UPPER PARRAMATTA RIVER

CATCHMENT TRUST

On-site Stormwater Detention Handbook

Fourth Edition

December 2005

The fourth edition of the On-site Stormwater Detention Handbook was prepared by Cardno Willing (NSW) Pty Ltd with the assistance of Haddad Khalil Mance Arraj Partners and Brown Consulting (NSW) Pty Ltd on behalf of the Upper Parramatta River Catchment Trust. The principal contributors to this document included Dr Brett C Phillips, Dr Allan Goyen, Mr Steve Arraj and Mr Robert Peterson.

This Handbook is published in accordance with the Upper Parramatta River Catchment Trust's On-site Stormwater Detention Policy. This policy was developed in conjunction with the four local councils in the catchment:

- Baulkham Hills Shire Council
- Blacktown City Council
- Holroyd City Council
- Parramatta City Council

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1. INTRODUCTION

On-site Stormwater Detention (OSD) involves the temporary storage and controlled release of stormwater generated within a site. Without adversely affecting the property, it relies on thoughtful design and passive engineering during site development to achieve significant reductions in downstream flooding. OSD is required to ensure that the change in stormwater runoff from a site due to development does not increase flooding problems downstream except in very severe events. OSD systems must be properly maintained to make sure that stormwater flows from the site are regulated for the life of the development.

OSD is only one aspect of the management of the water cycle on a site. In recent years the Trust has begun to broaden its focus to include consideration of the complete water cycle for developments. A Water Sensitive Urban Design (WSUD) approach aims to better mimic the natural water cycle and may include the installation of rainwater tanks to harvest and re-use rainwater, the treating and re-using of grey water and implementing a range of measures at lot, neighbourhood and regional scales to reduce the rate and volume of runoff and to improve runoff quality. In particular, it aims to mitigate the impact of urban runoff during more frequent storms on natural creeks and watercourses.

The Upper Parramatta River Catchment Trust and the four catchment councils support the philosophy of WSUD. They are currently working with other groups to better understand the processes involved and the opportunities to implement better water management as part of the development process. Through its requirement that all new residential developments satisfy the water conservation target under the BASIX system, the NSW Government is also promoting the adoption of WSUD practices throughout NSW (visit: www.iplan.nsw.gov.au/basix).

Nonetheless, the role of OSD in ensuring that new developments do not worsen existing flooding problems remains critical. While sympathetic consideration will be given to WSUD measures such as rainwater tanks, such measures can at best only partially meet the requirement to provide OSD. In many cases more research will be required to demonstrate whether WSUD proposals such as water retention (eg. for infiltration) or rain gardens can be partly, or completely reduce the volume of OSD storage required. In the case of rainwater tanks, for example, the Trust has had research undertaken by the University of Newcastle based on local rainfall data and typical water usage rates. It was concluded that part of the volume of rainwater tanks could be offset against the OSD storage required. At the Trust's request the interaction of rainwater tanks and OSD at a range of scales up to 110 km^2 was also investigated by Cardno Willing in 2004. (See Section 4.2.8 for more details)

This Handbook has been principally prepared for experienced OSD designers. In the upper Parramatta River catchment, design and certification of OSD systems will only be accepted from persons having acceptable professional accreditation. The following are considered to be acceptable accreditation for the purpose of OSD design and certification:

- NPER in Civil Engineering (Engineers Australia);
- Surveyors Certificate of Accreditation in On-Site Detention and Drainage Design (Institution of Surveyors, NSW and the Association of Consulting Surveyors, NSW);
- Stormwater Register (Association of Hydraulic Services Consultants, Australia); and
- Accreditation as a certifier under the Environmental Planning and Assessment Act 1979 in the relevant discipline.

OSD can be provided most efficiently and effectively when it is considered as early as possible in the development process. The system is most easily maintained when owners have a clear idea of the location and function of the components of the system. For these reasons, this Handbook has wider application for architects, engineers, builders, developers, property owners and managers, local government officials or staff and concerned citizens who each have a role to play in the successful application of OSD in the upper Parramatta River catchment.

The format of the Handbook is set out in Section 1.2, but the following table provides a guide to those areas of the Handbook likely to be of most use to different groups within the community.

PROFESSION/GROUP	**RELEVANT SECTIONS OF HANDBOOK**
OSD Designers	Sections 3 – 7 and Appendices
Architects	Sections 1, 3 and 4
Solicitors and Conveyancers	Sections 1.3, 2.5, 4.3.6, Appendices C-H
Developers	Sections 1-3, 4.1 and 4.3.6
Owner Builders	Sections 1-3, 4.1, 4.3.6,4.2.9-11, 6.5, Appendices C-H
Owners/Tenants/Property Managers	Sections 1, 4.2.1, 4.3.6, Appendix C
Local Council Officials	Sections 1-3, 4.2.9, 4.3.6, Appendix C
Local Council Staff	Sections 1-7 and Appendices
Concerned Citizens	Sections 1, 2, 3.4, 4.2.6, 4.3.6 and 6.2

The OSD policy and the Handbook are primarily intended for use within the upper Parramatta River catchment. However, the catchment Councils generally require OSD in other catchments as well. Appendix Q provides the relevant parameters for those areas while Appendix R shows how the methodology can be adapted to other areas. The application of WSUD principles is dependent on a range of local factors, such as soil types, rainfall intensities and land uses, and reference should be made to the local Council for advice in other catchments.

1.1 General

There are two key components to the flood control effects of the local councils and the Upper Parramatta River Catchment Trust's flood mitigation effort. The first aims to reduce and eventually eliminate the present flood threat. This will involve public expenditure of more than $50 million on projects such as retarding basins, channel improvements and levees to protect some 2,200 properties threatened by mainstream and trunk drainage flooding.

The second component aims to prevent the growth of the already substantial flooding problem caused by increasing development of the catchment. This is achieved through planning and development controls of which OSD is the most important element.

Since the publication of the **first edition** in September 1991, the Handbook has been purchased by over 500 OSD practitioners. The **second edition** was released in November 1994 to take advantage of the considerable body of practical experience that had been developed, as well as including the results of several Trust-sponsored research projects.

The **second edition** incorporated:

- a reorganisation of the Handbook to better reflect the development process
- a requirement for OSD designers to be involved in the initial site layout through the preparation of the Stormwater Concept Plan
- an increased emphasis on designer supervision of the construction of OSD systems.
- generic dimensions for in-situ and precast discharge control pits
- a reduction in the minimum orifice diameter of discharge control pits
- increased attention to construction practices.

The **third edition**, released in December 1999, reflected the experience gained by Council staff and consultants in the practical application of OSD. The format was retained as closely as possible to provide continuity for both council staff and designers. The changes focussed on improvements to make the policy and its application more robust. These included:

Revision 1:
- revised covenants;
- an index;
- references for all three editions;
- revised discharge control pit;
- accreditation of designers;
- alterations to suit new planning legislation;
- promoting larger common storages;
- removing deferral of OSD;
- change in minimum development area;
- freeboard specified;
- access covers;
- authority to release plans to future owners;
- limiting storage in private courtyards;
- safety fences; and
- check lists.

Revision 2:
- simpler checklists added;
- reduction in the area of site not draining to the OSD storage;
- the use of rainwater tanks;
- consideration of Water Sensitive Urban Design;
- clarification of freeboard;
- calculations required for weirs and other overflows;
- clarification of deferral of OSD in small subdivisions;
- clarification of Holroyd City Council's position on Stormwater Concept Plans;
- providing OSD designers with an approved copy of the plans;

- OSD storages including wall footings to be wholly within property;
- pool fencing of storages in play areas;
- clarification of spacing of entry grates to underground storages;
- maintainability added to Hydraulic Compliance certificate;
- additional references added;
- design Summary Sheet altered to address flow from off site;
- reference to plan numbers added to restrictions on title;
- copy of Blacktown City Council's recitals for covenants and restrictions on use;
- list of maintenance contractors revised; and
- OSD Award winners updated.

The **fourth edition** reflects the outcomes of detailed investigations undertaken in recent years. In 2002 the Trust engaged a leading consultant (Dr Allan Goyen of Cardno Willing) to review the Trust's OSD parameters. His study used the latest version of the XP-RAFTS software which explicitly models the rainfall runoff process on an individual lot and the adjoining strip of roadway, then combines countless individual single lot models to simulate flood behaviour at the neighbourhood, sub-catchment and catchment scales, based on the Trust's very detailed hydrologic XP-RAFTS model. This approach was used to determine the OSD parameters required to ensure no increase in flood peak flows under a plausible ultimate development scenario. The report recommended that there be no change to the PSD, but that it may be possible to marginally reduce the SSR (Cardno Willing, 2002).

The OSD policy upon which preceding editions of the Handbook was based would prevent increased flooding during very large (e.g. 100 year ARI) storms, but would have no impact on smaller, more frequent storms (e.g. 1 year ARI). In environmental terms, these smaller storms can cause more damage to watercourses and disturbance to aquatic habitats. Furthermore, from a sustainability viewpoint, it would be desirable to have the stormwater runoff from developed sites more closely mimic pre-development conditions. Consequently, the possibility of using a two-stage outlet to control site runoff in both the 1.5 year ARI storm and the 100 year ARI storm, and by implication all intervening storm magnitudes, was investigated.

In these later studies, several significant changes to the current OSD policy were assessed including:

- an on-line OSD storage;
- dual outlets ie. primary and secondary outlets;
- an uncontrolled primary outlet, ie. outlet without HED; and
- a discharge control pit for the secondary outlet only ie. outlet with HED.

Under the alternative OSD arrangement that was investigated all site runoff is directed to the OSD storage. The water level in the OSD storage rises gradually. As it does, the discharge through the orifice also increases gradually as the depth of water (the 'head') above the orifice increases. In small storms the discharge leaving the site through the primary outlet (low level orifice) will be much less than occurred previously due to the adoption of a reduced PSD for the primary outlet. In major storms a secondary outlet with a higher PSD would control outflows from the OSD storage. In combination; these two outlets achieve the aims of reducing peak flows in frequent storms as well as in major storms.

Over a period of two years a large number of simulations were carried out in consultation with the Trust. The concept design of an OSD system that controls site runoff in both the 1.5 year ARI and 100 year ARI storms was refined and various design issues were addressed. The findings of this research were outlined three reports (Cardno Willing, 2002, 2004 and 2005).

Other features of the fourth edition include the:

- preparation of an UPRCT (Excel) Calculation Sheet to ensure that calculations are undertaken in a manner consistent with the procedures described in Section 4.2 by all OSD designers; and the
- discussion of the opportunities to integrate OSD with water quality measures.

To continue the improvement of OSD, the Trust welcomes suggestions, comments, design hints and examples of successful OSD designs for inclusion in subsequent editions of the Handbook.

1.2 Handbook format

The Handbook is divided into seven main sections and twenty appendices. The first two sections contain background information on the general principles of OSD. The next two sections cover policy and application of the policy. The final three sections provide the technical information required to prepare an effective and functional OSD system.

Section 1 – outlines the development and format of the Handbook and includes a glossary of terms and abbreviations used;

Section 2 – presents the concepts and principles of a catchment-based OSD policy;

Section 3 – defines the policy, the catchment area, the developments to which it applies and the method of implementation;

Section 4 – details the approval process, the minimum information required at each stage and important issues to be considered;

Section 5 – covers the design of the OSD system;

Section 6 – provides technical advice on the integration of the storage into a site, effective site drainage techniques and related issues;

Section 7 – presents a number of case studies;

Section 8 – discusses water quality and presents a case study; and

Section 9 – lists reference documents.

1.3 Glossary of terms

AEP	Annual Exceedance Probability – probability of a given discharge or rainfall being equalled or exceeded within a period of one year.
ARI	Average Recurrence Interval – average or expected value of the period between exceedances of a given discharge or rainfall.
Certificate of Hydraulic Compliance	A certificate prepared by the OSD designer and submitted to the relevant council on completion of the OSD system. The certificate verifies that the works have been carried out in accordance with the approved design.
DCP	Discharge Control Pit – a chamber that receives stormwater from the site and discharges it to the gutter or drain at a controlled rate not exceeding the PSD.
Detention storage	Detention devices capture and temporarily store stormwater runoff during major (infrequent) storm events. Stormwater is then discharged to the drainage system at a controlled rate. Detention devices act to mitigate potential downstream flooding impacts.
Development Area	The area of a property to be affected by the construction/reconstruction of buildings, structures, sealed surfaces, landscaping, driveways and car-parks.
Extended Detention storage	The lower portion of the OSD storage, which detains stormwater in smaller, frequent storms up to the 1.5 yr ARI event in order to reduce stormwater runoff closer to the rates under natural, pre-development conditions. This helps minimise damage and disturbance to downstream watercourses and aquatic ecosystems.
Flood Detention storage	The upper portion of the OSD storage that detains stormwater to prevent any increase in downstream flooding in moderate to major storms. Water held in the Flood Detention storage drains away through both the primary and secondary orifice outlets.
Flowpath	See Overland Flowpath.
Grey Water	Waste water from non-toilet plumbing systems such as hand basins, washing machines, showers and baths. Grey water is differentiated from black water, which is wastewater from toilets.
HED	High Early Discharge – method for ensuring that the discharge from a DCP approaches the PSD soon after flow spills into the DCP.
Infiltration	The vertical movement of water through a permeable material, such as sand or soil. The rate at which the flow occurs is dependent on the properties of the material and the relative volume of voids (air spaces) it contains.

