6.0 STORMWATER DRAINAGE DESIGN

6.1 DESIGN STANDARD

Stormwater drainage is to be in accordance with the Institution of Engineers Australia publication "Australian Rainfall and Runoff 1987" and "Department of Housing Road Manual 1987". Interallotment drainage is to conform to Department of Housing Road Manual (June 1987) and the following Council requirements.

The major/minor approach to street drainage design is to be adopted as outlined in institution of Engineers Australia publication "Australian Rainfall and Runoff 1987, Chapter 14".

The minor system is the gutter and pipe network capable of carrying runoff from minor storms. The major system comprises the many planned and unplanned drainage routes which convey runoff from major storms to trunk drains.

All subdivisions are to be designed so as not to increase the limits of upstream and downstream flooding for all floods over the range of 1:1 to 1:100 year average recurrence interval storm.

6.1.1 Urban Residential Developments

In urban areas pipe capacities shall be calculated for pipes flowing full under gravity, with a minimum 5 year flooding frequency adopted for minor lines, and minimum 10 year flooding frequency for major lines replacing larger natural watercourses. However, allowance must be made for the flow of excess water when the capacity of any system is exceeded by maximum storms.

Minimum standards shall be:

(a) Flows to be calculated for 1:5 year average recurrence intervals.

(b) Maximum width of flow in gutter to be 2.5 metres.

(c) Allowance is to be made to permit the average recurrence interval storm to be contained within designated easements and open channels without adversely impacting public safety.

(d) Pipes are to be self-cleansing in the 1:6 month average recurrence interval storm.

(e) All urban streets to be used as floodways shall conform to the requirements contained in Figure 13.

6.1.2 Industrial & Commercial Developments

In industrial and commercial areas, pipe capacities shall be calculated for a minimum 10 year flooding frequency, with allowance for overland flow. This applies to both internal and road drainage. For industrial subdivisions the provision of a piped outlet (capacity Q10) from within each lot to the road drainage system will be required. This may be either an interallotment drainage system or separate connections to the road drainage.

6.1.3 *On-Site Stormwater Detention*

(a) For storage up to 100m^3 it is acceptable to use "Evaluation of Simplified Methods for Design of Retarding Basins" by M.J. Boyd (Lecturer, Department of Civil Engineering, University of Wollongong).

For storages above 100m^3 the detention structure will be required to be modelled by a reservoir routing model.

(b) Provision is to be made for 100 year average recurrence interval flows through the detention structure via an overflow spillway and/or overland flow path.

(c) Floor levels for commercial buildings are to be at least 500mm above the 100 year average recurrence interval water level.

(d) Floor levels for industrial buildings are to be at least at the level of the 1:100 year average recurrence interval storm.

6.1.4 *Rural Developments*

In rural areas generally a minimum flooding frequency of 10 years and a maximum of 50 years is to be used for drainage structures. The frequency will require finalisation prior to design and will be assessed for each individual subdivision on the basis of the extent of land expected to be flooded, the structure and its associated afflux, the importance of the watercourse, the importance of the road, and other relevant factors.

6.2 DRAINAGE DETAIL PLAN

Drainage plan shall show a complete stormwater management plan, including long-sections and typical cross-sections of permanent open drains with sufficient detail to concrete lining and batter treatment, inlet and outlet treatments, catchment areas etc.

6.3 STORMWATER DISCHARGE ONTO ADJOINING PROPERTY

Where stormwater discharge is concentrated onto adjoining property and/or works are necessary on the other property, it is the responsibility of the developer to make appropriate arrangements and provide Council with a copy of consent from the owner prior to the release of approved plans. This may necessitate the creation of a drainage easement through the adjoining property and all costs and compensations shall be borne by the developer.

6.4 DRAINAGE PITS

All drainage pits are to conform with Council's current standards, with the length of the kerb inlet to be shown on the engineering plans. Pits are to be located to prevent ponding at intersections and to restrict gutter flow to a maximum 2.5 metre width. Steps iron are to be provided in all pits deeper than 1.2 metres. The maximum spacing of pits in street gutters shall be 100 metres and pits shall be required in most instances on the upstream end or kerb returns and at the tangent points of sharp carriageway curves.

