	0.86	0.90	0.95	1.04	1.08
Special Business (3b)	0.72	0.77	0.86	0.90	0.95	1.04	1.08
General & Light Industry (4a & 4b)	0.68	0.72	0.80	0.85	0.89	0.97	1.02
Extractive Industry (4d)	0.63	0.67	0.75	0.79	0.83	0.91	0.95
Special Uses (5a)	0.51	0.54	0.60	0.63	0.66	0.73	0.76
Public Open Space (6a)	0.31	0.33	0.37	0.39	0.41	0.45	0.47
Private Open Space (8a)	0.31	0.33	0.37	0.39	0.41	0.45	0.47
National Parks & Reserves (8a)	0.31	0.33	0.37	0.39	0.41	0.45	0.47
Business park (10a)	0.59	0.63	0.70	0.74	0.78	0.85	0.89

Table 4.8 - *'C' Values for the Hawkesbury Catchment Area*

4.12 Catchment Area

The catchment area of any point may be determined from contour plans obtained from the detailed survey of the site. Where no detailed survey

is available, 1:4000 orthophoto maps may be used to determine catchment boundaries and areas.

The determination of sub-catchments within urban subdivisions requires accurate contour information and a catchment plan shall be provided with the calculations.

The design should take into account realistic future road patterns where the contributing catchment includes areas subject to future development.

4.13 Hydraulics

Hydraulic calculations shall generally be carried out in accordance with Australian Rainfall and Run-off (1998). The detailed hydraulic grade line method is recommended for the analysis of stormwater pipe systems based on an analysis proceeding from downstream to upstream through the system. Calculations shall substantiate the hydraulic grade line adopted for the system and shown on the drawings.

The downstream water surface level shall be in accordance with the following:

- The hydraulic grade line level from downstream calculations including pit losses at the starting pit in the design storm event; or
- A level of 0.15 metres below the invert of the pit inlet in the downstream pit where the downstream starting point is a pit and the hydraulic grade line level is unknown; or
- The top of the outlet pipe for the minor event where the outlet is an open channel; or
- The top of the outlet pipe for the major event where the outlet is an open channel and the flood levels are not known; or
- The 1:100 year flood level for the major event where the outlet is an open channel and the downstream flood levels are known.

Council will require the submission of the calculations in the format of that shown on Council's summary sheet for hydraulic calculations (See Appendix C), together with details of all program inputs and outputs.

4.14 Minor Drainage System Criteria

The minor drainage system shall be capable of controlling flows from frequent run-off events up to and including the ARI's shown in Section 4.8.

The roadway flow width shall not exceed 0.45 metres at bus stops, pedestrian ramps and kerb returns; and 2.5 metres at other locations. The widths mentioned above shall be measured from invert of the kerb and gutter.

The product of depth (d_g) and velocity (V_{ave}) in the kerb and gutter should not exceed 0.6 m^2/s (AR&R, 1998) to reduce hazard for pedestrians within the roadway. However, where there is an obvious danger of injury or loss of life, the $d_g V_{ave}$ product should be limited to 0.4 m^2/s.

The water surface level for inlet pits shall be 0.15 metres below the invert of gutter or 0.15 metres below the under side of the lid for junction pits.

4.15 Major Drainage System Criteria

The major drainage system in the form of overland flow paths shall be capable of controlling flows which exceed the capacity of the minor drainage system from run-off events up to and including the ARI's shown in Section 4.08. Minor system blockages shall be assessed when designing for the major event.

The product of depth (d_g) and velocity (V_{ave}) in the kerb and gutter should not exceed 0.6 m^2/s (AR&R, 1998) to reduce hazard for pedestrians within the roadway. However, where there is an obvious danger of injury or loss of life, the $d_g V_{ave}$ product should be limited to 0.4 m^2/s.

The following requirements shall be provided in open channels, roadways and stormwater surcharge paths:

Generally:

- Overland flow paths shall not be located in private property.

Roadways:

- Total flow shall be contained within the road reserve.
- Flow depths in roadways shall not exceed 200 mm.
- A minimum freeboard of 500 mm shall be provided between the 100 year flood level and habitable floor levels.
- Where a road is in fill, a freeboard of 100 mm shall be provided between the 100 year flood level and the lowest point in the footpath.