	In the case of the clay soils typical of Western Sydney, infiltration rates are extremely slow whereas in sandy soils or fissured rock the rate of infiltration may be much faster.
Maintenance Schedule	Set of operating instructions for prospective property owners or occupiers setting out the routine maintenance necessary to keep the OSD system working properly.
Orifice	A circular hole with sharp edges machined to 0.5 mm accuracy in a corrosion resistant steel plate that controls the rate of discharge from a storage.
OSD	On-site Stormwater Detention: temporary storage of stormwater generated within the site so as to restrict the discharge leaving the site to a pre-determined rate.
Outlet	The pipe conveying the stormwater discharge from the OSD storage downstream of the orifice. Generally it should have a capacity twice the sum of the SRDs.
Overland Flowpath	Surface drainage system that caters for minor flow from an upstream catchment. Also the drainage system that caters for surcharges from the OSD storage in events larger than the 100 year ARI flow or when a blockage occurs.
Permeable	A property of a porous material that allows a liquid to flow through it.
Positive Covenant/ Restriction-as-to-use	Legal protection placed on a property title requiring owners to repair and maintain the OSD systems.
Potable	Fit for drinking. Potable water may be used, without further treatment, for drinking. Kitchen sinks, basins, showers and baths are considered to be potable uses because of the chance of water being ingested, especially by the young.
Primary Orifice	Lower orifice located at the base of the OSD storage. It alone controls the rate of release of runoff from the site in smaller, frequent storms when water only fills part of the (lower) Extended Detention portion of the OSD storage.
PSD	Permissible Site Discharge - the maximum allowable discharge leaving the site in litres/sec/hectare (L/s/ha) or in litres/sec (L/s) when applied to a specific site. Refer also to Site Reference Discharge.
Rain Garden	A combination of an infiltration and filtration device. Water is directed to a local hollow where it soaks into an organic filter medium such as topsoil or compost. Some water soaks into the ground while the remainder is collected and piped to the stormwater drainage system. Components of a rain garden include a grass pre-treatment area, temporary ponding, planting soil, sand mixing with the soil, an organic layer, and plant material. Infiltration can be a component depending on soil conditions.

Residual Site Area	The residual site area is the area of the site less the roof area of the dwelling(s).
Retention	Refers to procedures and schemes whereby stormwater is held for considerable periods causing water to continue in the hydrological cycle via infiltration, percolation, evapotranspiration, rather than via direct discharge to watercourses (Argue, 1986). This description can be expanded to include rainwater tanks of various types.
SCP	Stormwater Concept Plan – conceptual layout of the OSD system submitted with the development or subdivision application. **Note**: Holroyd City Council do not accept SCPs (See Section 4.1).
Secondary Orifice	Larger orifice located at the base of the Discharge Control Pit. Because it is much larger the secondary orifice controls the rate of release of runoff from the site in larger, rarer storms when water has filled the lower Extended Detention storage and starts to fill part of the upper Flood Detention storage.
SRD_L	the Site Reference Discharge from the extended detention storage in litres/sec/hectare (L/s/ha), or in litres/sec (L/s) when applied to a specific site, when the volume of runoff stored in the extended detention storage equals the SSR_L
SRD_U	the Site Reference Discharge from the DCP that receives stormwater when the volume of runoff exceeds the volume of the extended detention storage in litres/sec/hectare (L/s/ha), or in litres/sec (L/s) when applied to a specific site. The site reference discharge occurs when the DCP is completely filled and HED conditions are established at the commencement of flood detention.
SSR_L	the minimum volume (in m^3/hectare or in m^3 when applied to a specific site) required for the lower Extended Detention storage when the outflow is restricted to the SRD_L.
SSR_T	the total volume (in m^3/hectare or in m^3 when applied to a specific site) required for overall storage (combined Extended Detention storage and Flood Detention storage) when outflows occur through the primary and secondary orifice outlets.
Structural Storage	A storage system, generally below ground level, where the volume is contained within a closed structure.
Sump	A locally lowered section of a pit or storage used to prevent silt and debris blocking the outlet.
Surface Storage	A storage system, generally above ground, where the volume is contained within an open area.
Sustainable	Capable of being maintained at length without interruption, weakening, or loss of power or quality.
Water Cycle	The natural cyclical process whereby atmospheric water falls as rain and infiltrates to groundwater or runs off as stormwater

	as rain and infiltrates to groundwater or runs off as stormwater to receiving waters and is then evaporated back into the atmosphere. At various stages of the process, water may also be released into the atmosphere (transpired) by living things.
Water Sensitive Urban Design	A process of urban design for development or re-development that seeks to mimic the natural water cycle so as to create a sustainable development by integrated management and conservation of water and treatment and re-use of wastewater and stormwater.
Work-as-Executed Plans	Plans showing the levels, dimensions and location of what is constructed. In the context of this Handbook the plans refer to the OSD system and must be prepared by a Registered Surveyor.
WSUD	See Water Sensitive Urban Design.

2. CONCEPTS

2.1 The Problems

In many parts of the Sydney metropolitan area, the drainage system has become increasingly inadequate. This is shown by the growing frequency and severity of stormwater surcharge and flooding. At the same time, there are doubts about the capacity of local authorities to fund upgrades to the drainage system or, indeed, the wisdom of doing so. Many of today's flooding problems are the result of well-intentioned improvements to the drainage systems that simply transferred and compounded the overall problem.

Until relatively recently, the objective of urban stormwater drainage was to get rid of stormwater as quickly as possible. To that end, pits and drains were built, roads were sealed and drained, swamps were filled, surfaces were 'smoothed' and stream channels were lined and straightened. Although successful in reducing the local nuisance of stormwater, no thought was given to the effect these measures may have on flooding elsewhere in the catchment. It was not sufficiently appreciated that if stormwater leaves one area more quickly, it must arrive somewhere else equally quickly!

Around 1970 it became evident that increased downstream flooding (caused by urban development and a more efficient drainage system) could be mitigated by temporarily holding back some of the stormwater in flood retarding or detention basins. Retarding basins could be built either to reduce the increased stormwater runoff from existing developments or to offset the expected increase when a rural catchment is urbanised. Since the mid 1970s, most new-release estates in Australian cities have incorporated a series of flood retarding basins intended to maintain the pre-development flood peak discharges.

Today there are hundreds of these basins in areas where there has been extensive land development over the past 20 years. In general, these basins performed satisfactorily during the series of major storms in Sydney in the late 1980s.

The most severe flooding occurred in older middle distance suburbs of western Sydney that had been developed without retarding basins. Over more than two decades, governments and local councils have spent tens of millions of dollars constructing large retarding basins on whatever large publicly owned sites could be found in these areas. Inevitably their cost was greater, and their effectiveness less, than had the basins been built at the time the areas were first urbanised.

2.2 Development and Redevelopment

Sydney's middle distance suburbs are now undergoing redevelopment. Considerable design and construction of dual occupancies, townhouses, villas, duplexes, and semi-detached residences is under-way. These medium density developments mean more intensive site usage and more efficient stormwater drainage systems. Without some compensating measures, they will progressively and cumulatively increase the amount of stormwater run-off and decrease the available flood storage, causing local and downstream flooding, and negating the benefits of the large flood retarding basins.

Further developments and redevelopments in Sydney's middle distance suburbs pose considerable difficulties for local authorities. The random and unpredictable nature of individually-small developments makes it difficult to design, fund and construct further public retarding basins to compensate for the anticipated loss of flood storage. Sites for these basins are scarce (the best publicly-owned sites already have basins) and acquiring private land is prohibitively expensive. The alternative of further improving the efficiency of the drains and creeks would merely transfer a larger stormwater problem to downstream areas, and repeat the mistakes of the past.

2.3 The OSD Solution

The Trust's catchment OSD policy, developed in conjunction with the four local councils in the catchment – Baulkham Hills, Blacktown, Holroyd and Parramatta – is the result of an extensive series of computer simulations using a detailed hydrologic model of the upper Parramatta River catchment. Since late 1991, all four councils have been applying the same OSD policy to their portion of the catchment.

The catchment OSD policy aims to ensure that subsequent developments will not increase flooding or stormwater flows at any downstream locations, in all flood events up to and including 100 year average recurrence interval (ARI) events.

OSD is more likely to be successful than previous approaches because it addresses the fundamental reason for our present and growing urban stormwater flooding problems – loss of flood storage.

Rainfall/runoff modelling of the Upper Parramatta River catchment has been undertaken on a semi continuous basis for over 25 years. The XP-RAFTS rainfall/runoff program has been adopted for the hydrologic inputs to more advanced hydraulic analysis of the major tributaries throughout the catchment. Initially the catchment was divided into only a few sub-catchments to represent the inflows from the various tributaries. Subsequent modelling, carried out by the Trust, has progressively expanded this model to 778 sub-catchments with 18 public retarding basins, 13 private basins and 22 natural storages that act as de facto basins. The XP-RAFTS rainfall/runoff program has been used to analyse OSD solutions for all four editions of the handbook.

2.3.1 Previous OSD modelling

The computer modelling approach adopted by the Trust for the first three editions was to aggregate OSD storages on a subcatchment basis and to represent these aggregated storages as small flood retarding basins. The flood peak discharges were calculated throughout the 110 km^2 catchment both under current conditions and with the catchment redeveloped to different degrees.

The simulations compared the catchment without any OSD and with OSD systems on all development sites, limiting runoff to different rates ranging from 60 to 150 litres per second per hectare (L/s/ha). The simulations were repeated for a range of storm durations and storm frequencies.

Comparing post-development flood peak discharges with existing-condition discharges, the Trust found that run-off from development sites must be limited to 80 L/s/ha to ensure there is no increase in flood discharges anywhere in the catchment under all storm frequencies and durations. This was called the permissible site discharge (PSD). It was shown that, in this catchment, if the PSD is achieved early in the storm event ('high early discharge') and the stormwater storage is off-line (rather than in line with the discharge control pit), 470 cubic metres per hectare (m^3 /ha) of storage is required to control runoff in all storms up to and including 100 year ARI events. This was called the site storage requirement (SSR).

2.3.2 Recent OSD modelling

The fourth edition, however, has been based on an enhanced modelling approach. A recently developed allotment based "Process Tree" numerical modelling approach was adopted to better represent complex property drainage structures throughout larger sub-catchments. This approach focuses on the allotment processes without losing the ability to simulate the totality of the watershed as a whole. It is based on the work of Goyen, 2000.

The methods described in Goyen, 2000 were incorporated into the sub-catchment hydrograph estimation module of XP-RAFTS. This allowed the existing 778 node model of the upper Parramatta River catchment to be utilised as the starting point for further assessment of more advanced WSUD facilities in conjunction with changes in the catchment including medium density developments in areas currently represented by residential and other low density development.

The modifications to the XP-RAFTS analysis procedure included an alternate sub-catchment analysis procedure. Runoff is estimated separately for roof/gutter, adjacent road surfaces, paving and pervious gardens and lawn areas. A virtual allotment drainage network is constructed to provide lagging, bypass, capture and additional storage routing and infiltration/evapotranspiration within the various WSUD facilities. The outputs from each structure, as well as bypass flows, are then combined to estimate the total runoff hydrograph from a typical allotment. Individual allotment outflow hydrographs in each isochronal slice area are then scaled and appropriately lagged to the sub-catchment outlet.

This approach was used to determine the OSD parameters required to ensure no increase in flood peak flows under a plausible ultimate development scenario. The report on these recommended that there be no change to the previously adopted PSD, but that it may be possible to marginally reduce the SSR (Willing & Partners, 2002)

The previous OSD policy would prevent increased flooding during very large (e.g. 100 year ARI) storms, but would have no impact on smaller, more frequent storms (e.g. 1-2 year ARI). In environmental terms, the smaller storms can cause more erosion damage to watercourses. Furthermore, from a sustainability viewpoint, it would be desirable to have the stormwater runoff from developed sites more closely mimic pre-development conditions. The possibility of using a two-stage outlet to control site runoff in both the 1.5 year ARI storm and the 100 year ARI storm, and by implication all intervening storm magnitudes, was subsequently investigated.

Under the alternative OSD arrangement investigated all site runoff is directed to the OSD storage which is on-line. The water level in the OSD storage rises gradually. As it does the discharge through the orifice also increases gradually as the depth of water (the 'head') above the orifice increases. In small storms the discharge leaving the site through the orifice will be much less than the PSD (referred herein to as the Site Reference Discharge (SRD) for on-line storages).

Over a period of two years a large number of simulations were carried out in consultation with the Trust. The findings of these investigations are presented in Cardno Willing, 2004.

The outcomes of these investigations were:

- An OSD storage volume (SSR) of 455 m^3/ha;
- All site runoff is directed to the OSD storage: that is the storage is on-line;
- The OSD system is to have two orifice outlets and a small spillway;
- The primary or lower orifice normally has a SRD of 40 L/s/ha;
- This is located as close as possible to the storage invert;
- There is also a secondary orifice located at the base of a DCP providing HED with a SRD of 150 L/s/ha;
- The crest of the DCP is at the water level of the 1.5 year storm when the volume in the lower storage reaches 300 m^3/ha;
- The secondary orifice starts to operate when the water level in the storage exceeds the crest level and water starts to overflow into the DCP; and
- A small spillway of suitable length to prevent flooding of the residence/business if the outlets become blocked is provided at the top of the storage (i.e. at 455 m^3 /ha)).

2.4 Why so much storage is required

The 455 m^3/ha of storage required under the amended upper Parramatta River catchment OSD policy, or 470 m^3/ha required under the former OSD policy, are approximately three times greater than the volumes required under former Council policies. While this volume may at first appear excessive, the former policies only aimed at controlling 5 year ARI or 20 year ARI storm flows for one particular storm duration.

However, the flood mitigation standard adopted in this catchment, and generally throughout New South Wales, is the 100 year ARI event. Even though the 2005 Floodplain Development Manual (NSW Government, 2005) redefines as flood-prone all land below the Probable Maximum Flood level, development constraints apply mostly to land below the flood planning level that is typically the 100 year ARI flood level plus a freeboard allowance.

As the catchment OSD policy deals with storms of all durations up to 100-year ARI events, it must detain much greater volumes of runoff. If the policy aimed only at controlling, say, the 30 minute – 20 year ARI storm, much less storage would have been required.

Another point of concern was that a PSD of say 80 L/s/ha corresponds to the 5-year ARI – 2 hour storm duration runoff from a fully developed site calculated using the Rational Method. For longer duration storms the runoff is even less. Is it reasonable, some have asked, to limit the 100 year ARI runoff to the 5 year ARI magnitude or less?

It needs to be appreciated that, even if OSD limits the post-development peak discharge to the pre-development rate, the overall post-development volume of runoff is still greater. As a result the post-development stormwater discharge after the peak (on the hydrograph 'tail') will be greater. Moreover, by maintaining outflow at the PSD rate for some time, OSD further increases these discharges.

Rational Method OSD procedures necessarily ignore the cumulative downstream implications of these increased 'tail' discharges. However, with a catchment hydrologic model, it is seen that the accumulation of increased 'tail' discharges can (and does) result in greater flood discharges at some points further downstream. It is to avoid this that the PSD must be less than that required merely to avoid increasing peak discharges at some specific site.