6.4.1 *Gully & Junction Pits*

Standard gully pits are to be constructed in accordance with Council's Plan No. SD11. Other pits are to be constructed in accordance with R.T.A. standards. Non-standard structures are to be constructed as detailed on the plan. Precast pits are to be installed as per manufacturer's specifications.

All pits are to be constructed on a sound bedding. For insitu pits the floors shall be poured first so that walls may be fully supported on the base slab. Walls are to be bonded to the floor by cement grout to form a tight joint. Minimum floor, wall and lid thickness for insitu pits shall be 125mm. Pits poured in multiple height sections shall require starter bars of minimum diameter 12mm.

Lids are to be adequately reinforced and provided with approved lifting eyes. The disturbed area around any pit is to be restored and shaped to suit the surrounding levels. A 50mm thick layer of topsoil and 300mm wide turf strip shall be provided around each pit.

6.4.2 *Pit Entry Capacities*

Pit entry capacities shall be determined from Figures 8 and 9 for 2.4, 3.0, 3.7 and 4.3 metre lintels and sag pits.

Unless design aspects require otherwise, drainage lines and structures are to provide minimal disturbance to flows with regard to the following measures.

6.4.3 *Drainage Pits/Junction Boxes*

Drainage pits and junction boxes are to be streamlined by infilling with concrete to a maximum of half outlet pipe diameter height, and shaping transitions from incoming pipes to the outlet pipe.

Changes in direction of drainage lines through pits being up to the maximum shown hereunder.

Pipe Diameter	Maximum Change in Direction
375	90 degrees
450-675	45 degrees
750-900	15 degrees

6.4.4 *Cover of Stormwater Pipes*

Cover of stormwater pipes in roads is to be in accordance with that prescribed by the manufacturer and shall be a minimum of 450mm below gutter level (current Australian Standard or Concrete Pipe Association of Australia "Concrete Pipe Guide").

6.4.5 *Junction Boxes*

The maximum spacing of junction boxes in continuous pipeline shall be 100 metres. Partial area effects are to be checked when determining flows. Other design criteria and calculation tabulation shall be as shown in Figures 10 and 11 (lintel lengths and depth of flow).

6.4.6 *Placing of Lintels*

Precast lintels shall be joined to pit walls by standard concrete mix. Steel lifting hooks shall be removed flush with concrete and effectively sealed.

6.4.7 *Grates*

Approved/standard bicycle safe grates or types approved by Council's Engineer are to be used for residential and heavy duty type for industrial developments.

6.5 PIPE CULVERTS

6.5.1 Size & Type

All drainage pipes shall be a minimum 375mm diameter, of spigot and socket rubber ringed type and of class specified on the plans. Only pipes produced by approved manufacturers and conforming to AS4058 shall be used.

Bulkheads of approved materials are to be placed across and in line with the trench up to within 300mm of the underside of the kerb and gutter on both sides of the road.

6.5.2 *Design Velocities*

The maximum and minimum design velocities of flows in piped systems shall be 6m/sec. and 1m/sec. respectively.

6.5.3 *Design of inlet Structures*

Particular attention is to be given to the design of inlet structures collecting water from catch drains and watercourses, and outlet structures discharging into earth drains or creeks. Entry and exit velocities are critical in this regard. (Erosion protection is to be provided on all outlets. Note: the discharge velocity into natural streams is to be limited to 1.7ms-7.)

6.5.4 *Drain Inlets*

Drain inlets are to be protected by temporary sediment interception devices until sealing is complete. Drain outlets are to incorporate velocity dissipaters and other measures to avoid downstream channel scour.

6.5.5 *Outlets Under Pathways to Reserves*

Drainage outlet pipes under pathways shall extend a minimum of 5 metres into Council's reserve. This is to allow both pedestrian and vehicular access where applicable.

The provision of an approved hand rail or treated timber log fencing suitable for in ground use will be required around the outlet headwall.