Open Channels:

- A minimum freeboard of 500 mm shall be provided between the 100 year flood level and floor levels.

Where the above requirements can not be met for "in-fill" type subdivisions, Council may vary the requirements subject to approval being obtained from the Manager.

4.16 Roadway Flow Capacity

Roadway flow capacity shall be calculated by the method presented by Technical Note 4 in Chapter 14 of AR&R (1998). Table 4.9 provides the recommended values for Manning's Roughness Coefficient (n) and Flow Correction Factor (F).

Roadway Surface Type	**n**
Concrete	0.013
Asphaltic Concrete	0.015
Sprayed Seal	0.018
Kerb and Gutter Type	**F**
Roll	0.9
150 mm Integral	0.9

Table 4.9 – Manning's Roughness Coefficient (n) and Flow Concentration Factor (F)

4.17 Pits

i. Non-standard drainage structures for pipes larger than 750mm diameter shall be designed and certified by a Registered Structural Engineer by way of an accompanying letter or by statement on the engineering plans.

ii. Drainage pits shall be designed wherever possible such that the inlet and outlet walls are perpendicular to the centerline of inlet and outlet pipes.

iii. Wherever possible, drainage pits shall be designed so that the pipe centerlines intersect on the downstream pit face.

iv. All drainage structures deeper than 1.8m shall be reinforced with appropriate Fabric to Engineer's (structural) requirement and pits deeper than 3.0m shall be structurally designed and certified.

v. Drainage pits shall be designed and constructed in accordance with Section 6.16 of Council's Works Specification – Subdivisions / Developments.

Pits should be located at junctions; kerb returns; sag points; and changes in grade, level, direction, pipe size or pipe class. Kerb inlet pits shall be located so that the gutter flow width is in accordance with the requirements of Section 4.14 and at a maximum spacing of 90 metres where flow widths are not critical. Surface Inlet pits shall be located in drainage reserves, overflow paths and parks.

The theoretical inflow capacity of the drainage pits shall be read off the appropriate charts (Refer Appendix D). A blockage factor should be applied to the theoretical inflow capacity obtained in accordance with Table 4.10.

Condition	**Pit Type**	**Theoretical Capacity Allowed**
Continuous Grade	Kerb Inlet Pit	90 %
Sag	Kerb Sag Pit	80 %
Surface Inlet Pit Cover	Surface Inlet Pit	50 %
Surface Inlet Pit Cover with legs	Surface Inlet Pit	80 %

Table 4.10 – Provision for Blockage in Drainage Pits

Pit sizes shall be in accordance with the following:

- A minimum opening of 1.8 metres for pits on grade and 2.4 metres for sag pits shall be provided for kerb inlet pits.
- Other drainage pits shall be 600 mm x 600 mm for depths up to 800 mm; 600 mm x 900 mm for depths up to 1500 mm; and 900 mm x 900 mm for depths greater than 1500 mm.
- The minimum dimensions of surface inlet pits for use within development sites shall be 300 mm x 300 mm.

4.18 Pipes and Culverts

Piped and box culverts shall be constructed in accordance with Council's Work Specification – Subdivisions/Developments and should be designed in accordance with the following:

- As an overall gravity system with due regard to the upstream and downstream system.
- Pipes shall be determined using the Colebrook-White formula with the recommended roughness coefficients referred to in Table 4.11.

Pipe Material	Recommended K value (mm)
UPVC	0.03
VCP	0.04
RHS	0.046
FRC	0.06
RCP	0.3

Table 4.11 – Recommended Roughness Coefficients (K)

- Minimum pipe culvert size in Council property of 300 mm diameter.
- Minimum box culvert size in Council property of 600 mm wide by 300 mm high.
- A minimum grade of 1.0 % shall be provided for self cleansing purposes under low flow velocities.
- A maximum grade of pipelines shall be in accordance with Table 4.12.

However, where pipe grades necessitate drop pits, these grades may be varied pending approval from Council's Manager - Subdivision and Development Certification.

