



**CITY OF
PARRAMATTA**

Development Engineering Design Guidelines

June 2018

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Section 1: Drainage

1.0 Introduction

This guideline is intended to set out Council's requirements for the design of stormwater drainage and other engineering elements associated with development. It is not intended to be a comprehensive design manual nor a stand-alone document but rather to be read in conjunction with relevant instruments, policies, codes, industry guidelines and standards including:

- a) Parramatta Local Environment Plan 2011,
- b) Parramatta Development Control Plan 2011,
- c) Auburn Local Environmental Plan 2010
- d) The Hills Local Environmental Plan 2012
- e) Holroyd Local Environmental Plan 2013
- f) Hornsby Local Environmental Plan 2013
- g) Auburn Development Control Plan 2010
- h) The Hills Development Control Plan 2012
- i) Holroyd Development Control Plan 2013
- j) Hornsby Development Control Plan 2013
- k) Carter Street Precinct Development Control Plan 2016
- l) Homebush Bay West Development Control Plan 2004 (Volume 1)
- m) Homebush Bay West Public Domain Manual 2005 (Volume 2)
- n) Homebush Bay West Development Control Plan (Amendment No. 1) 2013
- o) Wentworth Point Precinct Development Control Plan 2014 State and Regional Environmental Planning Policies and Acts,
- p) Stormwater Disposal Policy,
- q) Local Floodplain Risk Management Policy,
- r) NSW Government Floodplain Development Manual,
- s) Australian Rainfall and Runoff,
- t) Upper Parramatta River Catchment Trust (UPRCT) On-site Stormwater Detention (OSD) Handbook (3rd and 4th editions),
- u) Water Sensitive Urban Design Technical Guidelines for Western Sydney,
- v) Draft NSW Music Modelling Guidelines,
- w) Australian Runoff Quality,
- x) Australian Standard AS 3500.3 - National Plumbing & Drainage Code
- y) Soil and Water Management for Urban Development - NSW Department of Housing
- z) Building Code of Australia,
- aa) National Construction Code,
- bb) BASIX Guidelines,
- cc) Parramatta City Assets Construction Guidelines/Standard Drawings.

It is anticipated that adherence to this guideline will expedite the approval process however it should be noted that the design guidelines do not limit Council's right to vary any necessary engineering requirements in accordance with industry best practices.

These design guidelines and Council's Stormwater Disposal Policy prevail over any other design guidelines in former Council areas to the extent of any inconsistency. Applicants are advised to contact Council's Development Engineers to discuss their proposal where an inconsistency may arise.

1.1 Available Council Information

To assist in the design process, the following information is available and can be obtained from Council and other sources.

1.1.1 Flooding

Site specific flood information and levels can be obtained by submitting a flood enquiry application via the Online Services portal on Council's website. (A fee is payable for this service)

1.1.2 Piped Stormwater Drainage Network

Preliminary information relating to Council's piped stormwater drainage network can be viewed at Council's Customer Service Centre. Supplementary information, relating to sizes and approximate locations, can be obtained from Council's Civil Infrastructure Unit on 9806 8250. A fee may be payable for this service. Any information issued by Council is indicative only. Prior to preparing stormwater drainage plans for your development, the applicant shall physically locate all Council assets to ensure that there will be no conflict with their proposal. Council accepts no liability where the applicant has failed to carry out due diligence.

1.1.3 Contour Maps

Contour maps can be obtained from Council's Civil Infrastructure Unit on 9806 8250. A fee may be payable for this service.

1.1.4 Utilities

Dial Before You Dig (DBYD) is a free national referral service designed to prevent damage and disruption to the vast pipe and cable networks which provides Australia with essential services. DBYD can be contacted via their website at www.1100.com.au or phoning the national call centre on 1100.

1.1.5 Title Searches

To determine whether a site is affected or benefitted by an easement, a title search needs to be carried out. Council cannot advise you whether your land is affected or benefitted by an easement. This can be performed via the NSW Land Registry Services website (www.nswlrs.com.au) or by a consultant such as a Registered Surveyor or a solicitor specialising in property law who can then also interpret the information for you.

1.2 Consultants

The selection of qualified and experienced consultants with an understanding of Council's requirements and relevant guidelines and standards can expedite the approval of developments submitted to Council. Experienced consultants are also more likely to provide a more amenable and cost effective design.

The design and certification of stormwater drainage and On Site Detention (OSD) systems in the City of Parramatta will only be accepted from persons having suitable professional accreditation. The following are considered to be acceptable accreditation for the purpose of stormwater drainage and OSD design and certification:

- a) A Professional Engineer registered with the National Engineering Register (NER) in Civil Engineering;
- b) A holder of Surveyors Certificate of Accreditation in On-Site Detention and Drainage Design (Institution of Surveyors, NSW and the Association of Consulting Surveyors, NSW);

- c) A member of Stormwater Register (Association of Hydraulic Services Consultants, Australia); and
- d) A Certifier accredited by the Building Professionals Board (under the Environmental Planning and Assessment Act 1979) in any of the following categories: B1, C1, C2, C3, C4, C5, C6, C7, C12, C15.

The designer shall identify their professional accreditation on any plans, certificates, documents or reports submitted to Council in relation to stormwater drainage and OSD systems.

The designing engineer must complete and confirm that the Stormwater and Engineering checklist submitted with a development (DA), s4.55 or s8.3 applications is accurate and is consistent with Council's controls and policies.

2.0 General Requirements

All developments are required to demonstrate that stormwater runoff from the site is collected and conveyed to a legal point of discharge without adversely impacting adjoining or downstream properties in accordance with these guidelines.

2.1 Drainage Design Submission

A stormwater drainage plan must be prepared (and submitted with the application) to demonstrate that stormwater runoff from the site is collected and conveyed to a legal point of discharge without adversely impacting adjoining or downstream properties. The plan shall include the following information as appropriate to each development:

- a) Details of the stormwater drainage system including:
 - i. Roof drainage system, i.e. roof fall, gutters, downpipes,
 - ii. Surface drainage system, i.e. pits, grates, pipes,
- b) Details of an on-site detention (OSD) system (if required by these guidelines),
 - i. Including an assessment of any overland flows from the local upstream catchment,
- c) Details of any flood affectation by mainstream flooding or overland flow,
- d) Erosion and sediment control (refer relevant section of these guidelines)

2.2 Major/Minor System Design

All systems shall be designed with consideration to the major/minor system design principle in Australian Rainfall & Runoff allowing for overflows of the piped system and flows in excess of the piped system capacity to be discharged in a controlled manner in the same direction as the pipe to a legal point of discharge.

2.3 Impact on adjoining properties

All developments are to consider the potential for adverse effects on stormwater drainage on adjoining properties. Developments that have an adverse impact on adjoining/surrounding properties in relation to the following issues will not be approved:

- a) Changes in site levels that impede, divert or concentrate natural surface flows from upstream properties,
- b) Diversion of flows between drainage catchments,
- c) Concentration of surface or piped flows onto an adjoining property/s without an appropriate easement.

Please Note: A person has a common-law obligation not to carry out any work on their property that will adversely affect adjoining properties.

2.4 Erosion and Sediment Control

All developments, where the site is to be disturbed, shall include details of Erosion and Sedimentation Control measures designed in accordance with the Soil and Water Management for Urban Development – NSW Department of Housing.

3.0 Drainage Options

All developments are required to drain via a gravity fed drainage system. Concessions can only be made for existing dwellings in the case of rebuilding or minor additions and alterations where no OSD is required.

3.1 Connection to Council's Kerb and Gutter

For developments discharging up to 30l/s, discharge via a kerb outlet will be permitted. The pipe crossing the footway shall be a 200mm (w) x 100mm (h) hot dipped galvanised rectangular hollow section (RHS). The kerb connection shall be reinstated in accordance with City of Parramatta's Standard Drawing No. DS2 issued with the road opening permit (ROP).

3.2 Connection to Council's Underground Piped Drainage Network (incl. pits and pipes)

Where the total discharge from any development exceeds 30l/s, discharge from the site shall be connected to Council's underground piped drainage network. Where no Council pipe exists in the immediate vicinity, disposal will require a suitable designed and constructed pipeline to the nearest available Council drainage system (generally not exceeding 15m).

Where stormwater disposal can be facilitated by direct connection to Council's underground piped drainage system, connection to the system will be permitted in the following forms:

- a) connection to an existing pit,
- b) construction of a new pit to Council's specification, or,
- c) direct connection to a pipe with an approved connection method or device.

Stormwater discharge in this manner is to be consistent with the fall of the land to ensure that there is no catchment redirection or likelihood of street water surcharging within private property.

Please note: A separate approval from Council's Civil Infrastructure Unit is required prior to the issue of any construction certificate. A bond may also be payable to ensure that the works are carried out in a satisfactory manner and inspected by Council's Inspectors.