2.5 Legal basis of the Policy

Legal advice obtained by the Upper Parramatta River Catchment Trust states that local Councils have the power to impose a condition on development consent or building approval requiring the construction of OSD systems on a development site.

OSD also satisfies the test of 'reasonableness'. New developments should not be allowed to add to downstream flooding and drainage problems. Without OSD or other compensatory flood storage, the cost of dealing with additional stormwater runoff from a new development is passed onto downstream residents in the form of increased flood damage and distress, or onto the local authorities that must upgrade the drainage system or construct additional flood mitigation works.

OSD is also consistent with, and supports, urban consolidation. One of the principal arguments against urban consolidation is that the stormwater drainage system cannot cope with the increased stormwater runoff. By ensuring there is no increase in peak runoff from urban consolidation sites under all circumstances, OSD completely overcomes this objection.

2.6 Better water quality

The existing OSD policy already provides some water quality benefits in that the screen surrounding the orifice traps pollutants, such as trash, litter, leaves, grass clippings, other organic matter and coarse sediments. The revised OSD policy will, however, provide enhanced water quality benefits in two ways.

Firstly, by controlling stormwater runoff from the site, even in minor storm events, the OSD systems will reduce peak flow rates further downstream. This is important because the mobilisation and transport of surface pollutants, then the scouring of the bed and banks of watercourses and the turbidity in streams due to remobilisation of suspended sediments are all directly related to the peak flow rates.

Secondly, the new OSD creates an opportunity to remove further pollutants at the point where they leave the site. By severely restricting site runoff in minor storms the new OSD policy will result in only a trickle leaving sites during minor storms. It therefore becomes feasible to improve its water quality by passing flow through a small bio-retention filter, located at the very front or rear of the property, before it leaves the site. Blacktown City Council and several other councils already require both OSD and water quality treatment on many new developments. Accordingly the Handbook provides simple concept designs, a design procedure and a worked example of simple single lot water quality treatment devices.

2.7 Water Sensitive Urban Design

Current trends in urban development seek to address the issue of creating a more sustainable urban environment. Global warming and climate change are now seen as issues to be addressed in the present not just the future. Droughts and dry land salinity have highlighted the need to review our national approach to water usage, while the increasing population in major cities has increased attention on the supply of potable water and the disposal of wastewater. Water supply authorities are reviewing the appropriateness and cost implications of using treated, potable water for domestic or industrial uses that are predominantly non-potable.

As the driest continent in the world, Australia must conserve water, which is one of its most precious resources, if the country is to prosper in the long term. Action now will give future generations an opportunity to enjoy the quality of life we currently enjoy. Failure to act could create enormous problems within the next generation.

Water Sensitive Urban Design (WSUD) is a process by which a development is designed so as to mimic the natural pre-development water cycle. In an undeveloped site rainwater may fall on vegetation or pervious ground surfaces. Typically there will be some infiltration into the topsoil, ponding on flat areas from where the water may evaporate and absorption by vegetation. Any overland flow that results is likely to be sheet flow over a vegetated surface which means that velocities are low and the stormwater may take a considerable time to reach the nearest watercourse. This extended period of flow to watercourses reduces the risk of flooding because a significant portion of the rainfall takes a long time to reach the watercourse.

Rainwater that has infiltrated into the topsoil may also find its way to local watercourses but this takes much longer again. This water may also flow into ground water if the subsoil is sufficiently pervious.

After development however there is less vegetation, more impervious area and a more efficient means of collecting and transporting flows off site. This increases the volume of flow into the watercourses and reduces the time taken to reach the waterway. This leads to greater flow depths in the creek and the likelihood of flooding. OSD is one way that stormwater can be temporarily detained close to where the rain falls to help overcome the quickening of flows to the creek systems. The same volume of stormwater will reach the waterway but at least it takes several hours longer which, in this catchment, helps reduce the risk of flooding downstream.

In keeping with a WSUD approach, the amended OSD policy has as its core objectives:

(i) The limiting of flow peaks throughout the catchment, in a 100 yr ARI event, to estimated peak flows under 1999 conditions, even if the further development of the catchment is equivalent to full medium/high density redevelopment throughout the catchment; and

(ii) The reduction of post development peak flows, throughout the catchment, in the 1.5 yr ARI event to be as close to natural flow rates as practical.

3. ON-SITE STORMWATER DETENTION POLICY

3.1 Policy statement

The primary aim of the catchment OSD policy is to ensure that new developments and redevelopments do not increase peak stormwater flows in any downstream area during major storms up to and including 100 year ARI (1% AEP) events. The secondary aims of the policy are to reduce post development peaks throughout the catchment in the 1.5 yr ARI event to be as close to natural levels as practical and to encourage the integration of OSD with other water quality measures.

The OSD solution should create a sustainable solution for peak stormwater flow management, which complements any WSUD aspects of the development. There should be no increase in the site discharge to the downstream drainage system nor reduction in the volume of storage provided unless specifically allowed in following sections. (Section 4.2.9 details the volumes of rainwater tanks that can be offset against the OSD storage.)

3.2 Objectives

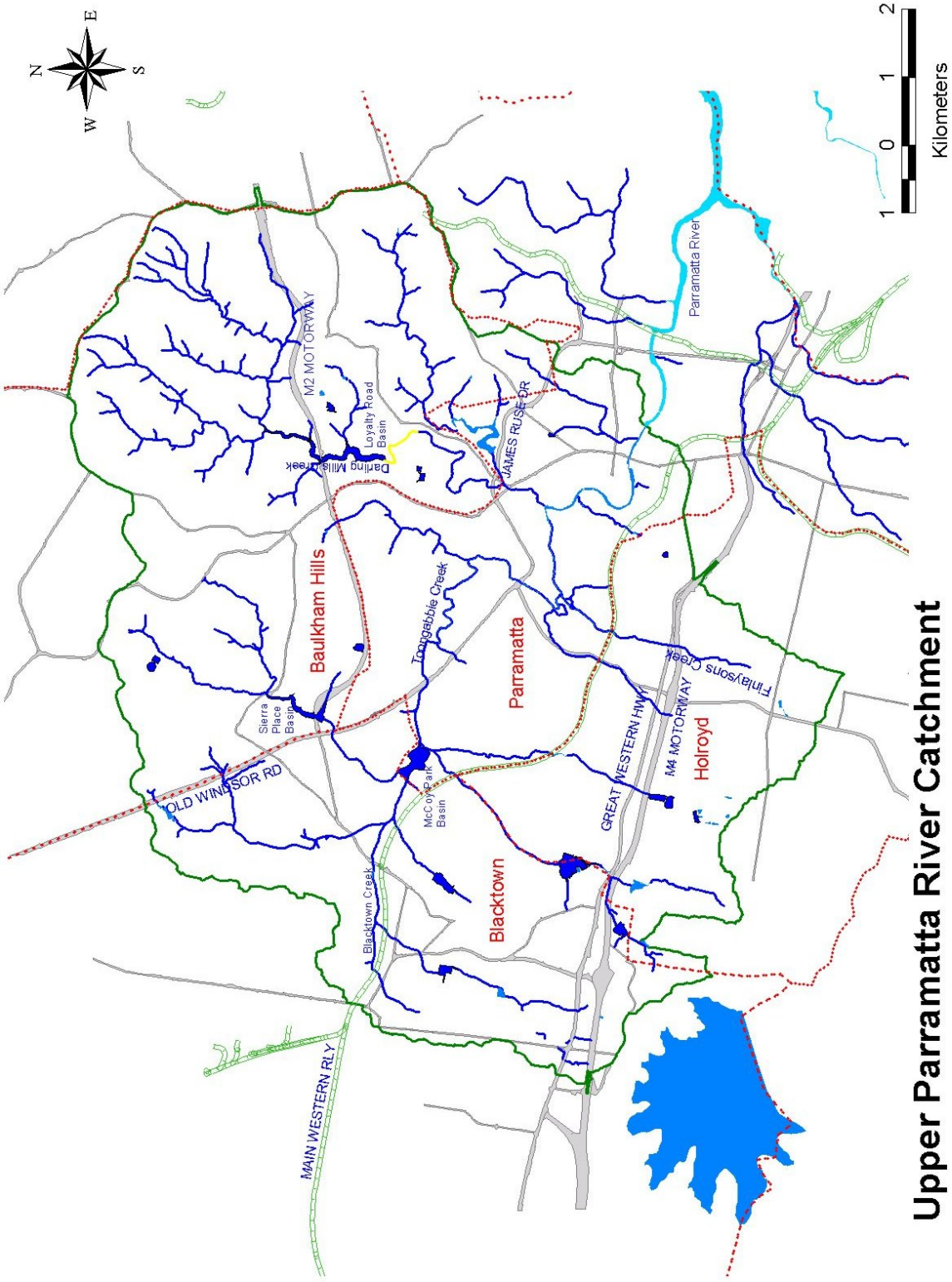
The objectives of the OSD policy are to:

- To limit flow peaks throughout the catchment, in a 100 yr ARI event, to estimated peak flows under 1999 conditions, even if the further development of the catchment is equivalent to full medium/high density redevelopment throughout the catchment thereby preventing any increase in downstream peak flows resulting from new developments or redevelopments by temporarily storing on-site the additional and quicker runoff generated;
- prevent increases in downstream flooding and drainage problems that could:
    - increase flood losses
    - damage public assets
    - reduce property values
    - require additional expenditure on flood mitigation or drainage works.
- reduce post development peaks, throughout the catchment, in the 1.5 yr ARI event to as close to natural levels as practical;
- encourage integration of OSD systems into the architectural design and layout of the development so that adequate storage areas are included in the initial stages of the site design;
- encourage integration of the OSD facilities into a sustainable overall water management plan for the site; and
- require construction supervision of OSD systems by the OSD designer to improve construction standards.

3.3 The catchment area

The policy, control standards, procedures and approval processes detailed in this Handbook apply throughout the 110 km^2 of the upper Parramatta River catchment. The four local councils, Baulkham Hills, Blacktown, Holroyd and Parramatta have adopted the common OSD policy for those areas within the catchment. The catchment boundaries are shown in Figure 3.1.

Figure 3.1 Upper Parramatta River Catchment



For areas outside the catchment, interested parties should contact the relevant local Council. An approximate procedure for applying the methodology outside the catchment is given in Appendix R and the parameters for the design of OSD systems in other catchments within the four council areas are given in Appendix Q.

3.4 Policy application

On-site Stormwater Detention (OSD) systems temporarily detain stormwater on a site, in order to limit the discharge leaving the property to a pre-determined rate that will ensure that the development does not increase downstream flood discharges for storms up to the 100 year ARI event.

OSD is applied as a condition of development consent by Council under the Environmental Planning and Assessment Act 1979. Any existing obligation to provide and maintain an OSD system will be found in the development consent applicable to the property or on the property title itself. In the case of a proposed development, the guidelines given below in Sections 3.4.1 and 3.4.2 show whether OSD will be necessary.

OSD is not generally required on residential lots created by subdivision prior to 1991 when a common OSD policy was adopted by the four councils in the upper Parramatta River catchment. All lots created after 1991 have a requirement for OSD applied as a condition of development consent for the subdivision.

3.4.1 Developments to which OSD applies

OSD requirements generally apply to all types of development and redevelopment on both flood liable and flood-free sites. These include the following:

- subdivisions (including residential) approved after 1991;
- single dwellings on lots created by a subdivision approved after 1991, unless a communal OSD system was constructed as part of the subdivision;
- all commercial, industrial and special-use developments and buildings;
- town houses, villas, home units, duplexes and dual occupancies;
- semi-detached residential/commercial and residential/industrial properties;
- buildings, car parks and other sealed areas of public sport and recreational facilities;
- single dwellings, extensions and additions[1] (refer also Section 3.4.2);
- sites that include WSUD and water re-use[2].
- tennis courts;
- roads, car parks, paths and other sealed areas; and
- public buildings;

[1] In the Parramatta City Council area only where the proposed development involves an increase in impervious area greater than 150 m^2 and the land is designated as Grey or Grey Hatched on Council's Flood Prone Land Map

[2] Consideration will be given to variations to the PSD or SSR only where it has been proved conclusively that infiltration/recycling or reuse of runoff will invariably reduce the site stormwater discharge for the full range of storm events

3.4.2 Developments to which OSD does not apply

OSD policy does not apply to:

- single dwellings, extensions, additions and improvements on single residential lots created before November 1991 (when the OSD policy was adopted), 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 3.4.1;
- 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 for the new lots created.) Subsequent single residential building/additions on the residual lot will also not be required to provide OSD;
- 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.);
- dual occupancy residences on a lot with an existing residence involving less than 150 m^2 of development area;
- sub-divisions of existing dual occupancies where no changes to the buildings or site are proposed;
- boundary adjustments and consolidations of allotments where no additional lots are created;
- one-off minor developments, minor additions and repairs where the proposed development area is less than 150 m^2 (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 150 m^2 of impervious surfaces nor to dual occupancies;
- change of use where no physical changes to the outside of the property are proposed;
- areas within large properties (usually commercial or industrial but may be residential) not covered by the development application or construction certificate;
- new developments in subdivisions where OSD has already been provided for the entire subdivision;
- buildings in Rural/Non-urban areas[3];
- the grassed playing field and vegetated area of public sports and recreational facilities that are not part of a development.

[3] Baulkham Hills Shire Council does require OSD for buildings in Rural/Non-urban areas. Contact Council's Subdivision Section to obtain the OSD requirements.

3.4.3 Area of the site to which OSD applies

Generally, OSD applies to the entire site, but there may be exceptions in certain circumstances.

Additions & extensions

On an already-developed property, the OSD requirements apply only to the area of the new development, provided runoff from previously developed areas can be excluded from the OSD storage.

Dual occupancies

Where an additional dwelling is proposed on a lot with an existing dwelling, the OSD requirements will relate to the additional dwelling and a curtilage for anticipated paths, driveways and paved areas. In the absence of details on the plans, the curtilage will be taken as 10% of the area of the proposed second dwelling. Where two or more dwellings are constructed on the same lot at the same time, the OSD requirements will be applied to the entire site.