Pipe Diameter (mm)	Maximum Grade (%)
300	20.0
450	11.0
525	9.0
600	7.5
675	6.5
750	5.5
825	5.0
900	4.5
1050	3.5
1200	3.0
1350	2.5
1500	2.2
1650	2.0
1800	1.7
1950	1.5
2100	1.4
2250	1.3
2400	1.2

Table 4.12 – Table of acceptable maximum pipe grades

- Grades in variation to the above may be approved by the Manager, however, where grades exceed 15.0% bulkheads shall be provided in accordance with Council's Works Specification – Subdivision/Developments.
- The minimum velocity in the pipe and box culverts shall be 0.6 m/s for self cleansing purposes.
- A maximum velocity of 6 m/s for scouring protection.
- Pipelines within roadways shall be generally located under the kerb.
- A downstream pipeline of smaller diameter than the upstream shall generally not be permitted.
- Curved pipelines shall be permitted in accordance with the Manufacturer's recommended minimum radii.
- All pipe inlets should enter the main pipe system at junction pits and shall be cut flush and grouted into the pit wall.
- Council's Engineer may approve direct connection to the main pipe system for, up to and including, 225 mm diameter pipes. Where these connections are approved the pipe shall be cut flush and grouted into the main pipe wall.
- Pits shall be designed with benching to improve hydraulic efficiency and reduce water ponding.

4.19 Hydraulic Losses

Hydraulic losses shall be determined from the appropriate charts in Appendix E for the following:

- The pressure change coefficient (*Ke*) for pit losses.
- Where approval from the Manager has been obtained for the use of bends, the appropriate values of pit pressure change.
- The energy loss coefficient for expansion and contraction (where approval from the Manager has been obtained for the use of smaller downstream pipe sizes).
- Obstruction or penetration losses.

Pipe friction losses shall be determined using the Colebrook-White formula with the acceptable roughness coefficients mentioned in table 4.11.

4.20 Open Channels

Open channels shall be provided to convey flows from the major storm event from a development site to the receiving water body in accordance with the following:

- The design will be generally in accordance with Chapter 14 of AR&R (1998).
- Friction losses shall be determined using the recommended Mannings "n" values referred to in Table 4.13.

Surface Type	**Roughness Coefficient (n)**
Concrete	0.013
Asphaltic concrete	0.013
Flush seal	0.014
Rough Texture surfaces – eg. Pavers	0.018
Gravel	0.02
Bare Clay – Loam earth	0.022
Lawns	0.05
Short grass	0.06
Long grass	0.1
Natural channel with earth bed	0.04
Natural channel with rock bed	0.045
Natural channel with coarse gravel bed	0.05

Table 4.13 – Recommended Mannings "n" Values

- The design will specifically provide for the safety of persons who may enter the channel where the product of depth (d_g) and velocity (V_{ave}) is greater than 0.4 m^2/s.

- The desirable maximum side slopes shall be 1:6, the absolute maximum should be 1:4 and cross slopes for the channel floor should be 1:20.
- Low flow provisions shall be provided in man-made or altered channels by the provision of pipelines, concrete lining or sub-soil drainage.
- Vegetated creek lines shall be retained in their natural state with enhancements to prevent scour due to increased frequency of bankfull flows and urbanization.
- Low flow inverts of creeks shall be designed as a wet invert and planted with suitable riparian vegetation.
- Pipe outlets discharging to watercourses are to join the watercourse at mean dry water level, angled at 45 degrees downstream and protected by gabions or rock filled mattress to Council's requirements. Discharges to existing rock outcrops will be considered on individual merits.

4.21 Bridges and Culverts

Bridges and major culverts shall be designed for the major storm event generally without afflux in urban areas. A minimum clearance of 0.3 metres should be provided between the major flow level and the underside of a major structure to allow for passage of storm debris.

4.22 On-Site Stormwater Detention

The Local Government Area of The Hills Shire drains two main catchments, these being the Upper Parramatta River Catchment and the Hawkesbury River Catchment. The on-site stormwater detention (OSD) requirements are different for each catchment.