6.6 TRENCH DRAINAGE

6.6.1 *Subsoil Spigot Pipes*

At all downstream pit connections, a 3 metre length of approved subsoil drainage pipe shall be placed alongside the main pipe so as to enter the pit at the same invert level and provide adequate drainage of the main trench. The open end of the subsoil line is to be properly capped and sealed and the remainder covered with an approved filter material all round so as to prevent penetration by sand or silt. Type and size may be varied by Council's Engineer, dependent on site conditions.

6.7 CONCRETE BOX CULVERTS

6.7.1 *Culvert Design*

Recommended design procedures are detailed in the following manuals:

(a) "Pipe and Culvert Hydraulics Manual" Rocla.

(b) Section 3 of the Concrete Pipe Association of Australia's publication "Hydraulics of Precast Concrete Conduits - Hydraulic Design Manual".

6.7.2 *Standard Precast Units*

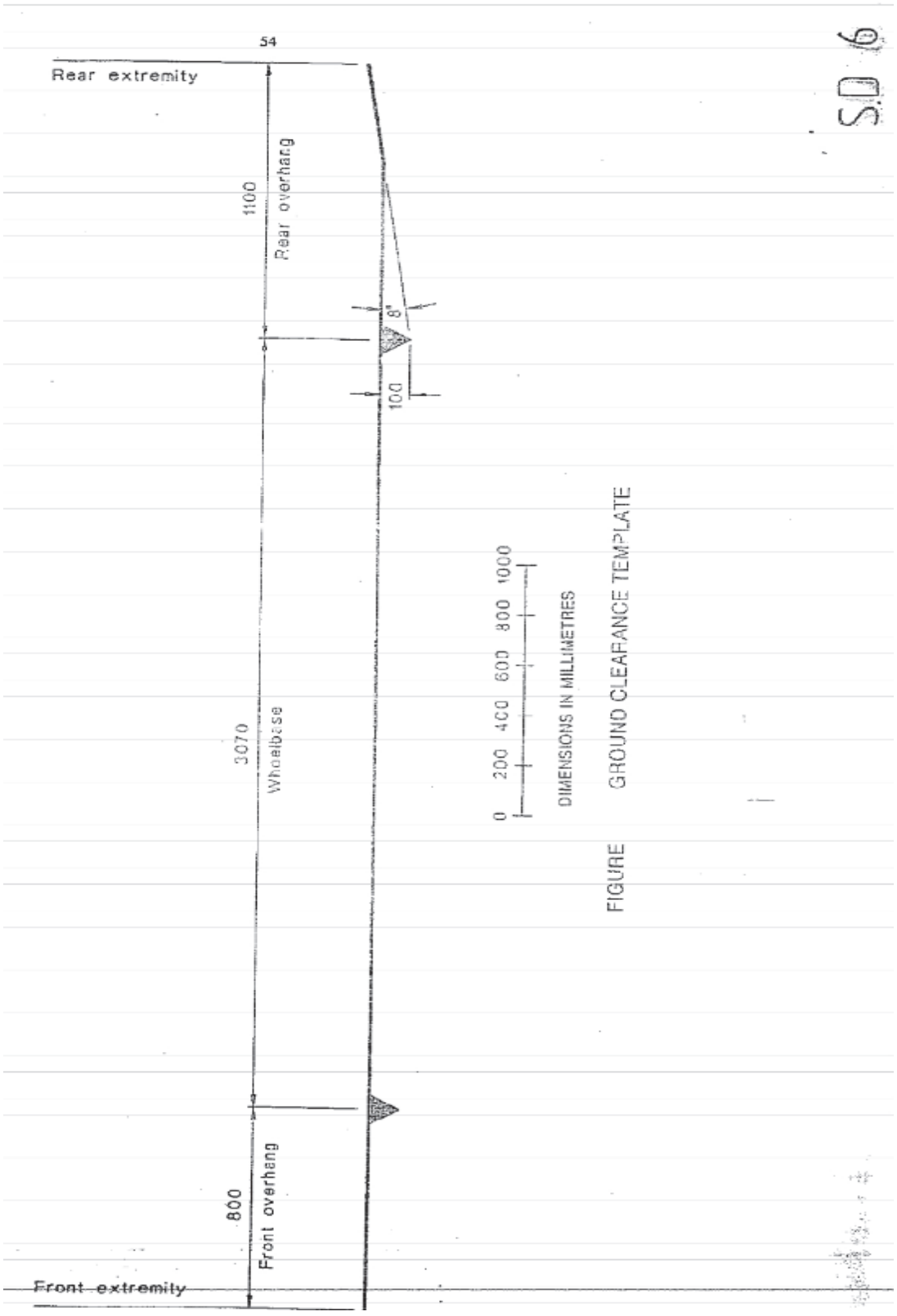
Only precast units by established manufacturers are to be used, but the base and wingwalls must be poured insitu unless otherwise approved.