3.3 Outlets to Watercourses

When discharge to a suitable natural waterway or creek is allowed by Council, the waterway is to be protected against erosion at the point of discharge with the provision of an outfall apron and energy dissipation structure. Stabilising a small length of the waterway in vicinity of the outlet is not acceptable.

Council reserves the right to insist on connection to existing outlets only.

Additional outlets will be considered on a merit basis and only a single discharge point per development will be considered.

Guidance on the design of outlets to watercourses can be obtained from:

NSW Office of Water Guidelines for Outlets to Natural Watercourses,
'Rock Sizing for Single Pipe Outlets' practice note produced by Catchments & Creeks P/L,
Queensland Urban Drainage Manual

Note: Any proposal to connect to a watercourse or creek must be discussed with Council at a pre-lodgement meeting before a Development Application is lodged.

3.4 Charged lines (Single dwellings only)

Discharge via charged lines will only be permitted for single dwellings on existing lots which fall away from the street. Charged lines must be designed in accordance with the following criteria:

- a) A longitudinal section of the charged line is to be included in the plans,
- b) Where a minimum 1.6 hydraulic head is not provided, hydraulic grade line (HGL) calculations are required to demonstrate that there is sufficient head to drive the system,
- c) Roof gutters, downpipes and pipelines shall be sized for the 100-year ARI (1% AEP) design storm.
- d) Downpipes are to be made watertight up to the connection with the gutter and painted, in a colour to compliment the development and to protect them against ultra-violet light damage from the sun.
- e) Sealed cleaning eyes must be placed at 20-meter intervals, at critical bends in the pipeline and at the lowest point in the drainage system.
- f) A dribble pit incorporating a pipe with a screw cap on the end and a hole in the cap, shall be provided at lowest point in the charged system. The base of the pit shall have weep holes which drain into an aggregate bed underneath the pit. The location of the dribble pit is to be shown on the engineering plans.
- g) No surface inlet pits or driveways can be connected to the charged line.

3.5 Absorption Trenches (Single dwellings only)

Where a charged line cannot be achieved or for minor paved surface areas, the use of absorption trenches will be permitted provided that they are designed & sized in accordance with the following criteria:

- a) The size of the absorption trench shall be sized at the rate of 2.5m³ per 100m² of impervious area draining into it,
- b) Designed to allow full infiltration into the aggregate layer beneath,
- c) A silt arrestor and trash screen must be placed in the drainage system immediately upstream of the absorption trench,
- d) The absorption trench shall be located parallel to the proposed or existing site contours,
- e) The absorption trench shall be located a minimum of 5.0m from any property boundary, dwelling, garage or structure to limit the effects of soil heave in clay type soils as a result of the constant wetting and drying cycles. A reduced setback will only be considered when a supporting geotechnical report has been provided.
- f) It must be demonstrated that ground/soil conditions are appropriate for absorption trenches. If not, an easement over a downstream property/s may be required.

3.6 Pump Out Systems (basement garages only)

Pump out systems can only be considered as a method of stormwater discharge for draining driveways and basement car parks and garages. Pump out systems shall be designed in accordance with the requirements of Section 9 of AS3500.3 and include:

- a) A holding tank shall be constructed capable of storing runoff generated from a 100 year ARI storm event of 2 hour duration.
- b) Two pumps, connected in parallel, with each pump being capable of emptying the holding tank at a rate equal to the lower of permissible site discharge rate, or rate of inflow from a 100 year ARI storm event of 2 hour duration.
- c) Pump out systems are to be connected to the internal site stormwater drainage system prior to discharge from the site.

Please note: Where a Pump out system is proposed, the proponent shall be required to submit written evidence that a contract has been let for regular monitoring & maintenance of the pump system prior to the issue of occupation certificate.

The proponent shall indemnify Council from all claims for damages arising from the failure of the pump system.

Please note: Pump out systems cannot be used to drain on site detention systems.

3.7 Drainage under Roads Maritime Services and Sydney Water Control

Where it is proposed to connect a drainage outlet to the street drainage system or into tidal reaches of Parramatta River (i.e. east of Charles Street Weir) under RMS control or to a Sydney Water Channel, the proponent shall be required to seek written concurrence from the relevant authorities prior to lodging the DA.

4.0 Low Level Properties

Development on sites that fall away from the street are required to drain via an easement over a downstream property or properties to a legal point of discharge.

Filling of sites to achieve gravity drainage, significant extensions of Council's drainage system (greater than 15m) or the use of pump systems for disposal of stormwater are not permitted.

4.1 Development on Low Level Properties or Flat sites which require OSD

Sites that fall away from the street, or are flat, are required to drain via an easement over a downstream property or properties to a legal point of discharge. Filling of sites to achieve gravity drainage, significant extensions of Council's drainage system (greater than 15m) or the use of pump systems for disposal of stormwater are not permitted.

Note: On site detention tanks are required for residential development. Refer to Council's Stormwater Disposal Policy

4.2 Private Drainage Easement

Where the development site falls away from the street and no Council pipe exists within the property, an easement to drain over downstream properties will be required to drain the development.

The easement shall be located on the lowest side of the site.

The system shall be designed to sufficiently convey all runoff from the development site and when draining developments with OSD shall be designed to cater for emergency overflows of the OSD system in all storms up to and including the 100 year ARI storm event.

Where the system is proposed through multiple properties, the system shall be designed to cater for any additional flows which can be directed into the system from those sites.

Pits shall be located at the downstream end of the drainage system within the development site and at the downstream end of the system within each downstream property.

Where it is proposed to connect into an existing easement, calculations to demonstrate that there is sufficient capacity to cater for the development site in addition to any existing flows is required.

The consent of downstream property owner/s agreeing to the easement/s must be obtained prior to lodgement of a Development Application (incl. s4.55 and s8.3 applications).

Details of the proposed easement and drainage works must be shown on the stormwater drainage plans.

A proposed easement must be clear of any structures (e.g. buildings, retaining walls, eaves, gutters etc.) and trees. Where encroachment into tree root protection zones may exist the applicant shall provide technical construction details on how a pipe/s can be laid within the easement.

Please Note: Full operational consent will not be granted until documentary evidence is submitted to Council confirming that the easement has been registered with NSW Land Registry Services.

4.3 Through Council Owned Land

Where a low-level property adjoins a public reserve, construction of a drainage line through the reserve will generally not be permitted unless all other possible avenues have been exhausted including easements through private properties.

Council cannot grant private drainage easements over land classified as community land, which can include parks, creeks and reserves.

Where determined by Council's Development Engineer that drainage through Council owned land is the only option to facilitate disposal of stormwater runoff from properties that slope towards these areas and have no other means of drainage, written approval from Council's Open Space and Civil Infrastructure Units shall be provided with the lodged DA plans.

Please note: There may be circumstances where development for a dual occupancy or multi-unit development is not possible due to the inability to accommodate a drainage easement.

If you are proposing development on a flat or low level site for the purposes of a dual occupancy or multi-unit development you need to discuss your proposal at a pre-lodgement meeting with Council.

4.4 Designing for Easements

Easements shall be free of any building encroachments, including eave overhangs and footings. Full details of any proposed piped system within an easement is to be submitted for Council approval at DA stage. No work is to be carried out in the easement until it has been registered with NSW Land Registry Services and the downstream property owner's permission and a relevant construction certificate has been obtained. All works in relation to easements are to be at no cost to Council.

4.5 Standard Easement Widths

The following standard easement widths shall be adopted for private systems:

Pipe Diameter (mm)	Width of Easement to Drain Water (m)
150, 225	1
300	1.5
375, 450	2
525, 600, 675	2.5
750, 825, 900	3
1050, 1200	3.5
1350, 1500	4
1650, 1800	4.5
>1800 and box culverts	As required by Council
Flowpath/floodway	Full width of nominated flowpath/floodway plus 0.2m

Where a Council pipe traverses private property and no easement exists, development of the site will require an easement to be created with the following minimum widths:

Pipe Diameter (mm)	Width of Easement to Drain Water (m)
375, 450, 525, 600, 675, 750, 825, 900	3
1050, 1200	3.5
1350, 1500	4
1650, 1800	4.5
>1800 and box culverts	As required by Council
Flowpath/floodway	Full width of nominated flowpath/floodway plus 0.2m

The above tables are only an indication of easement widths for shallow pipe systems. Larger easements may be required for pipe with excessive cover or where multiple pipes are proposed.

Consideration may be given to the minor reduction of the required easement widths (for sections where the full width of the easement cannot be achieved) where it is demonstrated that the full easement width cannot be obtained and the proposed pipe can reasonably and economically be installed, maintained and replaced satisfactorily.