- Upper Parramatta River Catchment – For those areas drainaing to the Upper Parramatta River Catchment on-site stormwater detention (OSD) shall be provided in accordance with the requirements of the Upper Parramatta River Catchment Trust (UPRCT). Details of these requirements can be found in the publication *"On-site Stormwater Detention Handbook"* by the UPRCT. This publication can be purchased directly from UPRCT or is available on the internet at *www.uprct.nsw.gov.au*.
- Hawkesbury River Catchments - Using the same principles as above, where a proposed development drains to the Hawkesbury River Catchment OSD will be required.
- The Permissible Site Discharge (PSD) and Site Storage Volume (SSV) requirements shall be derived from Table 4.14 for that portion of the Hawkesbury River Catchment area that falls within the Shire.

Site Slope	PSD (l/s/ha)	SSV (m^3/ha)
Greater than 15%	136	298
Between 10% and 15%	115	336
Between 6% and 10%	104	362
Between 3% and 6%	92	396
Between 0% and 3%	87	412

Table 4.14 - PSD and SSV Requirements for the Hawkesbury River Catchment

On-site stormwater detention shall not be provided in catchment areas that drain to an approved detention system. This generally includes new release areas. Council's Subdivision & Development Certification section can advise which catchment applies to the proposed development and the requirement for on-site detention.

The design of detention basins shall be in accordance with the principles of the Upper Parramatta River Catchment Trust policy and the following:

- Maximum depth of 600 mm in above ground systems, 200 mm depth in driveways, car parking areas and walkways.
- Desirable maximum side slopes of 1:6 for above ground basins, the absolute maximum should be 1:4 and minimum slope of floor should be 1:50.
- Provision of a grated access lid for each chamber of an underground system.
- Discharge control pits and grated access pits shall be 600 mm x 600 mm for depths up to 800 mm; 600 mm x 900 mm for depths up to 1500 mm; and 900 mm x 900 mm for depths greater than 1500 mm.

4.23 Inter-allotment Drainage

Inter-allotment drainage shall be provided to every allotment which does not drain directly to the street or to a lawful point of discharge.

The desirable minimum pipe grade shall be 1.0% and pipes shall be designed to accept concentrated drainage from OSD systems or the concentrated drainage from buildings and paved areas (impervious areas shall be obtained from Table 4.6) for flow rates having a design ARI the same as the minor street drainage system. Table 4.15 provides the general minimum pipe sizes for inter-allotment drainage.

Number of Allotments	Minimum Pipe Size (mm)
1-4 lots	150
5-8 lots	225
9-15 lots	300
16-25 lots	375

Table 4.15 – General minimum Pipe Size Requirements for Inter-allotment Drainage

Inter-allotment drainage pits shall be located at the lowest point of each allotment to be drained, changes of grade, pipe size or direction.

Where the pipeline serves more than five (5) lots, a hydraulic grade line analysis will be required with the design submission to ensure lots are not affected by surcharge.

Minimum cover for pipelines within allotments shall be 300mm, apart from footway crossings to kerbs with galvanized steel Rectangular Hollow Sections (RHS).

Where an OSD system is to be connected to an interallotment drainage system, the IAD pipeline is to have a minimum 1.0 metre cover.

4.24 Stormwater Discharge

Outlet drains and structures shall be designed to ensure that stormwater flow is discharged into existing natural water courses, kerb and gutter or channels in a manner that:

- Flow velocities are reduced below scouring velocity.
- Scouring at the structure is prevented.
- Provides safety measures alleviating hazardous conditions at the outlet.

The discharge to kerb and gutter shall be located so that stormwater flows are maintained within the flow width requirements of Section 4.14.

Energy dissipators shall be provided to outlet structures at natural water courses and open channels in accordance with Section 8 of the RTA Road Design Guide where the permissible velocities in Table 4.16 are exceeded.

Channel Gradient (%)	Permissible Velocity (m/s)
1	2.1
2	1.9
3	1.8
4	1.7
5	1.6
6	1.6
8	1.5
10	1.5
15	1.4
20	1.3

Table 4.16 – Permissible Velocities for Vegetated Channels

4.25 Water Sensitive Urban Design

The objective of Water Sensitive Urban Design (WSUD) is for a post-development water cycle to replicate or improve upon the pre-development water cycle through the use of design techniques to reduce development impact on receiving waters.