6.7.3 *Standard for Cast Insitu Units*

Cast insitu box culverts shall be constructed to conform to plan drawings and R.T.A. standards.

6.7.4 *Procedure for Placing*

All box culverts shall be placed inverted on a continuous reinforced concrete base slab in accordance with the approved plan. The use of fibrecrete in lieu of conventional reinforced concrete will be considered. Protruding steel lifting eyes or hooks shall be either sealed over with cement mortar or cut off and sealed over as directed by Council's Engineer.


54
Rear extremity
1100
Rear overhang
8°
100
3070
Wheelbase
800
Front overhang
Front extremity
0 200 400 600 800 1000
DIMENSIONS IN MILLIMETRES
FIGURE GROUND CLEARANCE TEMPLATE
S.D.6

6.8 **SUBSOIL DRAINAGE**

Subsoil drainage shall be designed in accordance with both ARRB SP41 and Subsurface Drainage Report No. 35 or as directed by Council. Subsoil drainage shall be provided where indicated on the plan and at such other locations as may be considered necessary by Council's Engineer during construction. Type and diameter of pipe and location in all cases is to be approved by Council's Engineer prior to installation. Refer to Drawing No. SD17.

6.8.1 *General Requirements*

(a) Trench width to suit the size of pipe used - should be a minimum of 300mm wide, and 600mm deep below subgrade.

(b) (i) Pipe backfilled with filter sand. Sand and sock must conform to the R.T.A. Grading Specification for subsoil drains wrapped with approved sock.

Or (ii) Pipe placed in trench, with single sized min. 10mm blue metal surround and trench lined with geotextile fabric.

Pipe shall be as follows:

(a) Grades less than 1% - slotted U.P.V.C. or F.R.C.

(b) Grades 1% and greater - aggflow pipe.

Subsoil pipes shall be laid with a minimum grade of 0.5% and properly connected to main drainage pipes or pits.

6.8.2 Location

(a) Residential developments generally, under kerb and guttering, however, depending on the types of gravels used for pavement construction, the subsoil may have to be located in front of the kerb and guttering and carried through to the base course layer.

(b) (i) Rural developments, under kerb and guttering or concrete dish drain on the high side. Refer to Drawing No. SD16.

(ii) Where no concrete dish drain, place under shoulder 600mm from edge of bitumen

(iii) At edge of other strategic locations as may be deemed necessary due to site conditions.

Flushing points to be provided every 80 metres. An approved standard R.T.A. subsoil access lid is to be provided flush with the surface, cast into concrete dish drain or cast into a concrete surround in shoulder where no concrete is provided.

6.8.3 *Specific Requirements*

Due to prevailing conditions at the time of construction, variation of the foregoing requirements, type of pipe required, and depth of placement may be necessary, and therefore no subsoil drainage is to be laid until advice is received of specific requirements from Council's Engineer.

6.9 DRAINAGE EASEMENTS

Where drainage easements are required, a minimum width of easement will generally be as follows:

(a)	Interallotment drainage	-	1.5 metres
(b)	Pipes 375mm to 1200mm	-	3.0 metres
(c)	Pipes 1350mm to 2400mm	-	3.5metres

.500mm clearance to each side of pipes will be required for all easements.