Subdivision of an existing residential property

When an existing residential property is subdivided to create a single additional lot, the OSD requirements will relate only to the area of the new allotment. The OSD storage facilities may be located on the remainder of the original property, provided the combined peak discharge (from both lots) is no greater than if the OSD systems were located on the new lot.

Subdivisions creating new public or private roads and paths

The OSD requirements apply to the whole development area including roads and paths, not just the individual lots. The best solution will normally be for the detention storage to be located on one lot for the whole subdivision. However, if individual storages are provided on each lot, the discharges should be adjusted to provide the equivalent storage for the area of roads or paths.

Undeveloped portions of a lot

Portions of large lots which are unaffected by the development may be excluded from the area to be controlled by the OSD systems, provided flows from these areas can be diverted around the OSD system. Council approval must be obtained before excluding portions of a lot from the OSD requirements.

Floodways (See Section 4.1.3)

Creeks, waterways and drainage swales that carry major concentrated flows around the storage area are defined as floodways. The area of the floodway can be excluded from the site area for the purpose of calculating the site storage requirements, provided that the area is protected from development by an appropriate covenant or easement.

Note: Overland flowpaths, which cater for minor flows cannot be excluded from the site area for the calculation of OSD.

New development or redevelopment

Where the proposed development is of a vacant site or a complete redevelopment of an already-developed property, the OSD requirement will relate to the whole property.

Battle-axe blocks

The access driveway to battle-axe blocks shall be included in the site area used for calculation of the site storage requirements.

3.4.4 Policy variations

Each council will, in consultation with the Trust, consider requests to vary control standards or provide/contribute to alternative storage facilities in accordance with the procedures outlined in Appendix A. For equity reasons, where OSD is waived for a particular site, an equivalent expenditure on measures providing environmental and/or community benefits from the development, such as water quality improvements, will be required.

In some situations, where the site is flood prone and the watercourse flows through the site, the council may accept the provision of additional mainstream flood storage in lieu of OSD. In these cases, the storage must be available over the full range of storm events and allow for the fact that mainstream flood levels will tend to decrease over time. The additional storage required is expected to be comparable but not less than the site's OSD storage requirement.

3.5 Control standards

3.5.1 Site Reference Discharge (SRD)

The SRD for the primary (lower) orifice outlet (SRD_L) is 40 L/s/ha. The SRD for the secondary orifice outlet (SRD_U) in the DCP is 150 L/s/ha. This will need to be adjusted in accordance with the procedures set out in Section 5.1 when the entire site cannot be drained to the storage.

3.5.2 Site Storage Requirements (SSR)

The overall (total) SSR for an OSD storage (SSR_T) is 455 m^3/ha. The SSR for the OSD storage is partitioned into extended detention (lower) and flood detention (upper) storages. The maximum SSR for the extended detention storage is 300 m^3/ha.

The SSRs is only adjusted if a rainwater tank is included in the development / redevelopment and an airspace "credit" is claimed to partially offset the SSR.

3.5.3 Minimum outlet size

To reduce the likelihood of the primary or secondary outlets being blocked by debris, the outlet openings shall have a minimum internal diameter or width of at least 25 mm and shall be protected by an approved mesh screen.

3.5.4 Ponding depths

Guidelines to assist in determining depths and frequencies of ponding for different classes of storages are given in Table 6.1. It is emphasised that these are general guidelines that will be varied according to the nature of the development and the location of the storage. The maximum depth of ponding in above ground storages is 600 mm.

Council may approve deeper ponding in individual cases where the applicant demonstrates that safety issues have been adequately addressed. For example warning signs and or fencing should be installed where the depth exceeds 600 mm or adjacent to pedestrian traffic areas.

3.5.5 Safety fences

Surface storages should be constructed so as to be easily accessible, with gentle side slopes permitting walking in or out. A maximum gradient of 1(V):4(H) (ie. 1 vertical to 4 horizontal) will be required on at least one side to permit safe egress in an emergency. Where steep or vertical sides are unavoidable, due consideration should be given to safety aspects, such as the need for fencing or steps or a ladder, both when the storage is full and empty.

Balustrades (fences) must comply with the Building Code of Australia (See Section D2.16 of the Code), while safety fences should comply with the Swimming Pool Act 1992.

3.5.6 Internal drainage system

The stormwater drainage system (including surface gradings, gutters, pipes, surface drains and overland flowpaths) for the property must:

- be able to collectively convey all runoff to the OSD system in a 100-year ARI (1% AEP) event with a duration equal to the time of concentration of the site; and
- ensure that the OSD storage is by-passed by all runoff from neighbouring properties and any part of the site not being directed to the OSD storage, for storms up to and including the 100-year ARI event.

3.5.7 Signage

Small OSD signs (see Figure N3) shall be located in or near the OSD facility to alert future owners of their obligations to maintain the facility.

OSD Warning Signs (see Figure N1) are only required for OSD systems where deemed necessary by a Council because of the depth and/or location of the storage.

Signs are required at each entry into confined spaces, such as deep pits or underground storages.

Guidance on the size of signs and appropriate materials is given in Appendix N.

3.6 Policy implementation

3.6.1 Development approvals for Subdivisions

In general, OSD requirements are imposed at the subdivision stage, in the following manner:

- Development Application – submission and approval of a conceptual layout of the OSD system (Stormwater Concept Plan)[4];
- Submission of Engineering Plans – submission and approval of the detailed design, including calculations and construction plans and details; and

[4] Except at Holroyd City Council where a detailed design is required with the development application

- Release of Subdivision Certificate/Linen Plans – submission and approval of work-as-executed drawings, certificates of hydraulic compliance, and legal instruments on property titles protecting the OSD system.

An OSD system should be constructed at the time of subdivision and not deferred until the construction of the individual dwellings, except where the subdivision is up to seven lots, if it is proven that there are site restrictions (See Section 4).

The various steps involved in the OSD approval process are set out in Figure 3.2.

3.6.2 Development approvals and construction certificates

When the OSD requirements are implemented through the development approval and construction certificate process, the approval is in three stages:

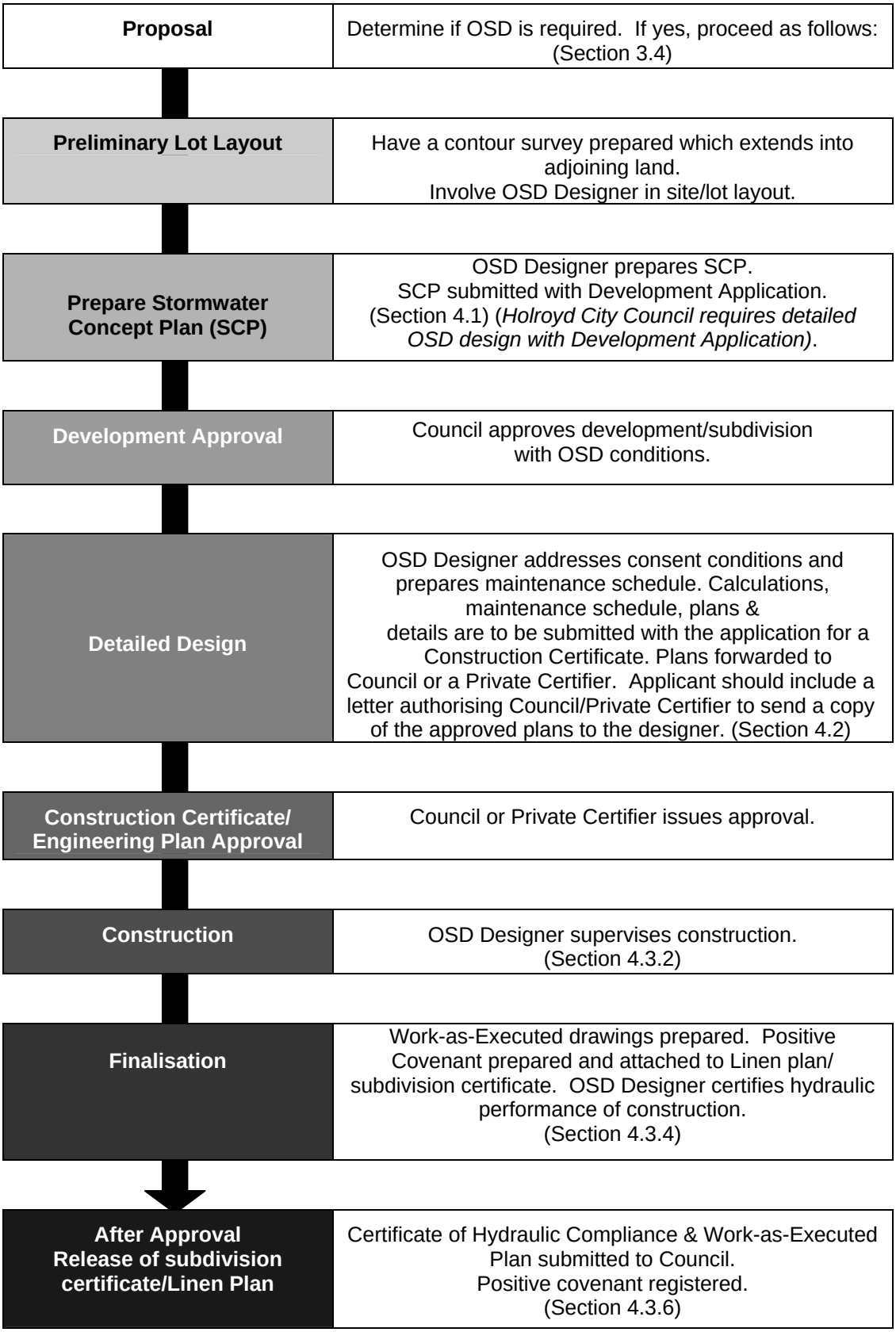
- Development Application – submission and approval of a conceptual layout of the OSD system (Stormwater Concept Plan)[5];
- Construction certificate – submission and approval of the detailed design, including calculations and construction plans and details;
- Final Approval – submission and approval of work-as-executed drawings, certificates of hydraulic (and structural, if required) compliance and legal instruments protecting the OSD system.

If the OSD system was constructed at the subdivision stage, the system should be re-certified at final approval to ensure it will function as designed and that runoff from the roof, paved areas and landscaped areas is directed to the OSD system.

The various steps involved in the OSD approval process are set out in Figure 3.2.

[5] Except at Holroyd City Council where a detailed design is required with the development application

Figure 3.2 OSD Approval Process



4. THE APPROVAL PROCESS

This section sets out the steps in the approval process from the Stormwater Concept Plan through the detailed design to the construction and final approval.

OSD is best considered as early as possible in the development process, particularly where the proposal includes WSUD principles, so that the most efficient and effective system can be designed and installed. There are a number of issues to be addressed at the conceptual stage that will have a significant impact on the final solution:

- in multi-lot subdivisions, a common OSD system should be constructed on one lot rather than a separate system on each individual lot;
- every attempt should be made to use surface storage for the OSD system. Underground storages should be the option of last resort. The use of surface storage reduces the cost of the system and improves accessibility for maintenance (See Section 4.2.6 and Appendix S;
- overland flows from upstream must be diverted past the OSD storage unless the storage volume is increased to cater for the upstream catchment;
- the OSD system is to be constructed at the time of subdivision and not to be deferred until the building is constructed without specific Council approval. Council approval will only be considered for subdivisions of up to 7 lots where there are demonstrable site restrictions. Any easements or inter allotment drainage cannot be deferred and must be created/installed at the time of subdivision.
- the site should be shaped to ensure all flows are directed to the storage even if blockages or larger storm events occur;
- development of flood prone sites must be carried out without any net loss of flood storage.

4.1 The Stormwater Concept Plan

A Stormwater Concept Plan (SCP) is required to support all development applications covered by the OSD Policy (see Section 3.4.1). The purpose of a SCP is not to provide a detailed design, but to identify the drainage constraints and to demonstrate that the OSD system can be integrated into the site's overall water management and proposed layout. The steps involved in preparing a SCP are summarised in Figure 4.1. It should be noted however, that Holroyd City Council no longer accepts SCPs in conjunction with the development application and requires a detailed OSD design because in many parts of the City, detailed levels are required to show that the OSD facility will function correctly.

An OSD system is an integral part of the entire development and can be expensive to retrofit once the site layout has been established. The control of stormwater flows through the OSD facility may facilitate the provision of water quality improvements on sites where these are required by the development consent. Treatment of the stormwater will often be easier once the discharge has been controlled by the OSD facility. Developers and architects should involve their OSD and WSUD designer(s) in developing the initial site layout. The integration of an OSD system with water quality measures is discussed in Section 8.

4.1.1 Objectives

The objectives of the Stormwater Concept Plan are to:

- emphasise that the OSD and drainage requirements need to be considered, as part of an overall site water management plan, in the initial planning stages of the development;;
- simplify the detailed design by identifying adequate storage areas in the planning stage and showing how the OSD design complements the WSUD components of the proposal;
- reduce project costs by maximising the use of proposed landscape and architectural features as part of the OSD system;
- allow the cost of development consent conditions relating to OSD to be determined at the planning stage; and to
- assist in addressing the concerns of local residents regarding drainage and flooding issues.