WSUD aims to:

- reduce water demand;
- reduce water discharges to receiving environments;
- maximise opportunities for water harvesting and re-use; and
- reduce water pollution.

WSUD measures are to provide sustainable and integrated management of land and water resources, incorporating best practice stormwater management, water conservation and environmental protection measures. Additionally, WSUD is to take into account water quality, stream stability, flow attenuation and runoff volumes.

All proposals are to incorporate WSUD measures into a new development and shall be submitted to Council for consideration with the Development Application.

Any proposal to incorporate WSUD measures is to recognize and design for ongoing operation and maintenance requirements.

WSUD measures shall be designed and constructed to comply with the requirements of Council policies and the following publications.

- Water Sensitive Urban Design Technical Guidelines for Western Sydney (NSW Government Stormwater Trust and UPRCT, May 2004); and
- Australian Runoff Quality (Engineers Australia 2005).

WSUD infrastructure recommended for implementation includes:

- rainwater tanks;
- stormwater treatment devices;
- bio-filtration;
- bio-retention;
- detention basins;
- swales;
- porous paving / surfaces; and
- wetlands
- gross pollutant traps

4.26 Gross Pollutant Traps

Gross Pollutant Traps (GPT) serve a specific purpose to reduce litter, vegetation matter, debris and coarse sediment from discharging into downstream waterways and water sensitive treatment train measures.

Council requires that GPT's are designed and installed in accordance with the guidelines provided within the following documents:

- Australian Runoff Quality, A Guide to Water Sensitive Urban Design, 2006 - Chapter 8 - Gross Pollutant Traps and Sediment Traps,
- Water Sensitive Urban Design, Technical Guidelines for Western Sydney, 2004.

The following criteria are to be considered in the design and installation of an appropriate GPT.

The type of catchment that is being treated and the primary pollutants to be targeted for capture. Treatment objectives should generally consider the following:

- Gross Pollutants - litter, vegetation matter and debris larger than 5mm,
- Sediment - particles larger than 0.125mm.

The size of the catchment to be treated. This will influence treatable flow rates, operating design flows and pollutant removal rates.

- Generally the treatment of a 3 month ARI design flow from a catchment will result in the treatment of a significant portion of flow.

The type of device, whether propriety or custom built, to provide for:

- The treatment of the targeted primary pollutants with the appropriate removal efficiency.
- The size is to match the treatable discharge from the catchment.
- On-going maintenance requirements.

The location of the device and site constraints in relation to:

- Physical constraints - topography and slope, soils, groundwater and available space.
- Social constraints - health and safety, odour, aesthetics and vermin.
- Maintenance requirements - ease of device operation, appropriate all weather access tailored to the maintenance equipment and systems required, frequency of maintenance and disposal of waste.

MISCELLANEOUS REQUIREMENTS

5.1 Scope

This section of the engineering guidelines provides miscellaneous engineering requirements not covered in the previous sections.

5.2 Aim

To provide the developer with an understanding of other Council engineering requirements that may be required in the development of land.

5.3 Pathway and Cycleways

Pathways and cycleways are to be designed to provide a safe and convenient network for pedestrians and cyclists, incorporating the street network together with all-weather paths and cycleways to provide access to public transport and points of attraction within the Shire.

Pathways shall be provided in accordance with any relevant Development Control Plan and, unless otherwise directed, shall generally be provided in accordance with the following:

- At sag points to cater for any overland flow requirements.
- Maximum longitudinal grade should not exceed 1:6 (V:H). Where the maximum grade is exceeded, stairs and handrails should be provided in accordance with Council's Works Specification – Subdivisions/Developments.

Lighting shall be provided to pathways in accordance with the Australian Standard 1158.1 and the relevant Authority's requirements.

Street Footpaving shall be provided in accordance with any relevant Development Control Plan and to the full frontages of any medium density residential development, high density residential development, or commercial development. The design shall detail the requirements of Council's Works Specification – Subdivision/Developments.