4.6 Building Adjacent to Drainage Easements

No buildings or structures will be permitted over drainage easements. Buildings adjacent to drainage easements shall be designed with footings located entirely outside of the easement and designed in accordance with the following requirements. These requirements should also be applied to structures adjacent to natural watercourses and Council pipelines not covered by easements.

4.6.1 Easement Containing Existing Pipeline

Where it is proposed to build adjacent to a piped Council stormwater drainage easement, the invert level of the pipeline must be established either by checking levels at adjacent drainage pits or excavation of the pipeline under Council's supervision.

4.6.2 Easement where no pipelines exist

Where the easement is not piped, a future invert level should be established in consultation with Council's Civil Infrastructure Unit, based on the existing pipe outlets and inlets in the vicinity.

Having established the existing or future invert levels of the stormwater drainage line, cross-section profiles are to be established, as required, at critical points where footings are likely to exert earth pressures on the pipeline when laid.

4.6.3 Design Procedure

- a) The soil type should be confirmed so the zone of influence can be determined. Where there is any doubt, Council concurrence of soil type should be sought.
- b) Depending on the soil type at each cross-section, a line indicating the zone of influence is drawn, at either 1(v):1(h) slope 1(v):2(h) slope, from the easement boundary at the invert level of the pipeline, as indicated in Figures 2 and 3.
- c) Where a footing is to be located within the zone of influence, it shall be pierced to a depth below the zone as indicated in Figures 2 and 3.
- d) No footing, structure or part thereof, including eaves, is to be located within the easement.
- e) Following design of footings, cross sections are to be shown at critical locations showing the piers and or strip footing relative to existing on proposed stormwater pipelines and the easement boundary.
- f) The calculated pier depths in accordance with this requirement, are the minimum requirements only to protect Council's pipes. It is the applicant's responsibility to engage a suitably qualified structural engineer to carry out detailed investigation to ensure that the footings and/or piers are structurally adequate for the particular site conditions and the nature of the development.