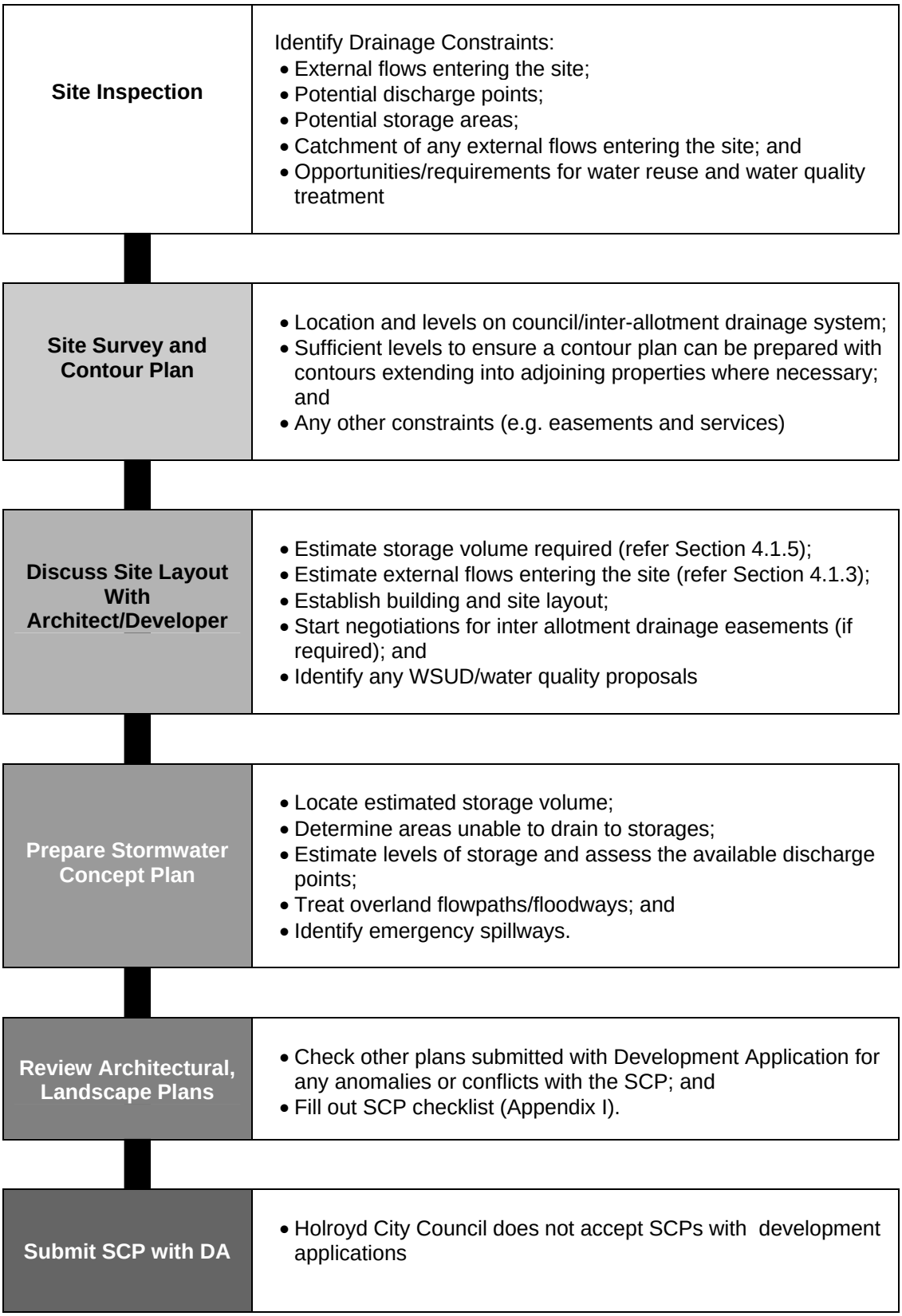
4.1.2 Minimum data requirements

The minimum information to be included in a SCP is:

- an estimate of the volume of OSD storage required;
- the relationship between OSD and any WSUD proposals for the site;
- calculations of the maximum 100 year ARI flow rate for flowpaths and floodways;
- a plan which includes:
    - the development/site boundaries and area
    - contours and spot levels (which reflect the site gradings and extend into adjoining properties)
    - the extent and area of any upstream catchment for external flows entering the site
    - the location and extent of detention storages
    - the location and levels of discharge points for the storages
    - the layout of the site, including location of all buildings, roadways and landscaped areas
    - the location and approximate extent of any floodways or flowpaths through the site
    - the location and area of any portion of the site unable to drain to the storages.

A SCP Checklist is provided in Appendix I.

Figure 4.1 Preparation of Typical Stormwater Concept Plan



4.1.3 Assessment of external flows

An OSD storage is designed to deal with stormwater runoff from only a particular area. If external flows enter the storage, it will fill more quickly, causing a greater nuisance to occupiers and it will become ineffective in terms of reducing stormwater flows leaving the site. The OSD design must therefore cater for external flows that can enter the storage. This is done by either increasing the size of the storage, or by diverting the external flows around the storage.

If upstream flows cannot be diverted around the storage, the storage size must be increased to cater for the additional catchment while maintaining the required SRDs.

Where the storage is not sized to detain runoff from the entire upstream catchment, a floodway/overland flowpath must be provided to ensure that the 100 year ARI runoff from outside the site by-passes the OSD storage. It is important to ensure that the by-pass flow is directed to a suitable outlet point and not directed onto an adjoining property. The diversion drainage should be designed to cater for the 100 year ARI flow for the upstream catchment, which may well have a longer time of concentration than the site. It is preferable if the diversion drainage can be designed to avoid unnecessarily concentrating the flow and in some instances it may be possible to respread the flow to sheet flow. The diversion may be achieved with a grass swale or raised garden bed in many instances. This will provide a softer solution than a concrete drain or piped system and may be easier to respread to sheet flow. In addition, the use of a landscaped solution will often be more attractive and cheaper.

For the purposes of the OSD policy, the external flows can be divided into two categories: overland flowpaths and floodways.

Overland Flowpaths

These are surface drainage systems which cater for relatively minor sheet flow from upstream properties and convey it around the storage or allow it to pass across the site without interference (eg. dish drain, grassed swale). The area of the flowpath must be included in the site area when determining the site storage requirements.

Floodways

These surface drainage systems convey relatively major concentrated mainstream, surface or surcharge flows from an upstream catchment around the storages (eg. overbank flow, natural gully or surcharge flowpath for a drainage line). The area of the floodway can be excluded from the site area for the purpose of calculating the site storage requirements, provided that the area is protected from development by an appropriate covenant or easement.

There are a small number of situations where part of the external flow would not enter the storage. This portion of the flow need not be collected nor diverted. For example:

- dual occupancies where a second dwelling is proposed on a lot with an existing dwelling[1];
- large properties where only a small area is being developed[2].

[1] OSD is required for the area of the additional dwelling plus a curtilage to cover paths and paved areas. Runoff from the remainder of the lot need not be directed to the OSD storage nor is it necessary to divert external flows affecting this portion of the lot.

[2] OSD applies only to the area covered by the development application, generally the building/paved area plus curtilage. Here again external flows affecting the undeveloped areas need not be diverted.

4.1.4 Areas not directed to the OSD storages

Where possible, the drainage system should be designed to direct runoff from the entire site to the OSD system. Sometimes, because of ground levels, the receiving drainage system or because of other circumstances, this will not be feasible. In these cases and provided Council's approval is obtained, up to 30% of the residual site area may be permitted to bypass the OSD systems, provided that as much as possible of the runoff from impervious site areas is drained to the OSD system. The storage volume is still calculated on the entire site area while the SRD is adjusted downwards according to procedures in Section 4.2.9. (See also Section 3.4.3 where the development affects only part of a site).

4.1.5 Estimating storage volumes

It is not necessary to select the discharge control device or accurately determine the SSR for the SCP. A storage rate of 500 m^3/ha can be used to approximate the required storage volume. This approximate volume is refined at the detailed design stage.

4.2 Detailed design

As of 1 May 1999, OSD designs and certifications are only accepted from persons having acceptable professional accreditation. The following are considered to be acceptable accreditation for the purpose of OSD design and certification:

- NPER in Civil Engineering (Engineers Australia);
- Surveyors Certificate of Accreditation in On-Site Detention and Drainage Design (Institution of Surveyors, NSW and the Association of Consulting Surveyors, NSW);
- Stormwater Register (Association of Hydraulic Services Consultants, Australia)
- Accreditation as a certifier under the Environmental Planning and Assessment Act 1979 in the relevant discipline.

A detailed design submission is required to support an application for a construction certificate or the engineering plans of a development. The specific site drainage constraints will have been identified and addressed conceptually in the SCP, thereby simplifying the detailed design.

The purpose of the detailed design submission is to finalise the design of all components of the OSD system, provide a set of plans and details for construction of the system, and detail the maintenance procedures necessary to ensure the long-term effectiveness of the system. The steps involved in a typical detailed design submission are outlined in Figure 4.2.

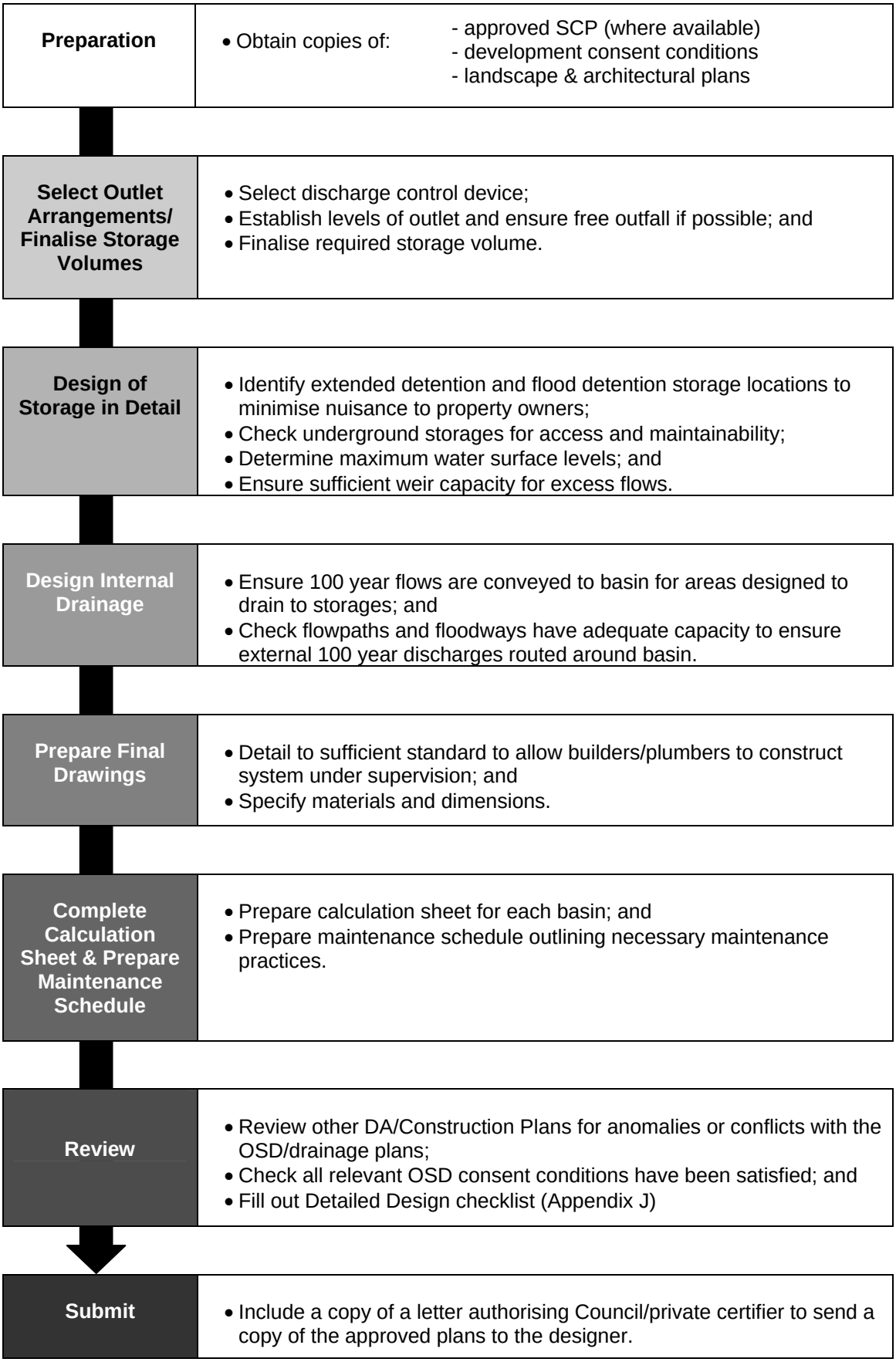
One of the concerns raised by OSD designers is that they may not see the approved OSD plans if they are not the applicant. Council may not be entitled to send a copy to the designer unless the applicant gives permission. If the applicant authorises release of a copy of the plans, this will allow designers to adjust future designs to better suit the Council's requirements. It will also ensure that the designer has the approved plans if engaged to provide the hydraulic certification for the OSD facility.

4.2.1 Objectives

The objectives of a detailed OSD design are to:

- ensure that all components of the OSD system are functional;

Figure 4.2 Preparation of a Typical Detailed Design Submission



- ensure that the OSD design complements the WSUD proposals for the site;
- simplify construction of OSD systems by providing detailed design plans;
- increase owner awareness and improve maintenance standards by simply outlining the necessary maintenance practices; and to
- encourage consideration of accessibility and maintainability of storages.

4.2.2 Minimum data requirements

The following information must be included in a detailed design submission:

- calculations for each storage, finalising the storage volumes and discharge rates in accordance with procedures in Section 5;
- where WSUD components are proposed, calculations and details of both the OSD and WSUD components are required that clearly demonstrate that the designer has integrated the systems so as to allow for the impact of each on the design of the other. For further information on the details to be submitted for the WSUD components please contact the local Council. Additional information is also available in the Water Sensitive Urban Design Technical Guidelines for Western Sydney dated May 2004 prepared for the Trust by URS Australia Pty Ltd. Copies of the final report can be downloaded from the Water Sensitive Urban Design in the Sydney Region website (www.wsud.org).
- calculations verifying that the flowpaths/floodways, internal drainage systems and any overflow weirs have sufficient capacity;
- design plans and details that include the:
  - location and extent of each storage with each storage wholly within the property;
  - locations and details of each outlet and/or discharge control device;
  - catchment area draining to each storage;
  - maximum water surface levels in each storage;
  - overflow structures and surcharge paths;
  - levels and location of the discharge points for each storage;
  - internal drainage system;
  - existing contours and final design levels;
  - final site/lot layout; and
  - location and extent of any floodway/flowpath.
- cross-sections through the storages;
- a maintenance schedule that simply sets out:
  - what maintenance is required
  - how will the maintenance be done
  - who should carry out the maintenance
  - when the maintenance will be done

- structural certification for components of the OSD system (if necessary);
- a completed Detailed Design checklist (See Appendix J); and
- a letter authorising Council to forward a copy of the approved plans to the designer.

4.2.3 Outlets

The outlet configurations for the on-site detention storage comprise (refer Figure 5.1):

- a primary orifice outlet to the extended detention storage with free discharge; and
- a secondary orifice controlled High Early Discharge (HED) outlet in a modified DCP that commences operation once the capacity of the extended detention storage is exceeded.