6.9.1 *Drainage Calculations*

All calculations are to be based on the ultimate development of each catchment area and not necessarily the development of the area in existence at the time of development. All calculations are to be shown on the plan detailed in table form and set out in a concise manner indicating catchment areas contributing to each pit and drainage line.

6.9.2 *Types of Materials*

All concrete drainage pipes used in development construction shall be of spigot and socket type with flexible rubber ringed joints and this shall be clearly indicated on plans. The class of pipe used in relation to the available cover and ground conditions shall be in accordance with manufacturer's specifications.

6.10 MAJOR DRAINAGE SYSTEMS

The major system is to be designed for the 100 year average recurrence interval flow.

6.10.1 Drainage Reports

The following format is recommended for flood studies to be submitted to Council in conjunction with engineering plans:

(a) Introduction:-

(i) Catchment Description.
(ii) Aim of Flood Study.

(b) Hydrology:-

(i) Comments regarding analysis carried out.

(ii) Summary tables providing flow comparisons.

(c) Hydraulics:

(i) Details covering detention basin design.
(ii) Basin configuration, showing contours and drainage structures.
(iii) Tables showing stage/storage/discharge relationship.

(d) Conclusion:-

Appendices - providing summary of all computer runs.

6.10.2 *Low Hazard Areas*

In low hazard areas (for example roads, pathways, walking trails, recreational areas etc.) the system is to be designed:

(a) Such that the product of depth (m) and velocity (m/s) is to be 0.4 or less.
(b) Flows shall be contained within road reserve and pathways.
(c) Using a pit blockage factor of 50% for all pits.

6.10.3 *High Hazard Areas*

In high hazard areas (for example creeks, concrete channels, major drainage channels, areas where the velocity exceeds 2m/sec. etc.) the system is to be designed:

(a) Such that the product of depth (m) and velocity (m/s) is to be 1.0 or less.

(b) Including signposted with warning signs.

(c) To have adequate safety measures to reduce the risk of accidental entry, for example fencing, planting, moulding etc.

(d) To provide a free board of 200mm above the 1:100 year Average Recurrence Interval Storm, when the storm is contained wholly within a high hazard area.

6.10.4 *Temporary Open Catch Drains*

Are to be constructed as indicated on the plan or as considered necessary by Council's Engineer for protection of adjoining work or property during construction. Catch drains and table drains are to be constructed in accordance with standard practice and may require stone pitching or lining with filter fabric to prevent scouring where necessitated by grade or nature of soil.

6.10.5 *Permanent Open Catch Drains*

Shall be fully concrete lined and dimensioned according to the catchment area. Catch drain outlets may require a level spreader or provision of permanent scour protection, Details to be shown on engineering plans.

6.10.6 *Permanent Open Drains/Channels*

All permanent open drains/channels shall have a provision for low flows either by placement of a concrete dish or low flow pipe where practical.

The concrete dish or pipe is to be designed to carry 25% of the 1 year ARI storm.

Notwithstanding the above, where the flow velocity from the 5 year ARI storm exceeds 1 m/second, concreting of the channel base will be required to contain the 5 year ARI storm volume and control erosion.

Wherever possible, it will be sought to incorporate open channels in landscaping for aesthetic purposes and possibly to utilise modified batter as active open space and/or stormwater retention basins where appropriate.

6.10.7 *Concrete Table Drains*

Shall be installed in rural developments where the grade is 3% or greater, less than 1% and all table drains downstream of these gradients. This will also be dependent on the size of catchment and the type of soil present.

Sealing of road shoulder will be required adjacent to the concrete drain or similar structure.

6.11 **DRAINAGE INLETS/OUTLETS**

6.11.1 *Inlet/Outlet Protection*

Adequate provision is to be made for scour protection at all drainage inlets/outlets. Energy dissipaters shall also be provided where appropriate. All outlets shall be provided with silt control measures in accordance with Chapter 3.