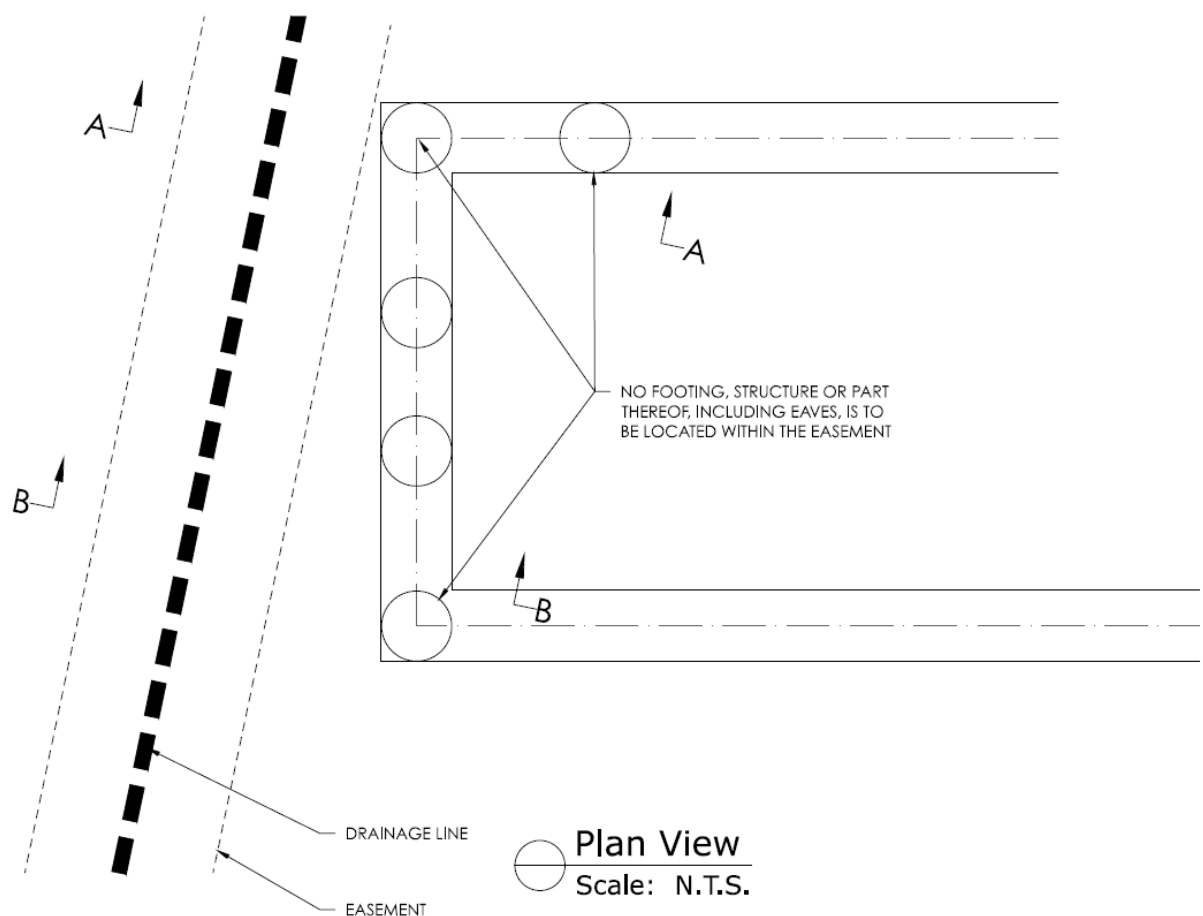


Figure 1 - Plan location of footings and piers adjacent to a drainage easement

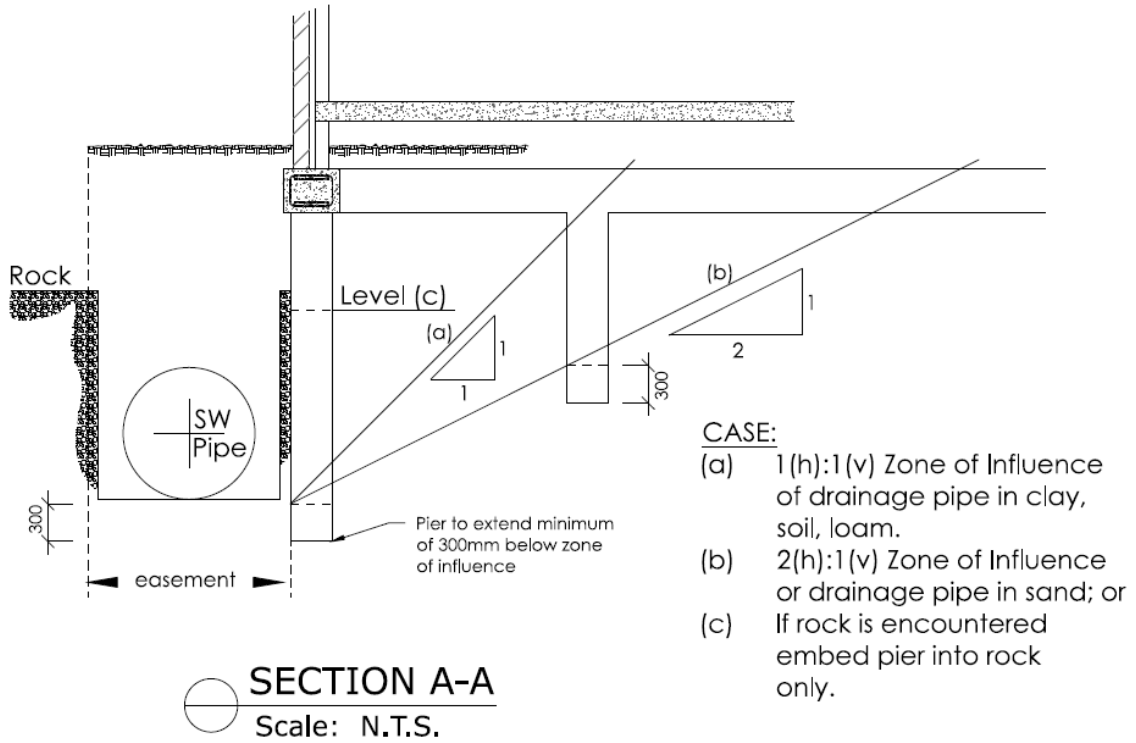


Figure 2 - Zone of influence directly adjacent to a drainage easement

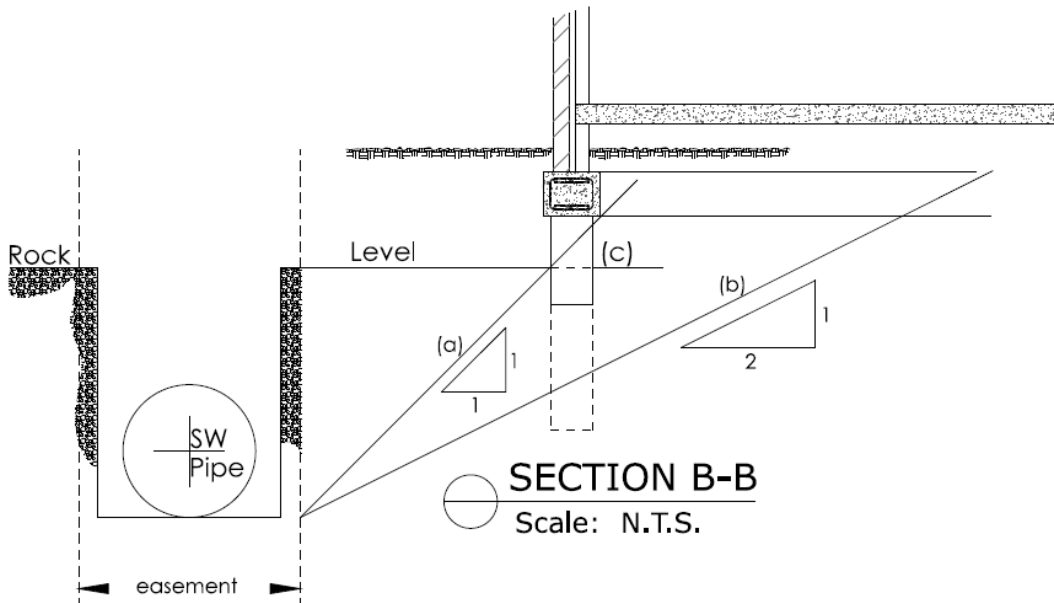


Figure 3 - Zone of influence adjacent to a drainage easement

5.0 Stormwater Drainage Design Standards

5.1 Average Recurrence Intervals

The following average recurrence intervals (ARI) shall be used for stormwater drainage design relating to development:

Component	Design ARI (Years)
Surface/piped drainage	5
Surface/piped drainage – critical facilities	100
Eaves gutters/downpipes	20
Eaves gutters/downpipes – charged line drainage systems or in association with an OSD system	100
Box gutters	100
Overland flow path	100
Outlet to natural watercourse	20
Inter-allotment drainage (where a flowpath for flow in excess of the pipe capacity has been provided)	20
Inter-allotment drainage (pipe only)	100
Street drainage	20

Longer recurrence interval design storms may need to be used in instances where the level of danger to persons or risk of significant property damage warrants such an approach.

5.2 Internal Stormwater Drainage Pipes

Pipe sizes shall be sufficient to cater for the run-off capacity of the attached system. Stormwater pipes shall be designed in accordance with the requirements of AS/NZS 3500.3. The minimum diameter of any pipe used for stormwater drainage shall be 100mm and comply with the following minimum longitudinal grades shall be used as per Section 7 of AS/NZS 3500.3.

Pipe Diameter (mm)	Minimum Gradient (% fall)
100	1.00
150	1.00
225	0.50
300	0.40
375	0.33

5.3 Internal Stormwater Drainage Pits

Stormwater pits or cleaning eyes shall be provided at the following locations where appropriate to provide access and maintenance functions:

- a) At all junctions, changes of gradient, changes in diameter and changes in direction of site stormwater drains;
- b) Inspection openings within buildings;
- c) Reflux valves;
- d) Flap valves fitted at the downstream ends of subsoil drains; and
- e) At a maximum spacing of 30m for cleaning access

Inlet pits are to be designed in accordance with AS/NZS 3500.3 and be installed in locations such that:

- a) All run-off from roofed and paved areas is collected;
- b) Run-off does not enter garages or buildings;
- c) Long term ponding of stormwater does not occur;
- d) Pedestrian access is not affected by depths of flow; and
- e) Flows over the public footway are minimised

The following minimum internal pit dimensions shall be incorporated as per Section 7 of AS/NZS 3500.3.

Depth to invert of outlet (mm)		Minimum internal dimensions (mm)	
		Width	Length
	≤600	450	450
>600	≤900	600	600
>900	≤1200	600	900
>1200		900	900

5.4 Hydraulic Grade Line

Where required, hydraulic grade line calculations shall be carried out in accordance with Australian Rainfall & Runoff (AR&R) procedures. Calculations shall include losses due to friction, obstructions, bends, junctions and pressure changes; design flow and tail water influences on the system.

Pipe losses can be estimated using the Darcy Weisbach equation with friction and K factors based on manufacturer design guides from:

- a) Vinidex (PVC)
- b) Iplex (PVC)
- c) James Hardie (FRC)
- d) Humes (RCP)
- e) Rocla (RCP)

Pit losses can be estimated using factors obtained from Missouri or Hare charts.

5.5 Tailwater

Where the effect of any downstream controls is to be considered, the following levels are to be used as a starting point for back calculations

Condition	Level
Free outfall	Pipe invert
Discharge to kerb & gutter or existing pipe	Top of kerb or relevant flood level (whichever is higher)
Discharge to receiving waters	Flood level of creek during pipe design ARI event

5.6 Sub-soil Drainage

Sub-soil drainage systems are to be designed and constructed as per Section 6 of AS3500.3. Subsoil drains shall be connected to the site drainage system and disposed of in a manner that will not have any adverse impact on adjacent properties.

5.7 Rainwater Tanks

Rainwater tanks shall be provided to developments in accordance with the requirements of BASIX and Section 3.3.6 of the Parramatta DCP.

Where rainwater tanks are required, they shall comply with the following:

- a) Tanks must not collect water from a source other than roofs on a building or a water supply service pipe.
- b) Tanks must be fitted with a first-flush device, being a device that causes the initial run-off of any rain to bypass the tank to reduce pollutants entering the tank,
- c) Tanks must be structurally sound and prefabricated, or be constructed from prefabricated elements that were designed and manufactured for the purpose of a rainwater tank,
- d) Tanks must be assembled and installed in accordance with the instructions of the manufacturer or designer of the tank,
- e) Any plumbing and installation works, which might affect a water service pipe or water/sewer main, require approval from Sydney Water,
- f) No part of the tank or any stand for the tank is to rest on a footing of any building or other structure, including a retaining wall,
- g) Tanks must be located at least 500mm away from any property boundary and must not exceed 2 metres in height above ground level.
- h) A sign must be affixed to tanks clearly stating that the water in the tanks is not for human consumption.
- i) Tanks must be enclosed, and any inlet to the tank must be screened or filtered, to prevent the entry of foreign debris or vermin,
- j) Tanks must be maintained at all times so as not to cause a nuisance with respect to mosquito breeding or uncontrolled overflows.
- k) The overflow from the tank must be piped to the site stormwater drainage system.
- l) Any motorised or electric pump attached to the tank must not generate offensive noise above existing background dBA levels and should be encased in sound insulation material. The electrical fittings must be installed by a licensed electrician.
- m) The tanks must be constructed of non-reflective materials and of a colour compatible with the development.

6.0 Water Sensitive Urban Design

For WSUD requirements refer to the relevant chapters in the applicable Development Control Plans for each of the former Local Council areas.

Section 2: On-Site Detention (OSD)

Objectives

- a) Prevent any increase in downstream peak flows resulting from new developments or redevelopments by temporarily storing on-site the additional and quicker runoff generated,
- b) Prevent increases in downstream flooding and drainage problems that could:
 - i. increase flood losses
 - ii. damage public assets
 - iii. reduce property values
 - iv. require additional expenditure on flood mitigation
- c) Encourage integration of OSD systems into architectural and landscape design and layout of the development so that adequate storage areas are included in the initial stages of the site design.
- d) Require construction supervision of OSD systems by the OSD designer to improve construction standards.

1.0 On Site Detention

1.1 Applications

OSD requirements apply to certain types of developments and re-development as defined below:

- a) Single dwelling or Proposed extension/addition to an existing dwelling within a “Grey” or “Grey Hatched” area as noted in the Section 10.7 Planning Certificate or as per City of Parramatta Council map (Plan No 13717 B) where the proposed development increases the impervious area greater than 150m²
- b) Single dwelling on lot created as a result of a subdivision approval after 1991.
- c) Dual occupancies, duplexes, townhouses, villas, and residential flat buildings.
- d) Commercial & industrial developments, and public buildings
- e) tennis court, car park, paths and other sealed areas of public sport and recreation facilities

In addition, Council will not accept:

- a) Off-site detention contributions in lieu of on-site detention storage.
- b) On site detention systems within areas affected by 100 year ARI mainstream flood events, subject to demonstration by an applicant that OSD would adversely impact the catchment or have no hydrological benefit.