A concept general arrangement for the primary and secondary outlets is given in Figure 4.3 with typical sections shown in Figures 4.4, 4.5 and 4.6.

The requirement to install sumps at the outlets varies between Councils as follows:

- Parramatta City Council requires 2 x 90 mm diameter pipes to be installed through the base of each sump (refer Figures 4.3 and 4.4);
- Holroyd City Council requires 2 x 90 mm diameter pipes to be installed through the base of each sump (refer Figures 4.3 and 4.4);
- Baulkham Hills Shire Council requires that sumps be filled with a mortar mix to the invert of the orifice; while
- Blacktown City Council does not require sumps to be installed.

Primary Outlet – Free Discharge Orifice

The orifice discharge equation is:

$$Q = C A (2gh)^{1/2}$$

where Q is the discharge in m^3/s
C is the coefficient of discharge
A is the orifice area in m^2
g is the acceleration due to gravity (m^2/s)
h is the depth of water above the centre of the orifice (m).

This equation relies on a circular sharp-edged orifice and free discharge from the orifice.

Orifice plates are to have the following characteristics:

- orifice plates are to be manufactured in corrosion-resistant 3 mm thick stainless steel plate, or 5 mm thick plate where the orifice exceeds 150 mm, with a circular hole machined to 0.5 mm accuracy;
- orifices fashioned in material other than stainless steel will be subject to the specific approval of the Trust. In determining whether an orifice is suitable, it will be necessary to demonstrate the:
  - discharge characteristics are constant and predictable
  - material is durable

- machined hole is to retain a sharp edge
- plate is to be permanently fixed to the storage wall with no gaps between the plate and the wall.

The minimum orifice diameter is 25 mm.

A concept orifice installation detail is given in Figure 4.7.

To ensure that free discharge is maintained the outlet needs to be well ventilated and the outlet pipe needs to be large enough to prevent submergence. The orifice should be centred in the outlet pipe to avoid edge effects.

Free discharge is not achieved when the outlet is affected by the tailwater levels in the downstream drainage system (see Section 6.4).

Secondary Outlet - Orifice Controlled by a High Early Discharge Control Pit

Hydraulic model tests conducted on behalf of the Trust by Manly Hydraulics Laboratory established a set of generic design parameters for DCPs incorporating HED, screens and orifice control.

Proprietary products or in-situ devices meeting these guidelines are not required to provide a laboratory-determined head-discharge relationship. Other forms of discharge control are commercially available and can be used in the catchment provided that the:

- hydraulic characteristics of a prototype have been determined and certified by a recognised hydraulics laboratory;
- risk of the device becoming blocked by debris is minimal;
- device can be readily inspected;
- device can be accessed for cleaning; and
- there is minimal risk of the system being tampered with.

The following minimum pit dimensions will achieve predictable hydraulic characteristics (where d is the internal diameter of the orifice and the minimum orifice diameter is 25 mm):

- minimum width = 3d (symmetrical about the orifice)
- minimum design head = 2d (centre of orifice to top of overflow)
- minimum screen clearance = 1.5d (orifice to upstream face of screen) .

These dimensions can be increased to allow greater screen sizes or improve access.

In order that HED can be assumed the volume of the DCP is to be small in comparison to the volume of the storage.

The Discharge Control Pit will need to be maintained regularly. To assist with inspecting and cleaning, the minimum internal dimensions of the DCP should be:

- 600 x 600 mm for up to 600 mm deep
- 900 x 900 mm for greater than 600 mm deep

Figure 4.3 Concept Outlet Arrangement

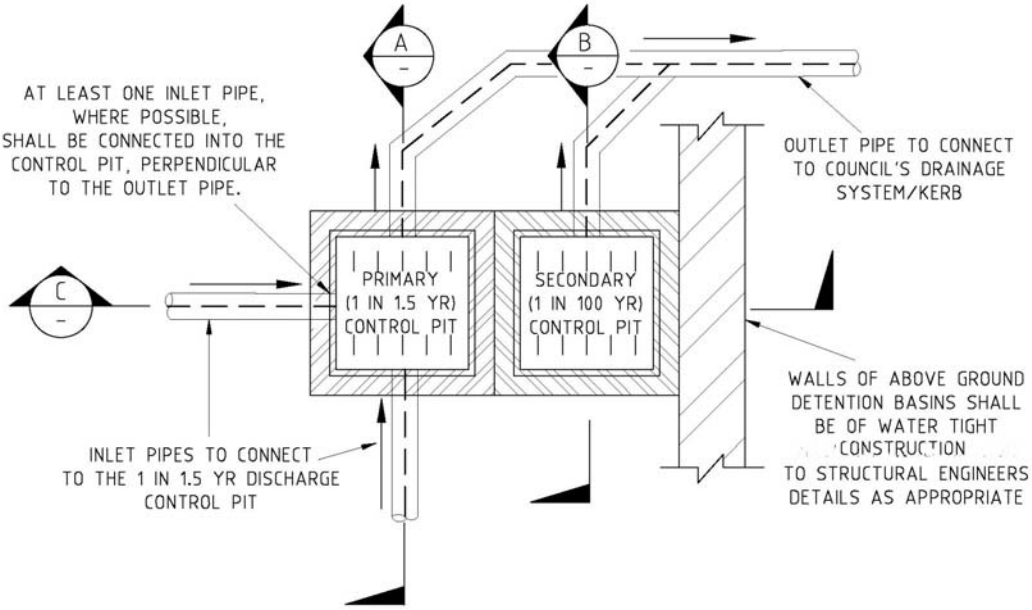


Figure 4.4 Concept Primary Outlet Arrangement

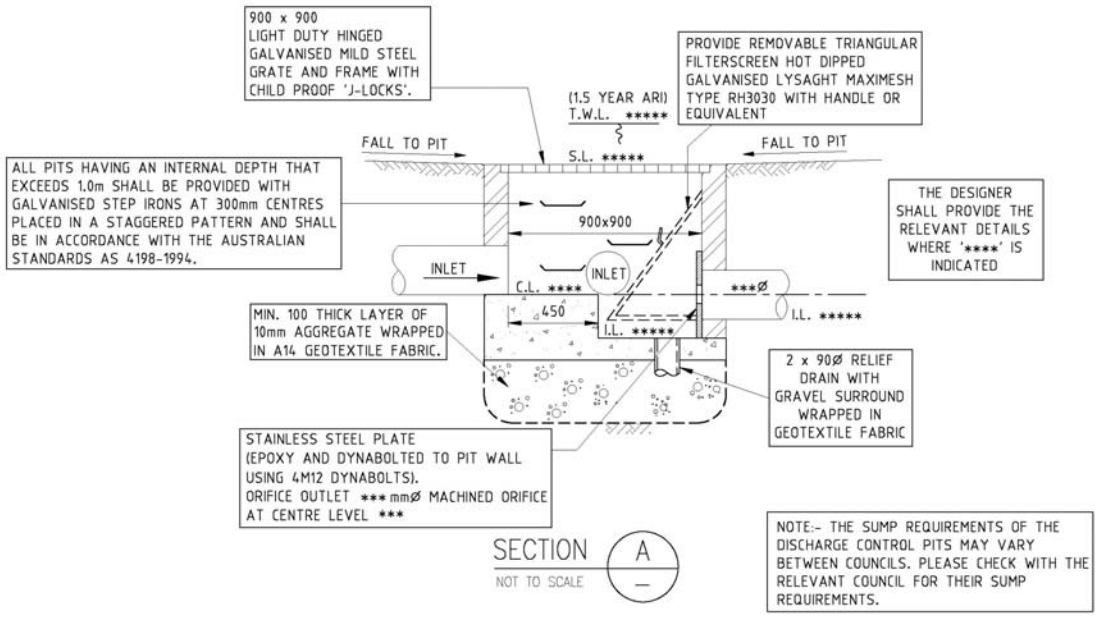


Figure 4.5 Concept Secondary Outlet Arrangement

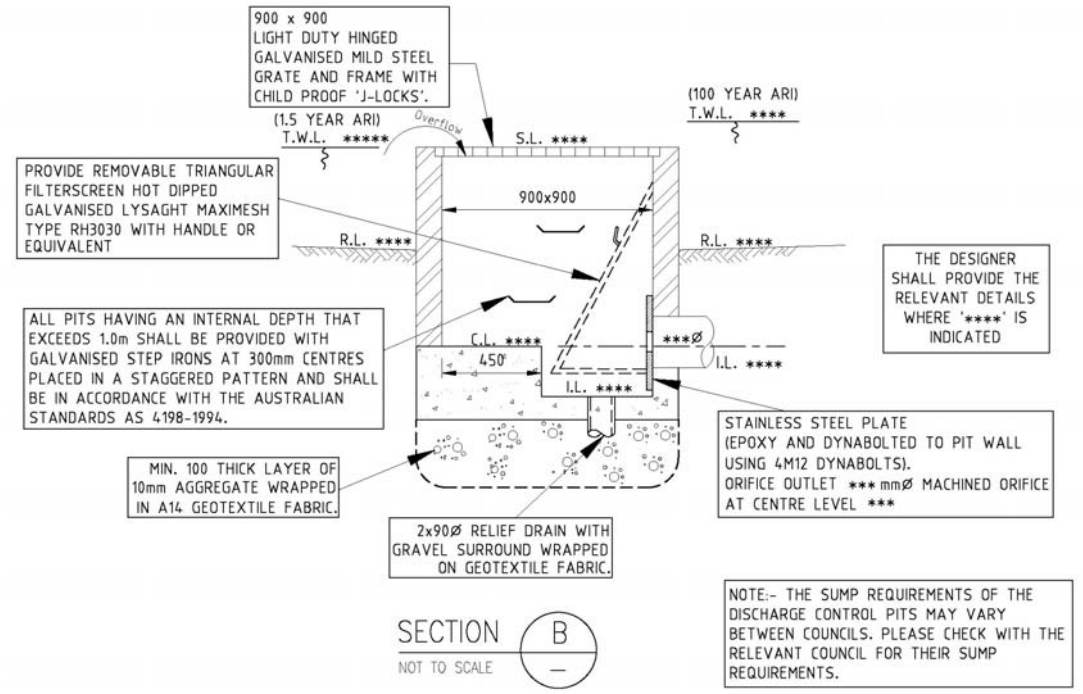


Figure 4.6 Concept Section of Primary and Secondary Outlets

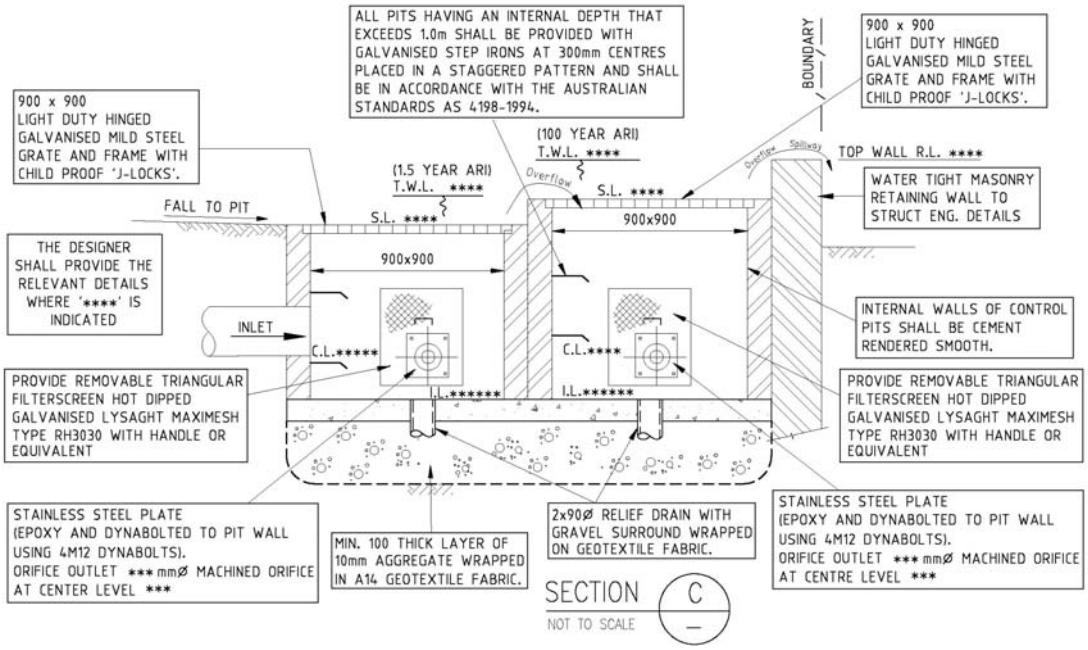
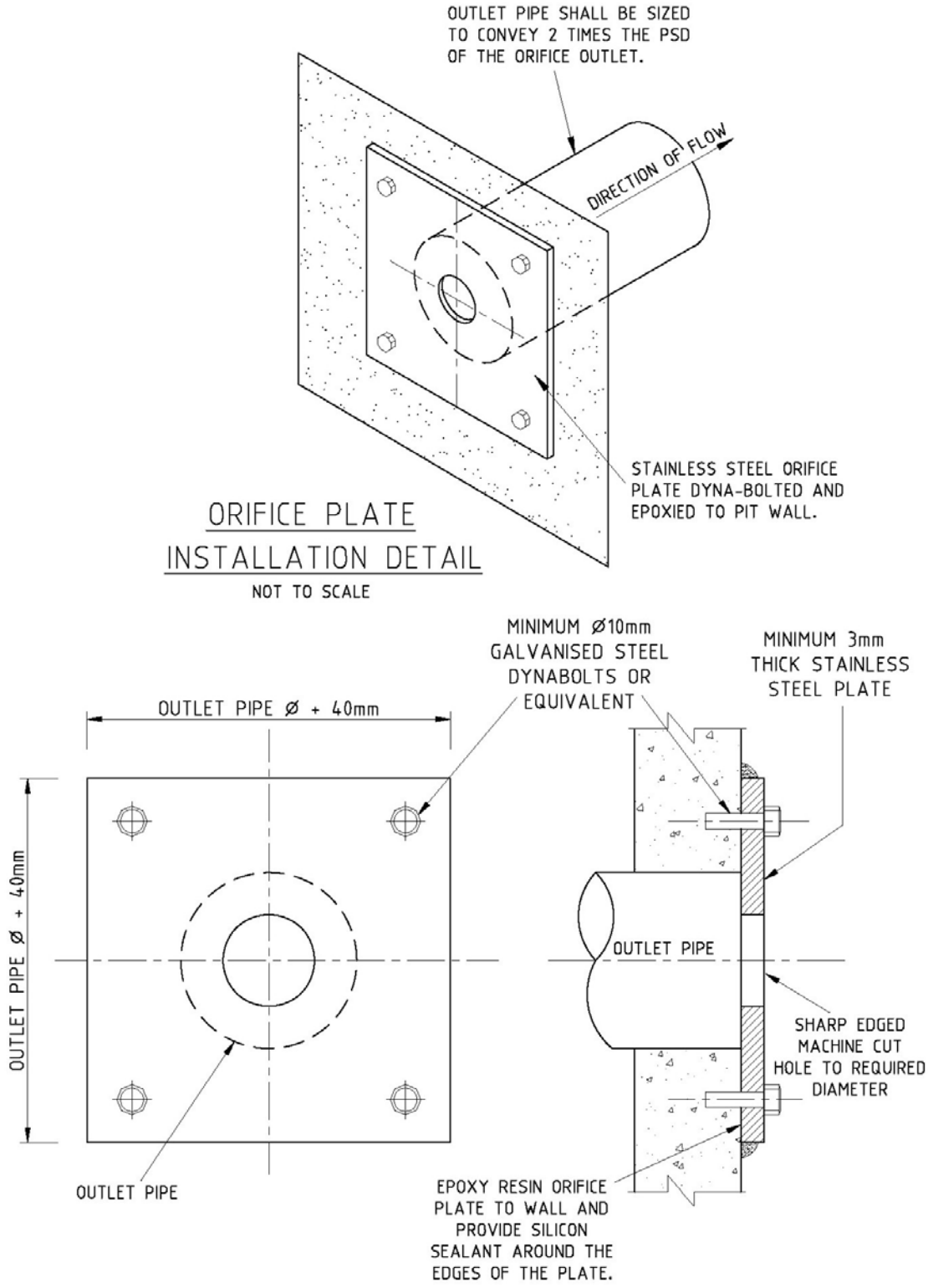