Cycleways shall be provided in accordance with any relevant Development Control Plan and shall be designed in accordance with AUSTROADS – Guide to Traffic Engineering Practice, PART 14, bicycles.

The location of pathways and cycleways shall consider pedestrian and cyclist safety, together with the above requirements and should preserve trees and other natural features where possible.

5.4 Battleaxe Handles

Where battleaxe shaped allotments are approved by Council, provision is to be made for the construction of suitable vehicular access within the proposed handles or rights of carriageway. The standards required by Council will generally be in accordance with Table 5.2.

	One Allotment	Two or More Allotments
Residential	4.0 metre wide access handle with no formal pavement required (1).	6.0 metre wide access handle with construction of a 5.0 metre wide (2) medium duty driveway.
Rural	6.0 metre wide access handle with the construction of a 3.0 metre wide all-weather pavement (3).	6.0 metre wide access handle with the construction of a 3.0 metre wide all-weather pavement (3) and suitable passing bays.
Industrial	8.0 metre wide access handle with construction of a 6.0 metre wide heavy duty driveway.	8.0 metre wide access handle with construction of a 6.0 metre wide heavy duty driveway. (3) and suitable passing bays.

Table 5.2 – Battleaxe Handle/Rights of Carriageway Standards

1. Vehicular access is to be made available to all allotments.
2. Where a reduction in pavement width is sought, provision is to be made for passing.
3. The construction of a sealed pavement and/or passing bays will be dependant upon the existing site features and consideration must be given to sight distances, existing trees, grade, drainage and length of access handle.

5.5 Access Driveways

Access driveways shall be provided in accordance with Council's Development Control Part D Section 1 – Parking 2007.

Driveway grades should not exceed 22.0% and steep driveways for residential dwellings should be constructed to Council's standard for maximum allowable grades (DWG No. SD16).

5.6 Disused Laybacks and/or Footpath Crossings

The removal of all disused laybacks and/or footpath crossings to the development site and their replacement with full kerb and gutter together with the restoration and turfing of the adjoining footpath verge area.

5.7 Applications

Separate applications, together with the payment of the appropriate fees, shall be made to Council for the following:

- Construction of gutter and footpath crossings.
- Construction of concrete Footpaving.
- Removal of gutter and footpath crossings.
- Road openings.
- Access across Council Reserves.

5.8 Temporary Roads

In some circumstances, Council may permit the creation and construction of temporary public roads.

Where approved, the following criteria must be considered:

- Construction must extend over a minimum of two(2) development lots;
- The temporary public road is not to be constructed upon land zoned for Business, Open Space, Trunk Drainage, Transport Corridor or Educational Establishment;
- A minimum trafficable width of 6.0m is to be provided to cater for two-way traffic with 3.5m wide verges on both sides;
- The allotment layout associated with temporary public road construction does not result in the creation of un-developable residue allotments;
- The safety of all road users (including service and passenger vehicles, pedestrians and cyclists) is not compromised;
- The temporary public road is to be constructed to a standard in accordance with THSC Design Guidelines for Subdivisions / Developments (Section 5.7); and
- The final road configuration is consistent with the pre-planned road layout and road type from Council's Development Control Plan (where applicable)

Any temporary public road construction proposal must be accompanied by the following:

- An engineering design for the temporary road, as well as plans demonstrating the future road configuration after the closure of such, including details of any necessary drainage and service utility provision requirements.
- A traffic safety report prepared by an appropriately experienced professional demonstrating how the partial road proposal provides for the safe usage of all road users; and
- The submission of written evidence demonstrating that an attempt to cooperate with adjacent landowners has been undertaken. Such evidence could be in the form of letters and responses (if applicable).

5.9 Partial Road Width Construction

Council does not encourage the partial construction of roads.

Should there be no alternative, partial road construction will be considered (where permitted under Council's Development Control Plan) subject to the following criteria being satisfied:

- The site(s) adjacent to the proposed partial road are zoned for residential use and are not in public ownership or identified for acquisition;
- A minimum trafficable road width of 6.0m is provided to cater for two-way traffic;
- The development potential of all adjoining allotments is maintained;
- The safety of all road users (including service and passenger vehicles, pedestrians and cyclists) is not compromised; and

- The final road configuration is consistent with the pre-planned road layout and road type from Council's Development Control Plan (where applicable).