1.2 Exclusions

- a) Single dwellings, extensions, additions and improvements on single residential lots created before November 1991 except where OSD is required as a restriction on the property title or in the case of local drainage problems in the City of Parramatta as noted in Section 1.1;
- b) The residual lot containing an existing dwelling that is excised as part of a subdivision of a lot created prior to 1991, provided that flows from the excised portion are directed away from the OSD system; (**Note:** OSD is required only for the new lots created.) Subsequent single residential building/additions on the residual lot will also not be required to provide OSD;
- c) The residual lot containing an existing industrial or commercial development which is excised as part of a subdivision of a lot created prior to 1991, provided that there is no significant development proposed on the residual lot and that flows from the residual lot are directed away from the OSD system; (**Note:** OSD is required for the new lots created.);
- d) Boundary adjustments and consolidations of allotments where no additional lots are created;
- e) One-off minor developments, minor additions and repairs where the proposed development area is less than 150m² (subsequent minor developments or additions shall require OSD). This exclusion is aimed principally at small areas within large commercial or industrial sites. It does not apply to any developments where the development area includes more than 150m² of impervious surfaces nor to dual occupancies;
- f) Change of use where no physical changes to the outside of the property are proposed;
- g) Areas within large properties (usually commercial or industrial but may be residential) not covered by the development application or construction certificate;
- h) New developments in subdivisions where OSD has already been provided for the entire subdivision;
- i) Developments in Zones 6 & 8 of the former Auburn Council area.

2.0 Permissible Site Discharge and Site Storage Requirements

Where OSD is required in areas formerly located in the Parramatta City Council area, the OSD system must be designed in accordance with either the 3^d or 4th edition of the Upper Parramatta River Catchment Trust (UPRCT) OSD Handbook.

The former Parramatta City Council Local Government Area is divided into 10 separate catchments. Each catchment utilises different parameters as specified in Table 1 below. It is recommended that the catchment and parameters are confirmed with Council before proceeding with detailed design.

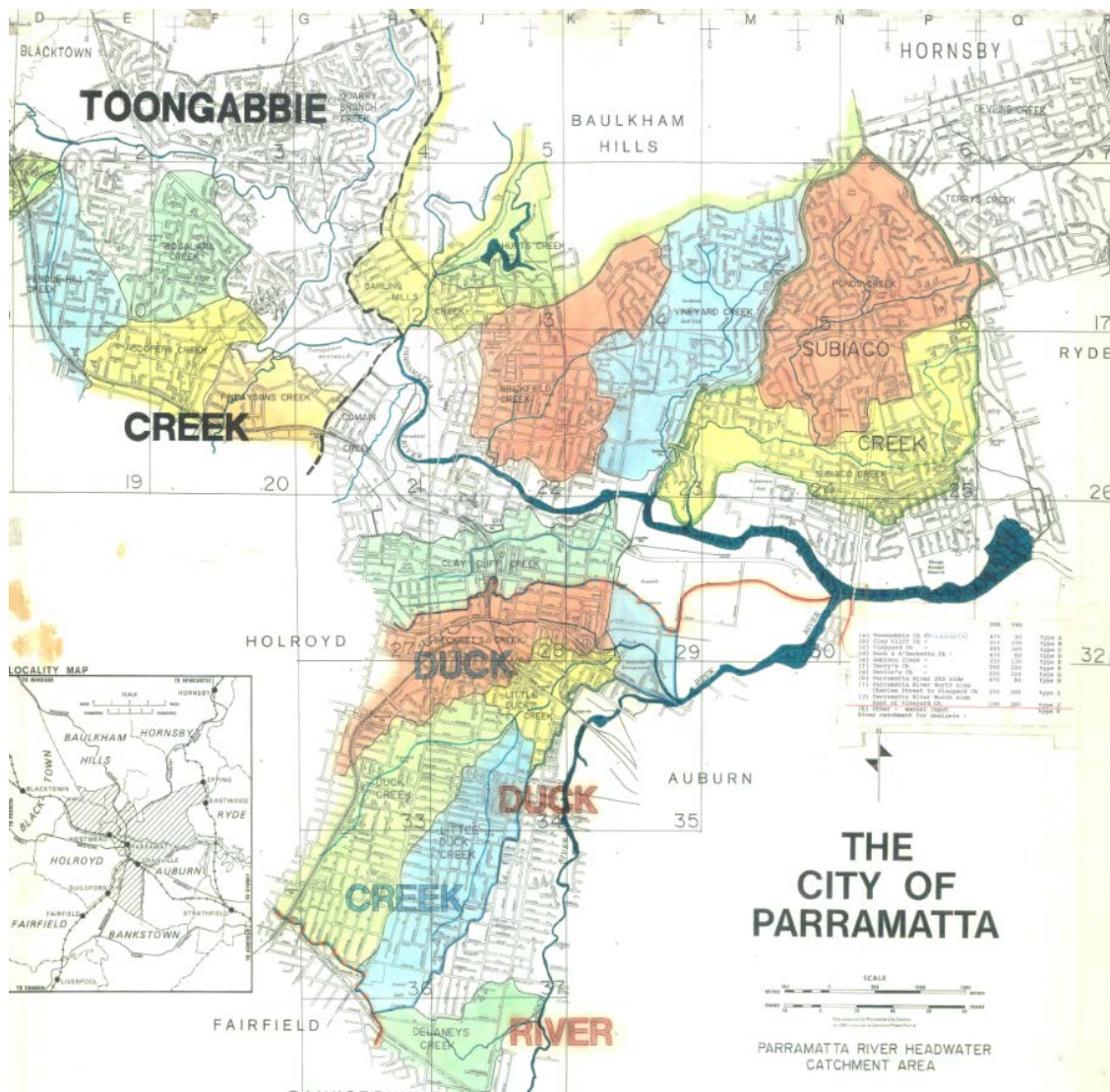


Figure 4 - OSD Catchments of former Parramatta City Council area

Table 1 - SSR & PSD parameters for use with UPRCT OSD Handbook (3rd edition)

Catchment	SSR (m ³ /ha)	PSD (L/s/ha)
Toongabbie Creek & Brickfield Creek	470	80
Clay Cliff Creek	215	235
Vineyard Creek	285	160
Duck Creek A'Becketts Creek	470	80
Subiaco Creek	330	130
Terry's Creek	250	210
Devlin's Creek	250	210
Parramatta River (South side)	470	80
Parramatta River North side (Charles Street to Vineyard Creek)	235	208
Parramatta River North side (East of Vineyard Creek)	190	280

SSR = Site Storage Requirement
 PSD = Permissible Site Discharge

Table 2 - SSR & PSD parameters for use with UPRCT OSD Handbook (4th edition)

Catchment	SRD _L (L/s/ha)	SSR _L (m ³ /ha)	SRD _U (L/s/ha)	SSR _T (m ³ /ha)
Toongabbie Creek & Brickfield Creek	40	300	150	455
Clay Cliff Creek	40	246	150	396
Vineyard Creek	40	262	150	415
A'Becketts Creek	40	278	150	432
Duck Creek	40	285	150	439
Subiaco Creek	40	284	150	438
Terry's Creek	40	233	150	382
Devlin's Creek	40	224	150	371
Parramatta River (South side)	40	212	150	358
Parramatta River North side (Charles Street to Vineyard Creek)	40	190	150	334
Parramatta River North side (East of Vineyard Creek)	40	245	150	396

Duck River (Confluence with Parramatta River)	40	276	150	430
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SSR_L = Site Storage Requirement (Lower storage)

SSR_T = Site Storage Requirement (Total)

SRD_L = Site Reference Discharge (Lower storage)

SRD_U = Site Reference Discharge (Upper storage)

Council also requires provision of rainwater tanks for on-site stormwater harvesting & reuse complying with BASIX requirements. Rainwater tanks may also attract credit towards offsetting OSD volumes. The dedicated airspace only of rainwater tanks may be considered as a partial offset for detention volume requirements in line with calculations and design requirements under the UPRCT OSD Handbook 4th edition only.

Areas Formerly located in the Hills Shire and Holroyd City Council Areas

Where OSD is required in areas formerly located in the Hills Shire and Holroyd City and now located within the City of Parramatta, the OSD system is to be designed using the following parameters.

Using 3rd edition parameters

SSR (m ³ /ha)	PSD (L/s/ha)
470	80

Using 4th edition parameters

SRD_L (L/s/ha)	SSR_L (m ³ /ha)	SRD_U (L/s/ha)	SSR_T (m ³ /ha)
40	300	150	455

Former Hornsby Shire Council Areas

Where OSD is required in areas formerly located in the Hornsby Shire Council area and now located within the City of Parramatta, the OSD system shall be designed to restrict the post development outflow from the site in the 20 year ARI storm event (Q_{20}) is restricted to the pre development outflow from the site in the 5 year ARI storm event (Q_5), i.e. $Q_{20, post} < Q_{5, pre}$.

Former Auburn Council

Where OSD is required in areas formerly located in the Auburn Council area and now located within the City of Parramatta, the OSD system shall be designed using parameters below. Areas located within Zones 6 & 8 do not require OSD.