Figure 4.7 Concept Orifice Installation Detail



For sites with multiple owners/tenants the outlets, and as much of the storage as possible, should be contained in the common areas rather than on private lots. This means that inspections and maintenance are simpler and remain the responsibility of the joint owners rather than an individual.

To ensure that free discharge is maintained the outlets need to be well ventilated and the outlet pipe needs to be large enough to prevent submergence. As a guide, designers should try to ensure that the outlet from the DCP has a just-full capacity of twice the summed SRDs. Free discharge is not achieved when the outlet from the DCP is affected by tailwater levels in the downstream drainage system (See Section 6.4).

4.2.4 Screens

Both primary and secondary outlets must be fitted with suitable screens. Each screen needs to:

- protect the orifice from blockage;
- create static conditions around the orifice which helps to achieve predictable discharge coefficients; and
- retain litter and debris that would degrade downstream waterways.

Screen type

A small aperture-expanded steel mesh, such as Maximesh Rh3030, is recommended for orifices less than 150 mm in diameter. This type of screen retains relatively fine material (eg. cigarette butts and grass clippings) while maintaining the performance of the orifice under heavy debris loading.

For orifices larger than 150 mm, the screen area necessary for a fine mesh screen can make it difficult to fit in a DCP. A grid mesh, such as Weldlok A40/203, may be used for these larger orifices. Where the grid mesh is used, where possible a fine mesh screen should be installed upstream of the outlet, for areas likely to collect litter or debris.

Screen area

The minimum recommended area (including blocked area) for an internal screen is:

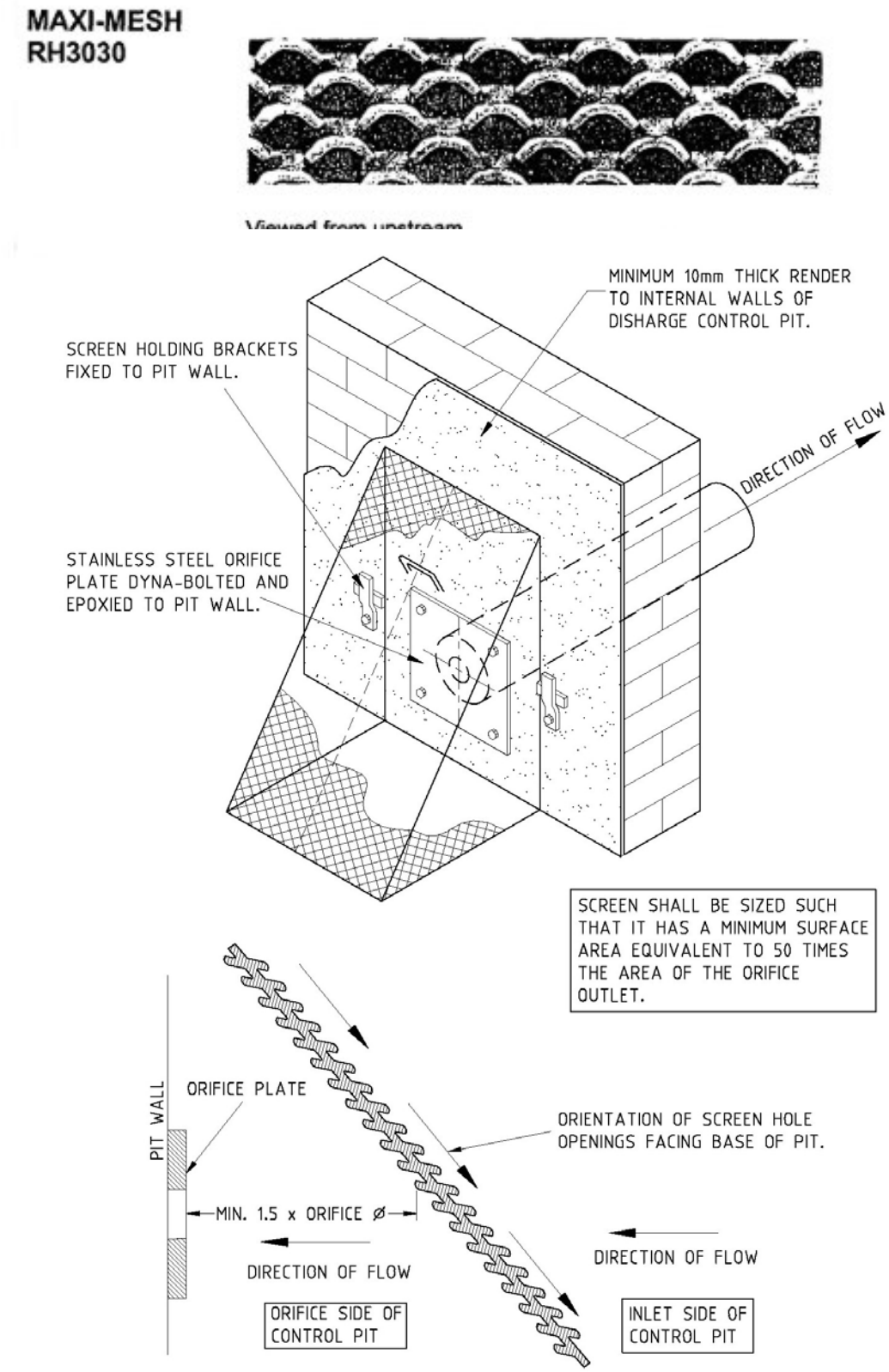
- 50 times the orifice area where a fine mesh screen is used (eg. Maximesh Rh3030);
- 20 times the orifice area where a grid mesh is used (eg. Weldlok A40/203).

Screen orientation

If inlet pipe(s) to the OSD are located close to the primary outlet then the inlet pipe should direct inflows parallel (or at a small angle) to the screen protecting the primary outlet. Perpendicular inflows drive debris into a mesh screen making it difficult to dislodge. The performance of the orifice and screen is influenced by the orientation of the screen.

To assist in shedding debris, the screen should be positioned as close to vertical as possible. This allows debris to fall off once the water level in the extended detention storage or the secondary DCP drops. However, the screen must fit securely to the tank/pit to avoid debris floating over or around the screen and blocking the orifice. The screen should be placed no less than 60 degrees to the horizontal.

Figure 4.8 Concept Screen (Maxi-Mesh RH3030) Detail



General

To prevent blockages, Maximesh screens must be positioned so that the long axis of the oval shaped holes is horizontal, the protruding lip is uppermost and above the hole and the screen is tilted downstream (see Figure 4.8). Blockages can occur if the screen is accidentally placed upside down. Fitting a handle to the screen not only reduces the chance of incorrect placement but also makes removal for cleaning easier. Fixings need to be selected to suit the screen and to promote easy removal for maintenance.

Reducing the screen size also facilitates cleaning by reducing the weight. Proprietary screens may be considered to achieve this end. A list of current suppliers of screens (and other OSD products) is given in Appendix P.

After being cut to size, Maximesh screens need to be 'hot dipped' galvanised to prevent corrosion. All mesh screens deflect under high inflows and heavy debris loading and should be braced to stop debris being carried around the screen.

4.2.5 Storages

The selection of the most appropriate type of storage for the site is critical to the quality, effectiveness and cost of the OSD design. Every attempt should be made to provide the majority of the volume as surface storage rather than below ground. Not only will this be generally cheaper to construct (savings of \$100-150/m^3 for storages between 20m^3 and 100m^3 were identified by a survey commissioned by the Trust and the NSW Department of Housing in 1996), but also greater flexibility is usually achieved in siting the storage. Also, maintenance is simpler and generally safer. Designers should be aware, however, of the increased risk of subsequent alteration to the storage by future occupants and should try to provide a finished landscape that needs no further improvement. It may be necessary to provide part of the extended detention storage below ground to reduce the chance of ponded water causing problems for occupiers of the site. However, innovative design can reduce the volume of below ground storage required.

Designers should also seek to provide larger common storages in multi-owner developments or subdivisions. This removes the need for a large number of smaller storages that will have increased design, construction and maintenance costs. Particular problems have been experienced in multi-lot subdivisions where OSD storages on individual lots have proved to be considerably more costly to install than a single OSD storage would have been.

Care should also be taken with the use of private courtyards (considered to be yards less than 60 m^2 in area) for storage for safety reasons. OSD storage in these courtyards will not be permitted if the area is less than 25 m^2 and Council's specific approval will be required for courtyards whose area is between 25 m^2 and 60 m^2. Recommendations for allowable depths and the frequency of ponding are given in Table 6.1.

OSD storages for subdivisions must be constructed prior to the release of the Linen Plan rather than deferred until the construction of the dwelling because of the problems faced by owners in deferred construction. The only exception to this requirement is the case of a subdivision of up to 7 lots where there are demonstrable site restrictions. Deferral still requires the written approval of Council. The construction of a single storage provides more flexibility in the design and siting of houses on the individual lots.

The walls of each storage must be entirely within the property so as to avoid possible disputes with adjoining land holders if the common boundary fence was used as part of the storage.

4.2.6 Surface storage systems

There are few absolute requirements when designing a surface storage. These guidelines have been framed to allow the designer maximum flexibility when integrating the storage in the site layout. A discussion of the general principles of storage design is included in Section 6. However the desirable minimum design parameters for surface storage systems are set out below.

General

The floor levels of buildings adjacent to surface storage areas should have a suitable freeboard to avoid the risk of water entering the building in storms more severe than the design storm or in the event of system blockage. The free board is to be calculated from the top water level including the depth of flow over the overflow weir. (See Section 4.2.8). The required freeboard is:

- 200 mm for habitable buildings
- 100 mm for garages.

A similar freeboard should be provided for flowpaths adjacent to buildings.

The walls creating each storage must be entirely within the property so as to avoid possible disputes with adjoining land holders if the common boundary fence was used as part of the storage.

Landscaped storages

- the desirable minimum surface slope is 1.5% for the base. The absolute minimum surface slope is 1.0% for the base;
- side slopes should be a maximum of 1V:6H where possible (see also Section 3.5.5);
- sub-soil drainage should be provided around the outlet to prevent the ground becoming saturated during prolonged wet weather;
- it is recommended that above ground storage avoid being co-located with children's play equipment. If the above ground storage is located in the same area as the children's play equipment then pool type fencing, including a child proof gate, must be provided to ensure that young children can only enter the area under supervision[3]. Water levels can rise quickly in the basin and pictorial signage such as that shown in Appendix N must be installed to reinforce to need to leave the area when it rains;
- where the storage is located in an area where frequent ponding could create maintenance problems or personal inconvenience to property owners, the extended detention storage should avoid active areas and be provided in an area able to tolerate frequent inundation such as:
  - a paved area not actively used eg. a sunken barbeque area
  - a small underground tank
  - a permanent water feature
  - a rockery or rock garden or a front setback.

[3] It is recommended that any gates in fenced storages should not open directly onto a public footpath

- if using private courtyards for OSD storage, the area of courtyard must be between 25 m^2 and 60 m^2 and specific Council approval must be obtained. In this Handbook, private courtyards are considered to have an area of 60 m^2 or less. Areas greater than that are treated as gardens. The storage should generally not commence ponding more frequently than once every 5 years ie. courtyards are unsuitable for extended detention. Provision should also be made for the future installation of garden sheds and the like by leaving an area of the courtyard above the storage depth. Refer to Table 6.1 for depths and frequency of ponding.

- the maximum depth of storage should be limited to 600 mm unless otherwise approved by Council and the area must be designed to allow safe egress as the storage fills with water.

- the structural adequacy of retaining walls must be checked, including the hydrostatic loads caused by a full storage.

- 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.

Driveway and car-park storages

To avoid damage to vehicles and minimise nuisance to motorists by:

- limiting the depths of ponding on driveways and car parks to less than 200 mm under design conditions;

- transverse paving slopes within storages areas should not be less than 0.7% with the surface sloped so that the deepest water is in the trafficable areas and shallower depths where people alight from their cars;

- where the storage is to be provided in a commonly used area where ponding will cause inconvenience (eg. 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 eg. a driveway.