Any partial road construction proposal must be accompanied by the following:

- An engineering design for the partial and full width road works including details of any necessary drainage and service utility provision requirements; and
- A traffic safety report prepared by an appropriately experienced professional demonstrating how the partial road proposal provides for the safe usage of all road users.

Any works to be carried out, or necessitate easements, over adjoining properties, shall be approved by the owner(s) of such land and suitable documentary evidence of this approval shall be submitted to Council.

5.10 Street Names

Section 162 of the Roads Act 1993 states:

1. A roads authority may name and number all public roads for which it is the roads authority.

2. The RTA may name and number all classified roads.

3. Neither a roads authority nor the RTA may name a public road, or alter the name of a public road, unless it has given the Geographical Names Board at least one months notice of the proposed name.

In this regard, road names are to be submitted to Council for approval and then the Council will follow the procedures set out in Clauses 7-10 of the Roads (General) Regulation 2008.

A brochure – "GUIDELINES FOR THE NAMING OF ROADS" – is available form Geographical Names Board (gnb@lands.nsw.gov.au search under publications).

5.11 Bridges and Culverts

The design of bridges and culverts shall be in accordance with AUSTROADS – Bridge Design Code and a structurally certified design shall be submitted to Council. Council will also require the submission of a structural certification of the constructed works by a Registered Structural Engineer.

5.12 Safety Barriers for Roads and Bridges

Safety barriers for roads and bridges shall be provided in accordance with Section 6 of the RTA Road Design Guide.

5.13 Encroachment in Council Drainage Easements

A public stormwater easement is vested in the Council and typically consists of both piped flow (minor) and an overland flowpath (major) as discussed in Section 4.3 of this document.

Minor works within a Council drainage easement may be approved by Council subject to the requirements set out below.

The proposed works must not impact upon flood behavior as it passes through the site. This will require:

- Hydrological modelling, using a DRAINS model or similar, to determine the volume of stormwater that passes through the site associated with this easement.

- Hydraulic modelling, using a HEC-RAS model or similar, to examine the flow conditions as they pass through the site in both the pre-development and post development conditions.

- The pre-development and post development conditions at the upstream and downstream site boundaries must be the same, to mitigate flooding impacts off-site. Similarly, flooding on-site must be managed with respect to the potential for injury, death or property damage, in accordance with this document.

The proposed works must not interfere with the rights afforded to Council, specifically with respect to the maintenance of the pipe and other structures within the easement.

The location of the easement may need to be varied or its width increased in order to comply with the above requirements and Section 4 of this document.

Any proposed encroaching structures must be easily dismantled (free standing).

Any proposed encroaching structures must be registered on the title of the subject site via a deed with Council. The purpose of the deed is to protect Council's rights to access the easement area, requiring the removal of the encroaching structure. A standard form deed is available from Council upon request. All costs associated with the preparation and registration of the deed shall be borne by the person seeking approval for these works.

5.14 Encroachments in Private/ Inter-allotment Drainage Easements

An inter-allotment drainage easement provides a legal point of stormwater discharge and is a constraint that must be considered in the design and construction of any structure on a burdened lot. Except for constrained land, lots are typically graded at the subdivision stage so that there should be no need for additional earthworks within an inter-allotment drainage easement at the dwelling design stage. The need to retain the existing ground surface levels should be considered early in the design of a dwelling to ensure compliance with this requirement.

Minor works within an inter-allotment drainage easement may be approved by Council subject to the requirements set out below.

Notwithstanding these requirements, any proposed works within an inter-allotment drainage easement must also be considered with respect to the associated impacts on neighbours concerning privacy, overshadowing and general amenity impacts as they are typically located adjacent to a property boundary.