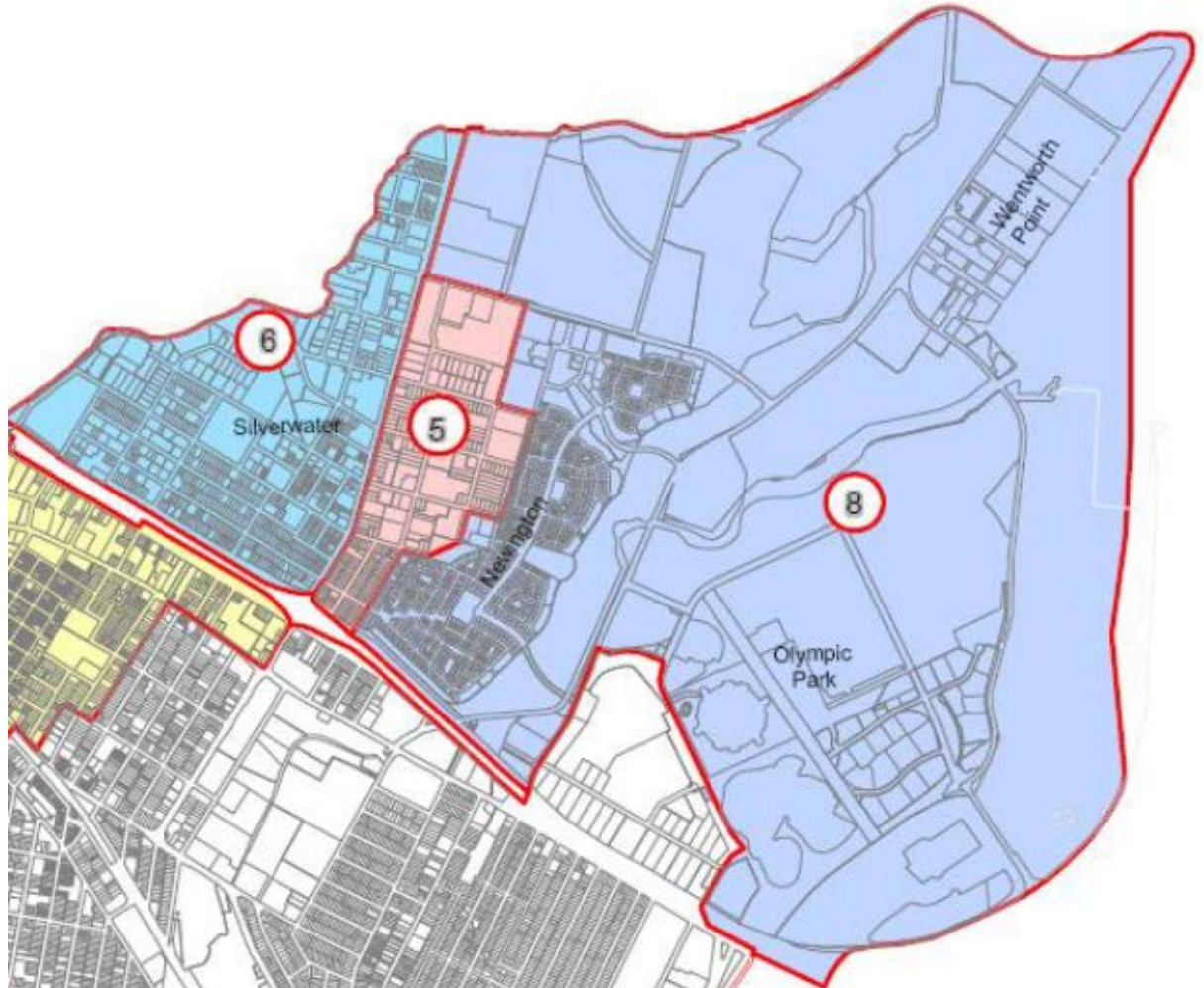


Figure 5 - OSD Catchments of former Auburn Council area

PSD Zone	PSD (L/s/ha)	SSR (m ³ /ha)
1	80	530
2	100	455
3	130	370
4	150	325
5	130	370
6	-	-
7	-	-
8	-	-

3.0 OSD DESIGN

3.1 General

The OSD design shall be prepared by a suitably qualified and experienced professional engineer registered, with the National Engineering Register in Civil Engineering, specialising in stormwater design. The designs shall be in accordance with the 3rd or 4th edition of the Upper Parramatta River Catchment Trust OSD Handbook, Australian Rainfall and Runoff and AS3500.3

- a) Above ground OSD basins are not allowed for residential development.
- b) All walls forming the detention basin shall be constructed wholly within the property boundaries of the development site.
- c) Sewer gully traps within close proximity of the OSD basin or within the spillway flow path shall be set 100mm above the top water level
- d) Sewer manholes within the above ground storage areas shall be provided with a water tight gatic lid in accordance with Sydney water requirements. Furthermore, any structures forming part of the OSD basin or tank within close proximity of an existing sewer manhole shall also be in accordance with Sydney Water requirements.
- e) On site detention requirements for different developments are as follows:

Development Type	OSD style
Residential developments, including multi-unit residential and or mixed use residential developments	Underground tanks only
Commercial and industrial	Above or below ground storage is permissible. Where possible underground storage is preferred

- f) The 1% Annual Exceedance Probability (AEP) storm event for developments or re-developments must not increase flooding or stormwater flows in any downstream areas.
- g) On site detention storage tanks/basins shall not be located in or within a natural waterway or overland flowpath.
- h) The OSD system shall function during all storm events up to and including the 100 year ARI storm event.
- i) The OSD system shall be designed with an overflow spillway. The overflow shall be directed towards the street where possible or in the direction of the overland flowpath. The flow path shall be clear of all obstructions including but not limited to rainwater tanks, walls, fences etc. Where possible a 900mm x 900mm overflow pit shall be provided.
- j) Overflow or site discharge shall not be directed into a downstream property without the consent of the neighbouring property owner and registration of a drainage easement.
- k) Developers and designers are encouraged to use principles of good aesthetics when preparing an OSD design. Long term viability, ease of maintenance and access to the drainage system and storage areas should also be considered in the design process. It is recommended that the OSD designer consults with the architect, landscape designer and arborist prior to completing an OSD design.

- a paved area not actively used e.g. a sunken barbeque area
 - a small underground tank
 - a permanent water feature
 - a rockery or rock garden or a front setback.
- f) The maximum depth of storage should be limited to 300mm unless otherwise approved by Council and the area must be designed to allow safe egress as the storage fills with water. All above ground storage areas shall consider the appropriateness of safety fencing to be provided.
- g) The structural adequacy of retaining walls must be checked, including the hydrostatic loads caused by a full storage.
- h) Free standing timber log retaining walls should not be used to create a storage, but timber can be satisfactory as part of an earth retaining wall which prevents any significant leakage.
- i) Limiting the depths of ponding on driveways and car parks to less than 200mm under design conditions.
- j) Where the storage is to be provided in a commonly used area where ponding will cause inconvenience (e.g. a car-park), the area should only flood once to twice every year, on average. This will require as much of the extended detention storage to be provided as possible in a non-sensitive area e.g. a driveway.

3.1.2 Structural/underground storages (Underground tanks)

- a) On Site Detention is to be in the form of below ground tanks for all residential development.
- b) Tank is relatively self-cleansing i.e. the base has a minimum 2% fall to the outlet and is appropriately shaped. All water is to be drained from the tank by gravity.
- c) Tank can be readily inspected from the surface for silt and debris. Under these circumstances, 20% of the surface area of the tank would be required to be grated at a maximum of 3m spacing.
- d) Invert of tank is above hydraulic grade line of downstream drainage system.
- e) Tank is structurally designed to adequately withstand all service loads and provide adequate service life throughout the life cycle of the development.
- f) Adequate access is provided to the tank for cleaning.
- g) Tank is well ventilated and will not cause any accumulation of noxious odours.
- h) Grates accessing the tank shall have a minimum size of 900mm x 900mm. The above grate needs to have a double opening in order to access the tank conveniently.

- i) Grated pit in children play areas are not permitted

Freeboard

Habitable floor levels of a building shall be set to have sufficient freeboard to avoid the risk on inundation when the OSD system malfunctions or overflows in the event of a 1% AEP storm event. The freeboard is to be calculated from the top water level including the depth of the overflow weir. The required freeboard is;

- a) 200mm for habitable buildings
- b) 100mm for garages

3.2 Ponding Depth

In order to satisfy safety & amenity aspects, above ground detention basin water depths are not to exceed as follows;

Parking and paved area	100mm desirable 200mm maximum*
Landscaping/grassed area	300mm maximum
Roof Area	As required by structural integrity

*Recommendations for depth and frequency for inundation of different classes of storages are noted above. It is emphasised that these are provided for guidance only and should not be considered prescriptive. The maximum depth of ponding for above ground storages should be limited to 300mm, and appropriate safety precautions should be made. This should include the provision of warning signs and fencing where depths exceed 300mm.