6.11.2 *Headwalls*

Aprons and cut-off walls shall be constructed in accordance with the relevant R.T.A. specifications or as shown on the plan, with due attention to workmanship and reinforcement and general requirements for concrete. In addition, handrails or other safety devices may be required by Council's Engineer.

6.11.3 *Gabion & Reno Mattress Structures*

Gabion or reno mattress structures are to be provided where permanent scour protection is required. These structures are to be constructed in accordance with manufacturers specifications. All structures are to be placed on a layer of geotextile fabric. Structures are to be filled with basalt rock, not sandstone or conglomerate based rock.

6.12 OVERLAND FLOW PATHS

6.12.1 *Concrete Pathway*

Where the concrete pathway is to act as an overland flow path, Council standard kerbed pathway is to be provided. Details of waterway calculations are to be provided to ensure that the 100 year event is contained within the pathway reserve.

6.13 TRUNK DRAINAGE

Trunk drainage systems shall be designed as "soft" systems, i.e. grass lined channels with low flow pipelines or concrete lined inverts. Design criteria shall be:

6.13.1 *Hydraulic Design*

Open channels shall be designed using an appropriate analysis, e.g. backwater or unsteady flow.

6.13.2 *Low Flow Pipelines/Lined Inverts*

Low flow pipelines are to be a minimum size of 375mm diameter or as determined by Council's Engineer, sized using a flow of 3 litres/sec/hectare for residential land uses and 10 litres/sec/hectare for industrial land uses. Low flow pipeline ring jointed with no lifting holes. Lined low flow inverts (minimum width to be 2.0 metres) shall accommodate flows equivalent to those of the low flow pipelines.

6.13.3 *Flow Velocities*

Maximum flow velocities in grass-lined channels shall be 1.5m/sec. Grass lined channels are to be designed to operate in a sub-critical flow state. This may mean that measures have to be installed so that the grassed channel cannot operate at critical or super critical flow states.

6.13.4 *Batter Slopes*

Batter slopes of grassed waterways shall be a maximum of 1 (vertical) : 6 (horizontal).

6.13.5 *Pipe Inlets*

Must be designed using 50% blockage factor for the 1:100 year Average Recurrence interval flow. All iniets are to incorporate trash racks where the clear spacing is to be 150mm and the clear surface area to be a minimum of twice the pipe cross-sectional area.

6.14 DETENTION BASINS

6.14.1 *Hydraulic Analysis*

Detention basins are to be designed so as not to increase the limits of upstream and downstream flooding for all floods over the range of 1:1 to 1:100 year Average Recurrence Interval storms.

6.14.2 *Water Levels & Freeboard*

The basin embankment is to be 500mm above the 100 year Average Recurrence Interval flood level.

6.14.3 *Spillways*

The spillway shall be designed to pass the Probable Maximum Flood without life threatening failure of the embankment.

Special consideration shall be given to erosion protection on the spillways and the techniques proposed shall require the approval of Council's Engineer prior to their final design.

6.14.4 *Batters*

Grassed internal batters shall be no steeper than 1 in 6. Grassed external batters shall be no steeper than 1 in 4. The minimum slope of the basin floor shall be 1%.

6.14.5 *Basin Safety*

The maximum depth of a detention basin for the 1:100 year Average Recurrence Interval flood should be 1.2 metres. For greater than 1.2 metres depths or ponding times in excess of 2 hours, the detention basin will be required to incorporate safety measures to prevent accidental entry.

Outlets must have debris and scour control, along with safety fence where applicable.

6.14.6 *Basin Embankment*

A typical section through the embankment wall is to be shown on engineering plans, indicating a clay core or cut off wall.

Filling is to be carried out in accordance with "Australian Standard 3798-1990 - Guidelines on Earthworks for Commercial and Residential Development, Level 1.

6.15 COMPUTER APPLICATION

The following programmes are acceptable. Other programmes which conform to "Australian Rainfall and Runoff, 1987" are also acceptable.