The works will only be permitted within the easement if the person seeking to undertake these works obtains written consent from each and every person either burdened or benefited by the easement. This will require the following to be submitted:

- A title search showing the easement and listing the properties burdened or benefited;

- A signed letter from the owners of each property above which states that they have no objection to the proposed encroachment;

Where written consent is not able to be provided for all affected properties the encroachment will not be permitted.

The proposed works must not "substantially" interfere with the rights afforded to those persons benefitting from the easement. Primarily, this relates to the maintenance of the pipe and other structures within the easement. For example, the cost and work involved in excavating a pipeline for maintenance purposes in the pre-development and post development condition (along its full length) could be compared and if the difference is negligible then it could be argued that the works do not impinge upon this aspect of the benefitting parties rights.

Any structures proposed within, or adjacent to, the easement as part of the works (for example, a retaining wall) must be designed such that it does not impart a load on the stormwater pipe in the easement. The design for any such structure must be accompanied by advice from a suitably qualified structural engineer confirming compliance with this requirement. Post-construction certification from a suitably qualified structural engineer must also be provided once the works are complete.

Typically, a surface inlet pit is provided in the lowest corner of each lot burdened by an inter-allotment drainage easement. Section 4.17 of this document specifies the required size of this pit, depending on the depth of the pipe. If filling is proposed within an inter-allotment drainage easement, it may be necessary to reconstruct a larger pit in order to comply.

Section 4.23 of this document requires a minimum ground cover of 300mm above a stormwater pipe within an inter-allotment drainage easement, increasing to 1m where OSD is required or 800mm where a rain garden is required. If cut is proposed within an inter-allotment drainage easement, the minimum pipe cover must be provided.

If the inter-allotment drainage easement services more than five lots, a hydraulic grade line analysis would have been carried out at the subdivision stage to address the potential for surcharge. If cut is proposed within an inter-allotment drainage easement, the impacts (if any) upon the hydraulic grade line and the potential for surcharge must be considered.

5.15 Insurance and Workers Compensation

a) Public Liability Insurance: The Applicant must ensure that Contractors, engaged on Development or Subdivisional Works, have taken out Public Liability Insurance which must include the interests of Council to at least the value of $10 million dollars.

Details of Insurance must be submitted to Council prior to work commencing.

b) Workers Compensation: The Applicant must ensure that Contractors engaged on Development or Subdivisional Works carry current Workers Compensation Insurance on all works as required by Statute.

5.16 Traffic Control for Works in Public Roads

A "Traffic Control Plan" must be prepared by a suitably qualified RTA accredited work site traffic designer for all works that are carried out in or adjacent to a public road. This Plan must satisfy all the requirements of AS 1742.3 – 2002.

It is the sole responsibility of the Applicant to have in place and maintain traffic facilities, i.e. barricades, signs, lights etc at all times, day and night, seven (7) days a week for the duration of the works in accordance with the Plan.

If it comes to the attention of Council that Traffic Control Devices are insufficient or inoperational (particularly in an after-hours situation), then Council may arrange to reinstate the Traffic Control Devices and recoup the costs from the Applicant.

Any changes to the approved Traffic Control Plan must be approved by Council prior to implementation.

5.17 Landscaping of Roundabouts and Median Strips

Description

The need for appropriate landscaping of civil infrastructure works on large collector roads should be considered to enhance the appearance of public areas and thoroughfares. The Applicant shall submit details of any proposed landscaping of roundabouts and median strips for the consideration to Council with the Development Application.

Design Requirements

i. In proposing the landscaping of civil works the following issues need to be considered:

- The potential damage to pavement from water and root system infiltration,
- Ensure the line of sight is maintained for vehicular and pedestrian movements,
- Ensure that tree and shrub species selection is suitable for the particular site in terms of growth height, width and vigour,
- The potential cost of maintenance and landscaping,
- Accessibility of landscaping for maintenance purposes,
- The adequate provision of services for landscaped areas including irrigation and drainage.

ii. Each site should be considered on it's merits in terms of appropriateness for landscaping including the following:

- Sight distances,
- Turning paths of various sized vehicles,
- Pedestrian movements,

- Provision and location of services,
- Cost of installation and maintenance of the landscaping,
- Safety of maintenance crews during works.

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX D

APPENDIX E