3.3 Access and maintenance

The OSD system is an integral part of the development and the effectiveness of OSD system in controlling run-off from developed sites is a function of its maintenance.

The proponent must ensure that the tank can be readily inspected & maintained by considering the following:

- a) The invert of the basin should be well graded to prevent permanent ponding.
- b) The orifice plate is to be screened.
- c) The basin should be located in a position such that it can be easily inspected and accessed for cleaning.
- d) The basin is to be protected by a restriction and positive covenant requiring the owners to carry out periodical maintenance.

For multi-unit residential developments, the desirable area to locate basin is in areas controlled by owners corporate or strata. Designs incorporating any OSD system in private courtyards or other inaccessible areas will not be approved.

- a) Access for maintenance and inspection purposes shall be taken into account when designing OSD tanks and basins. i.e. mowers, pedestrian access etc.

- b) Satisfactory access shall be provided for all OSD tanks and basins i.e.
 - i. Stairs, ramps and or batters not exceeding 1(V) in 4(H) for above ground basins
 - ii. Grates accessing the tank shall be a minimum of 900mm x 900mm, and a maximum lifting weight of 20 kg. As a minimum, grates shall be located:
 - over the primary outlet; and
 - over the secondary outlet if the tank provides both extended detention and flood detention storage;
 - access grates shall be placed at the extremities of the tank with a maximum distance of 3m from any point in the tank to the edge of the nearest grate.
- c) The minimum clearance height for an OSD tank is 900mm. Where the minimum clearance height for accessibility cannot be achieved due to level or site constraints, the following internal heights can be considered:
 - i. Commercial /industrial development 750mm
 - ii. Residential development 500mm

3.4 Drowned/Submerged Orifice

An OSD system is considered to be drowned or submerged when the downstream water level affects the hydraulic performance of the OSD system. This commonly occurs when the water level of the receiving system is higher than the orifice of the OSD system.

When connecting into the kerb and gutter or road drainage system, the top of kerb level is to be used as the tailwater level.

The tailwater level may be higher than the top of kerb where the point of connection is affected by mainstream or overland flooding. In these case, the relevant 1% AEP flood level is to be used as the tailwater level.

Where the orifice outlet will be functioning under drowned/submerged conditions, the following shall be provided with:

- a) Revised OSD summary calculations for the submerged / drowned orifice highlighting the revised/additional volume required,
- b) Revised OSD sections and detail demonstrating that the additional volume requirements can be achieved.

3.5 External Flows

Provision shall be made to ensure that external flows entering the development site do not cause the OSD system to unintentionally surcharge. Any flows generated from the local upstream catchment are not to be obstructed but rather permitted to drain into the development site. These flows shall be quantified and captured with an intercepting swale or directed into an overland flow path and subsequently directed to the point of discharge separate to the OSD system.

3.6.1 Overland flow path/ swale design criteria

- a) Calculations demonstrating that the swale has capacity to cater for all external flows entering the site as a result of all storm events up to and including the 1% AEP storm event.
- b) The proposed swale shall be designed using the minor/major system design principles noted in Australian Rainfall and Runoff 1987
- c) Flows generated by the local upstream catchment can be quantified using Rational Method or DRAINS,
- d) Floatable material (bark or timber mulch) shall not form part of the swale

3.6 Inter-allotment Drainage easement

OSD systems shall discharge into a Council drainage system (pipe/channel, kerb and gutter etc.) via gravity. Where a property drains to the rear or the drainage is to a Council drainage system through a neighbouring property/s a drainage easement will be required. Where an inter-allotment drainage easement is required, the consent of the downstream property owner/s agreeing to the easement must be obtained.

The following shall be included in the stormwater drainage plans where it is proposed to drain into an easement:

- a) The inter-allotment drainage system within the easement shall be designed to cater for the 1% AEP storm event and includes a surface swale to control flows in cases of surcharge.
- b) Extensive details of the proposed and any existing stormwater drainage system within the easement.
- c) Longitudinal section of the drainage pits and pipe within the easement.
- d) The drainage easement location is not disturb any structures or root zone of existing trees within the property/properties.
- e) All trees and existing structures within 5 metres of, or overhanging, the proposed easement shall be accurately indicated.

3.7 Legal Protection

OSD systems are structures intended to control site discharges over the entire life of the development. To guarantee the system's continued operation, it needs to be protected from alteration and regularly maintained.

Prior to any occupation certificate being issued, the OSD system and associated floodways and flowpaths need to be legally protected. This is achieved by applying a restriction on the use of the land and a positive covenant over the lot in favour of Council.

3.8 Signage

Signage shall be provided to the OSD systems in accordance with Appendix N of the UPRCT OSD Handbook (4th edition).

Section 3: Managing Watercourses and Overland Flow Flooding

1.0 General Requirements

- a) Sites impacted by flooding and/or overland flows from rainfall are to be assessed by Council and all designs must be consistent with the requirements of Council's Local Environmental Plans, Development Controls Plans, Stormwater Disposal Policy, and the NSW Flood Plain Development Manual as they relate to flood affected sites.
- b) Applicants are to obtain flood levels from Council's Catchment Management Unit via an online flood enquiry application where that information is held by Council
- c) Where Council does not hold that information, a flood study prepared by the applicant will be required. The flood study shall be prepared in accordance with the requirements of this Section and submitted to Council with the DA.
- d) 1D modelling is generally acceptable (HEC-RAS), however, 2D modelling may be required at the discretion of Council staff depending on the site, the nature of development and catchment complexity.
- e) It is strongly advised that development proposals on flood prone sites are discussed with Council at a pre-lodgement meeting.
- f) Sensitive land uses on flood affected sites are discouraged in line with the flood planning matrix located in Council's Development Control Plan.
- g) Piping and channelling of watercourses is not supported

2.0 Requirements for a Flood Study

Where a flood study is required by Council, the flood study is to be carried out in accordance with the parameters specified in this Section and a report submitted to Council with the DA which includes the following minimum information.

- a) Survey plan of the development site and surrounds, noting the location of existing buildings, retaining walls, trees and other structures of hydraulic significance,
- b) Catchment plan showing:
 - i. the extent and area of the catchment, including delineation of any sub-catchments,
 - ii. size and location of any existing drainage infrastructure, and, overland flow paths,
- c) Plan showing the hydraulic model layout (centreline of the watercourse or flow path and cross-sections) or digital elevation model including details of structures, any other flow obstructions or ineffective flow areas for both pre and post development scenarios,
- d) Modelling methodology and model schematics,
- e) List, description and justification of assumptions used including evidence of any ground-truthing exercises
- f) Discussion of results including a table and maps showing and comparing the pre and post development flood levels, depths, velocities and hydraulic hazard,
- g) Where a 2D model is used, maps showing flood depth with water surface level contours and velocity vectors and flood afflux shall also be included,

- h) Assessment of the development proposal against Council's flood planning controls in the DCP,
- i) Flood risk management measures to be incorporated into the development proposal,
- j) Any other information required to support the engineer's conclusion.
- k) Model files in an electronic format (compressed into a single .zip file).

3.0 Hydrological Modelling Parameters

3.0 Catchment Area

The use of contour maps, based on LIDAR data and obtained from Council or NSW Land Registry Services, can be used to determine the extent and area of the wider catchment. Where these are used, site inspections must also be carried out by the consultant engineer to confirm the catchment boundaries.

This is to be complemented with surveyed levels reduced to AHD from a Registered Surveyor within the development site, surrounding properties and other critical locations within the catchment.

3.1 Rational Method

Rational method calculations carried out in accordance with Chapter 14 of the AR&R may be used to determine the flow rate for small catchments with fairly uniform characteristics. Otherwise, the catchment is to be modelled in a runoff routing model, such as DRAINS or using the direct rainfall method (rainfall on grid).

Where the rational method is used, the minimum and maximum times of concentration that will be considered are 5 minutes and 20 minutes respectively.

3.2 Storm Events

The following storm events are to be considered in the flood study:

- a) 5% AEP (20 Year ARI),
- b) 1% AEP (100 Year ARI), and,
- c) Probable Maximum Flood (PMF).

3.3 Consideration of Piped Infrastructure

For the purposes of risk assessment, it is to be assumed that there is no benefit from the piped system, i.e. 100% pipe blockage.

In borderline circumstances where development may be precluded due to incompatibility with flood risk (due to hydraulic hazard), the sensitivity of the model can be tested with a 75% pipe blockage assumption (i.e. pipe flow is restricted to 25% of its capacity) to reclassify a site's flood risk. Where this scenario is adopted, flood risk management measures still need to be based on flood levels in the 100% blocked case.