6.15.1 *llsax*

Urban Drainage Catchment Model

(a) Parameters suggested in area:

Soil Type	3
Antecedent Moisture Content	3.5
Grassed Depression Storage	5mm
Paved Depression Storage	1mm

6.15.2 *RORB*

(a) Calibration - The model should be calibrated using the "Kch factor (M=0.8) against a discharge calculated in accordance with Chapter 5, Australian Rainfall and Runoff, 1987, unless gauged stream flows are available.

(b) Runoff Coefficient - For rural catchments in the Cessnock City area C10 = 0.45.

(c) Loss Models - The loss model chosen during the analysis is to remain the same for the design. For 100 year Average Recurrence Interval storm, assume:

* Infiltration and storage losses =0mm
* continuing loss = 2.5mm/hr.

(d) Fractions impervious -

* Residential Development = 0.45

* Medium Density Development = 0.65

* Pavement areas such as roads, industrial & commercial sites = 0.85
* Parkland areas are impervious.

(e) Design & Analysis - Plan showing Rorb Nodal Layout and diskette copy of the RORB data file to be submitted to Council.

Sub-catchments not to be greater than 25% of total catchment.

The total catchment is recommended to be greater than 5km2 with well defined water courses.

6.15.3 *Kinematic Catchment Model*

Programme using suggested parameter values in User Manual.

6.15.4 *HEC2*

Programme to determine water surface profiles. To be used in open channel design to calculate water levels.

6.16 INTER LOT DRAINAGE

6.16.1 *Location*

Inter lot drainage shall be constructed as shown on approved plans. All pipes shall be laid centrally within designated easements in cases where sewer lines are located adjacent to boundaries, inter lot drainage must be situated between boundary and sewer line. Interallotment drainage easements shall be a minimum width of 1.5 metres.

6.16.2 *Discharge of Stormwater from Existing Lots*

In the event of existing lots discharging stormwater runoff onto the proposed development, an inter lot drainage system shall be provided to alleviate this runoff.

The development shall provide either:

(a) An inter lot drainage system within the existing properties and inlet pits for each lot. This will necessitate the creation of a drainage easement through the existing lots, at full cost to the developer, or

(b) An inter lot drainage system within the proposed development and provision of pipe stubs into each adjoining lot.

6.16.3 *Type of Pipe*

All pipes shall be of U.P.V.C. (drainage pipe) or F.R.C. or R.C. of approved manufacture. Other types will be permitted only if specifically approved on engineering plans.

6.16.4 *Size of Pipe*

Pipe size shall be determined by drainage requirements. Minimum size pipe permitted is 150mm diameter and maximum of 300mm. If hydraulic assessment indicates pipe sizes in excess of 300mm are necessary, then those flows shall be dealt with in a public drainage easement.

6.16.5 *Collection Points for Roof Water & Yard Water*

Provision shall be made for collection of both roof and yard water at the low side of each lot.

Stormwater collection points shall be:

(a) Cast insitu or precast surface inlet pit, minimum 450x450m.

Inspection pits shall be provided at:

(a) Change of pipe grade, size or direction, and be a minimum size of 600x600mm precast or cast in situ.

Pits shall be covered by an approved grate to provide an adequate surface water inlet. Pit surrounds shall be turfed to a minimum width of 900mm to provide adequate scour protection.

Roof water connections shall be provided by setting a spigot of 150mm diameter pipe with screwed end cap into the side of the pit. All pits are to be streamlined.

6.16.6 *Depth of Pipes*

Pipes shall be laid with a minimum cover of 300mm.

6.16.7 *Bedding & Backfilling of Pipes*

Pipes shall be bedded on sand and backfilled with fine granular material, refer to Chapter 7 "Drainage Construction". In steep terrain, bulkheads are to be provided generally in accordance with standard practice for sewer mains.

6.16.8 *Pipe Diameters*

The following may be taken as a guide, however pipe sizing will be dependent upon catchment analysis:

Pipe diameters	One House	-	Only 0.15m diameter
	2-6 Houses	-	0.23m diameter
	7-13 Houses	-	0.30m diameter