Note that augmentation of the flow path (i.e. widening the flow path to allow shallower flow) may be an option to reduce hydraulic hazard and should be explored prior to adjusting this assumption.

3.4 Runoff Coefficient ('C')

Appropriate runoff coefficients can be calculated, based on the percentage of impervious area and design storm, in accordance with the procedures in Chapter 14.5 of the AR&R.

3.5 Partial Area Effects

Any partial area effects resulting from catchment shape or variations in slope or land use shall be considered in the model.

3.6 Initial and Continuing Losses

All models are to assume a fully saturated catchment. This is equivalent to an Antecedent Moisture Condition (AMC) of 4 in a DRAINS (ILSAX) based model.

3.7 Probable Maximum Precipitation (PMP) Estimates for The Probable Maximum Flood (PMF) Event

Estimates of PMP are to be carried out using the Bureau of Meteorology guidebook: The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method (2003). (This guidebook replaces Bulletin 53 referred to in AR&R.)

3.8 Climate Change

Increases in rainfall intensity associated with climate change shall be consistent with AR&R guidelines.

3.9 Other Parameters

Where parameters have not been specified in this section, justification shall be provided for their use in the modelling.

4.0 Hydraulic Modelling Parameters

4.1 Model Selection

The use of 1D models, such as HEC-RAS, is generally acceptable. However, 2D models, such as TUFLOW, may be required at the discretion of Council staff depending on the site, the nature of development and catchment complexity. The selection of model used in the flood study is to be justified by the consultant engineer.

4.2 Boundary Conditions

Appropriate boundary conditions are to be included in the model where it is considered that there will likely be a tailwater influence on the overland flow due to physical obstructions or coincidence with mainstream flooding. This may also require the model to be extended further downstream or replicated with artificial downstream water levels. Details of assumptions are to be included in the report submitted to Council.

4.3 Surface Roughness

Surface roughness coefficients (“n”) shall generally be derived from Chapter 14 of the AR&R. Generally, a roughness coefficient of at least 0.1 shall be used in highly urbanised catchments.

4.4 Grid Size in 2D models

An appropriate grid size shall be used in the model to ensure that physical features are adequately represented in the terrain model. This may include increasing the resolution around critical areas to ensure that the results are representative of expected flow conditions.

4.5 Cross Sections in 1D Models

A sufficient number of cross-sections are to be taken upstream and downstream of the development site and flow splits are to be included to adequately replicate expected flood conditions and to adequately represent the size and shape of flow obstructions. Cross-sections need to be taken perpendicular to the flow direction and “looking upstream”.

Ancillary structures such as retaining walls, driveways, stairs, raised landscaping beds, etc. which are likely to cause a flow obstruction are to be considered or otherwise represented by surface roughness assumptions.

Ineffective flow areas are also to be considered at locations likely to be flooded but not contribute to flow conveyance.

The channel is to be defined in the location of the flow path within the development site.

5.0 Flood Risk Management

5.1 Hydraulic Hazard

Areas subject to high hydraulic hazard are to be identified by the modelling. This is typically defined as areas subject to a velocity depth product greater than $0.4\text{m}^2/\text{s}$ or in accordance with Figure L2 in the Floodplain Development Manual. Development should not be exposed to floodwaters with a high hydraulic hazard.

5.2 Flood Risk Categorisation

A categorisation of a site’s flood risk precinct must be included in all reports. A site’s flood risk precinct (FRP) can be determined in accordance with Council’s Flood Prone Land Policy and the following definitions:

- a) High FRP – land below the 100-year flood that is either subject to a high hydraulic hazard or where there are significant evacuation difficulties.
- b) Medium FRP - land below the 100-year flood that is not subject to a high hydraulic hazard and where there may be some evacuation difficulties.
- c) Low FRP - all other land within the floodplain (i.e. within the extent of the probable maximum flood) but not identified within either the High Flood Risk or the Medium Flood Risk Precinct.

A site may have multiple FRPs depending on the flood characteristics.

The development and use of land is to be compatible with the site's flood risk precinct. Guidance on appropriate uses can be obtained from the flood planning matrix in Council's DCP.

5.3 Flood Impacts

Development will only be permitted where it can be demonstrated that it will not result in adverse flood impacts on adjoining properties, such as the concentration of flows, increase in flood levels, increase in flood velocities, or increase in flood hazard.

5.4 Filling

Filling within the floodplain is strongly discouraged, however, there may be cases where compensatory earthworks can be used to offset any impact. This can generally only be achieved on large sites which have adequate area for dedicated floodways.

5.5 Piping of overland flow to reduce flood affectation

The piping or channelling of overland flow or floodwaters to reduce flood risk, affectation or hazard will not be supported by Council.

5.6 Relating domestic scale buildings with watercourses and overland flow paths

Figure 5 below shows a typical arrangement for a minor development such as a single dwelling where overland flow flooding from a watercourse traverses a lot and is accommodated by building placement and elevation.

Key features of this arrangement include:

- a) Building footprint does not intrude into the "High Hazard" or 5% AEP (1 in 20 year) overland flow contour.
- b) Building structure is elevated 500mm clear of the 1% AEP, (100 year water) surface level.
- c) A free flow /flood area may be provided beneath the building from which storage and other uses are prohibited.

- d) Floodwater restrictions and easements for drainage and access are provided on title.

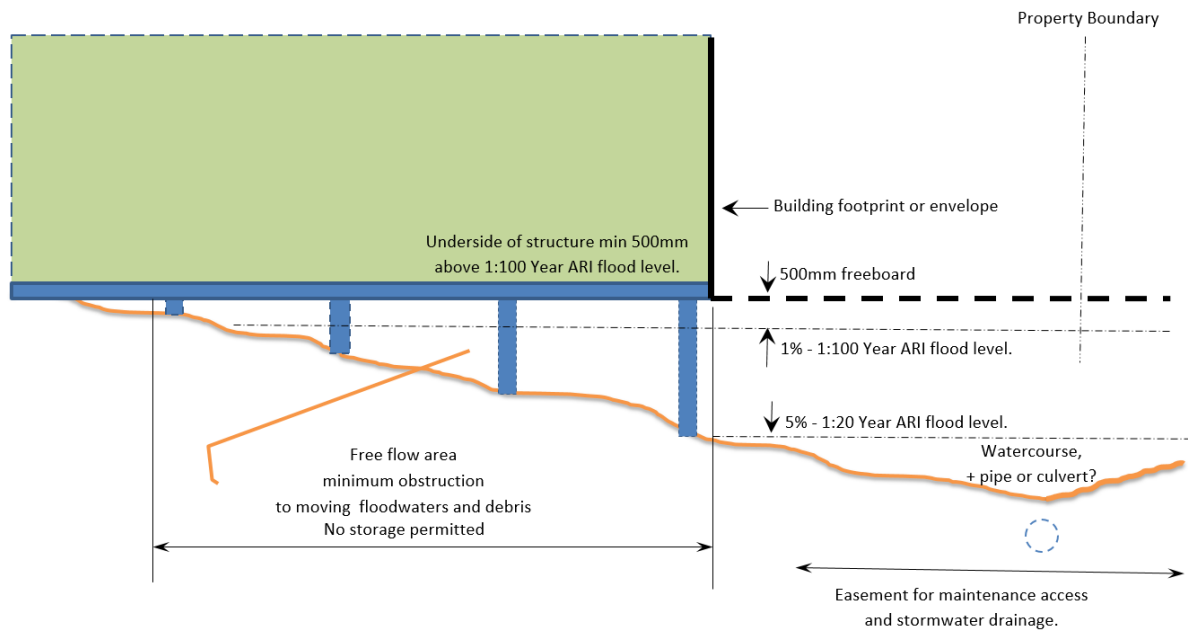


Figure 6 - Relating domestic scale buildings to floor level controls

6.0 Landform and Landscape Design

6.1 Culverts, inlets and landform – safety issues

The SES has repeatedly advised Councils of the hazards arising from culvert and headwall inlets. People have been killed during floods by being sucked into, or trapped by pipes as small as 300mm diameter. Such inlets, especially when concealed by floodwaters, are deceptively dangerous.

Landform may cause unexpected hazards beneath floodwaters – for example dips, hollows and sudden level changes that are not visible from above the water.

Grills and the like must not be placed on culvert or pipe outlets so that people and debris are not trapped inside the culvert.

6.2 Planting and landscape treatment of watercourses.

Soil surfaces of waterways should be stabilised with ground cover and other plants. Trees and shrubs are acceptable and beneficial in waterways, helping to even currents, reduce supercritical flows and possibly providing refuge. Planting adds landscape amenity, habitat niches and other ecological values. Planting may be seen as riparian vegetation and selected accordingly.

DPI offers suggestions for landscape treatments of watercourses including use of informal rocks, sedges and other macrophytic plants.