4.2.7 Structural/underground storages

The use of underground storages for total storage volumes should be avoided where at all possible. However, locating part of the extended detention storage underground can often enhance a development by limiting the frequency of inundation of an open storage area. In very difficult topography, the only feasible solution may be to provide all or most of the storage volume underground. However the designer should recognise that underground storages:

- are more expensive to construct than surface storage systems;

- are difficult to inspect for silt and debris accumulation;

- are difficult to maintain;

- can be dangerous to work in and may be unsafe for property owners to maintain.

The optimal solution will generally be a system where the property owner is able to carry out the routine maintenance. Where the structure cannot be maintained by the property owner or occupier, this must be clearly identified in the maintenance schedule.

When preparing a design for underground storage, designers should be aware of the provisions of AS 2865 -1995 Safe Working in a Confined Space. Where practicable, the design should eliminate the need to enter the confined space for maintenance or other purposes. A sign indicating that the storage is a confined space and that entry should be restricted to trained personnel must be fixed to each opening into the underground storage. A typical sign is included in Appendix N.

The walls of each storage must be entirely within the property so as to avoid possible disputes with adjoining land holders if the tank or underground storage encroaches onto their land.

Important design considerations – Blacktown City Council

- residents/owners must be able to inspect critical parts of the storage from the surface without having to remove heavy access covers. Concrete covers are to be avoided for this reason.
- openings must be wide enough to allow easy entry to a storage, ie:

  600 mm x 600 mm (storages up to 600 mm deep); or
  900 mm x 900 mm (storages greater than 600 mm deep)

- a continuous fall on the floor of the storage of at least 1% must be provided to the storage outlet to minimise ponding in the storage.
- the minimum clearance height for accessible tanks is 1200 mm. Where this cannot be achieved due to level or other constraints, the following internal heights may be considered if all other options including above ground storage have been proven impractical:

Commercial/Industrial developments	750 mm
Residential developments	500 mm

  provided that:

  - grates to be placed at the extremities of the tank with a maximum distance of 3 m from any point in the tank to the edge of the nearest grate. This should allow any point in the tank to be reached with a broom or similar implement without the need to enter the tank;
  - tanks less than 750 mm high must be precast to avoid difficulties with removing formwork.
  - all grates accessing the tank shall be a minimum of 900 mm x 900 mm, and a maximum lifting weight of 20 kg;
  - the base of the tank is shaped with a 2% crossfall to a Vee drain and with a 2% longitudinal slope along the Vee drain;

- where all the storage is provided in an underground structure, a large storm could be stored even with a totally blocked outlet. The storage should be designed to overflow and pond in a very visible part of the property so that the ponding will be noticed and the outlet blockage cleared before another storm event;
- all surface inlet drains upstream of the storage must be designed so that there is no overflow before the storage is full.

- the build-up of noxious odour in storages without a grated access can create problems. If the storage is sealed, vents should be provided.

- in addition to checking that the storage is structurally adequate for the normal earth, traffic and hydrostatic loads generated by a full storage, the structure should be checked for flotation. Depending on the surrounding soil conditions, the soil around the tank can become saturated during a storm. The underground tank will empty soon after the storm is finished, while the soil will remain saturated for much longer. Sub-soil drainage, weep-holes and wall drainage may be needed to equalise hydrostatic pressures.

Important design considerations – Holroyd City Council

- residents/owners must be able to inspect critical parts of the storage from the surface without having to remove heavy access covers. Concrete covers are to be avoided for this reason.

- openings must be wide enough to allow easy entry to a storage, ie:

  600 mm x 600 mm (storages up to 600 mm deep); or
  900 mm x 900 mm (storages greater than 600 mm deep)

- a continuous fall on the floor of the storage of at least 1% must be provided to the storage outlet to minimise ponding in the storage.

- the minimum clearance height for accessible tanks is 900 mm unless otherwise approved by Council. Where the internal clearance of less than 900 mm is required due to level or other constraints, the following internal heights can be considered:

Commercial/Industrial developments	750 mm
Residential developments	500 mm

  provided that:

  - all grates accessing the tank shall be a minimum of 900 mm x 900 mm, and a maximum lifting weight of 20 kg;

  - A grated access shall be provided to the following, as a minimum:

    - Above the discharge control pits

    - At the high end of the tank;

    - Intermediate access grates may be required, subject to design checking and Council requirements;

  - the base of the tank is shaped with a 1% crossfall to a Vee drain and with a 1% longitudinal slope along the Vee drain;

  - tanks less than 750 mm high must be precast to avoid difficulties with removing formwork.

- where all the storage is provided in an underground structure, a large storm could be stored even with a totally blocked outlet. The storage should be designed to overflow and pond in a very visible part of the property so that the ponding will be noticed and the outlet blockage cleared before another storm event;

- all surface inlet drains upstream of the storage must be designed so that there is no overflow before the storage is full.

- the build-up of noxious odour in storages without a grated access can create problems. If the storage is sealed, vents should be provided.

- in addition to checking that the storage is structurally adequate for the normal earth, traffic and hydrostatic loads generated by a full storage, the structure should be checked for flotation. Depending on the surrounding soil conditions, the soil around the tank can become saturated during a storm. The underground tank will empty soon after the storm is finished, while the soil will remain saturated for much longer. Sub-soil drainage, weep-holes and wall drainage may be needed to equalise hydrostatic pressures.

Important design considerations – Baulkham Hills Shire Council, Parramatta City Council

- residents/owners must be able to inspect critical parts of the storage from the surface without having to remove heavy access covers. Concrete covers are to be avoided for this reason.

- openings must be wide enough to allow easy entry to a storage, ie:

  600 mm x 600 mm (storages up to 600 mm deep); or
  900 mm x 900 mm (storages greater than 600 mm deep)

- a continuous fall on the floor of the storage of at least 1% must be provided to the storage outlet to minimise ponding in the storage.

- the minimum clearance height for accessible tanks is 900 mm.

- grates accessing the tank shall be a minimum of 900 mm x 900 mm, 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;

- Where the minimum clearance height for accessible tanks cannot be achieved due to level or other constraints, the following internal heights can be considered:

Commercial/Industrial developments	750 mm
Residential developments	500 mm

  provided that:

  - all grates accessing the tank shall be a minimum of 900 mm x 900 mm, and a maximum lifting weight of 20 kg;

  - grates to be placed at the extremities of the tank with a maximum distance of 3 m from any point in the tank to the edge of the nearest grate. This should allow any point in the tank to be reached with a broom or similar implement without the need to enter the tank;

  - the base of the tank is shaped with a 2% crossfall to a Vee drain and with a 2% longitudinal slope along the Vee drain;

  - tanks less than 750 mm high must be precast to avoid difficulties with removing formwork.

- where all the storage is provided in an underground structure, a large storm could be stored even with a totally blocked outlet. The storage should be designed to overflow and pond in a very visible part of the property so that the ponding will be noticed and the outlet blockage cleared before another storm event;
- all surface inlet drains upstream of the storage must be designed so that there is no overflow before the storage is full.
- the build-up of noxious odour in storages without a grated access can create problems. If the storage is sealed, vents should be provided.
- in addition to checking that the storage is structurally adequate for the normal earth, traffic and hydrostatic loads generated by a full storage, the structure should be checked for flotation. Depending on the surrounding soil conditions, the soil around the tank can become saturated during a storm. The underground tank will empty soon after the storm is finished, while the soil will remain saturated for much longer. Sub-soil drainage, weep-holes and wall drainage may be needed to equalise hydrostatic pressures.

4.2.8 Rainwater Tanks

Until 2001 the four local councils and the Trust have always refused to allow rainwater tanks to be considered as part of an OSD facility because of the probability that the tank would be full at the start of a major rainfall event. In recent years it has been argued, however, that a rainwater tank will not always be full at the start of a storm if its water is used inside and outside the dwelling for non-potable purposes – toilet flushing, laundry, hot water and garden watering.

As part of the detailed analyses of the cumulative impacts on peak discharges undertaken in recent years the interaction of rainwater tanks and OSD tanks was investigated. Analyses were undertaken of both rainwater tanks with dedicated airspace and dynamic airspace ie. the airspace in a rainwater tank that varies in response to rainfall and water demands (internal and/or external). This has led to a revision of the proportion of a rainwater tank which can be counted as part of the OSD storage. This "credit" reduces the SSR_L and SSR_T for an OSD system.

Dedicated Airspace

Based on the analysis of the results reported by Cardno Willing, 2004 the following reductions in the SSR values may be allowed subject to Council approval[4]:

- 50% of the dedicated airspace can be credited against the required extended detention volume (SSR_L);
- 100% of the dedicated airspace can be credited against the required overall detention volume (SSR_T);

subject to:

- a maximum dedicated airspace credit no greater than the ratio of the area of roof discharging to the rainwater tank to the lot area times the overall site storage volume that is required;

[4] It should be noted that Baulkham Hills Shire Council, Blacktown City Council, Holroyd City Council and Parramatta City Council currently do not permit dedicated airspace. Under exceptional circumstances consult with the relevant Council.

- the rainwater tank has a dedicated outlet to ensure that the dedicated airspace is recovered after a storm event and the maintenance schedule specifically requires checking and cleaning of the outlet;
- the PSD for the dedicated rainwater tank outlet is no greater than 40 L/s/ha;
- all outflows from the rainwater tank (outflows from the dedicated outlet and overflows from the rainwater tank) are discharged to the OSD storage.

Dynamic Airspace

Based on the analyses of the results of various rainwater tank simulations undertaken in late 2004 the following procedure is used to calculate the reduced SSR values that are allowed:

The rainwater tank dynamic airspace at the start of a storm is calculated using (refer Figure 5.2):

Dynamic Airspace (kL) = 8.7 x Nett Tank Vol (kL) $^{1.05}$ x Roof Area (m^2) $^{-0.5}$ x Demand (kL/d) $^{0.35}$

where Nett Tank Volume = Total Tank Volume - Dedicated Airspace - Top-Up Volume

Daily demands can be estimated using the following average daily demands for Western Sydney, as reported by Coombes and Kuczera (2003) (refer pp 240).

Outdoor (kL/d)	**Indoor (Total) (kL/d)**				
	No. of Occupants				
	1	2	3	4	5+
0.260	0.231	0.448	0.665	0.882	1.099

In the absence of detailed information on the proportion of various indoor uses for rainwater the following data can be used:

	% of **Indoor Demand**
Toilets	20%
Laundry	25%
Hot Water	25%

The reduced SSR values due to dynamic rainwater tank airspace is calculated using:

SSR_L = 300 - (1,950 x Dynamic Airspace (kL) $^{2.10}$ x Roof Area (m^2) $^{-1.50}$)

SSR_T = 455 - (1,650 x Dynamic Airspace (kL) $^{2.30}$ x Roof Area (m^2) $^{-1.50}$)

subject to:

- the development being residential, or its water usage can be considered to approximate that of a residence;
- the design is in accordance with Sydney water requirements (visit the Sydney Water website for the current requirements); and
- all overflows from the rainwater tanks are directed to the OSD storage.

4.2.9 Areas not directed to the OSD storages

Where possible, the drainage system should be designed to direct runoff from the entire site to the OSD system. Sometimes, because of ground levels, the receiving drainage system or because of other circumstances eg. retention of major trees, this will not be feasible.

In these cases up to 30% of the residual site area may be permitted to bypass the OSD systems, provided that as much as possible of the runoff from impervious site areas is drained to the OSD system and specific Council approval is obtained.

The storage volume is still calculated on the entire site area, while the SRD is adjusted downwards in accordance with the values given in the table below (see also Section 3.4.3 where the development affects only part of a site).

Residual Lot Capture	Primary Outlet SRD_L (L/s/ha)	Extended Detention Storage SSR_L (m^3/ha)	Secondary Outlet SRD_U (L/s/ha)	Overall Detention Storage SSR_T (m^3/ha)
100%	40.0	300	150	455
95%	38.5	300	140	455
90%	37.0	300	130	455
85%	35.5	300	120	455
80%	34.0	300	110	455
75%	32.5	300	100	455
70%	31.0	300	90	455

Note: 100% of Roof Area assumed to be directed to the OSD storage

4.2.10 Overflow

Provision needs to be made when designing a storage for storms more severe than the design storm or for blockages in the system. With most storages it is relatively easy to provide a weir capable of passing the entire discharge from a very large storm event with only a few centimetres depth of water over the weir.

The following design method should be used to check the adequacy of overflow structures, such as weirs or spillways, and freeboards to finished floor levels. Overflow and weir flow calculations must be included in the detailed design information submitted to the consent authority:

- Assume the outlet is blocked and the storage full.
- Calculate the approximate maximum 100-year ARI discharge to the storage (a Rational Method estimate will be adequate);
- Calculate the maximum depth over the spillway/weir assuming the entire 100-year ARI discharge passes over the spillway/weir;
- Check the floor levels of any buildings upstream of the storage to ensure that these buildings are not inundated. (refer Section 4.2.6 for suitable freeboards); and
- Overflows should be directed to a flowpath through the development so that buildings are not inundated nor are flows concentrated on an adjoining property.

4.2.11 Vehicular Access and Maintenance

Vehicular Access

The design must demonstrate that access to the OSD storage(s) is practicably available for any special vehicles that may be needed to maintain the storages.

Maintenance Schedule

As part of the detailed design submission, a maintenance schedule is to be prepared. The maintenance schedule is a simple set of operating instructions for future property owners and occupiers. It should be clearly and simply set out and should be accompanied by a simplified plan showing the layout of the OSD system. (See the sample plan in Figure C.2). The designer's consent to release of this plan to subsequent owners/occupiers should be provided to facilitate long-term maintenance of the facility.

What must be done?

The maintenance schedule needs to set out simply and clearly the routine maintenance necessary to keep the OSD system working. Some of the issues that will need to be addressed are:

- where the storages are located;
- which parts of the system need to be accessed for cleaning and how access is obtained;
- a description of any equipment needed (such as keys and lifting devices) and where they can be obtained; and
- the location of screens and how they can be removed for cleaning.

Who should do the maintenance?

The majority of OSD systems, particularly those where a large proportion of the storage is located above ground, will be able to be maintained by property owners, residents or handymen. Larger underground systems, particularly those with limited access and/or substantial depth, will require the owner to engage commercial cleaning companies with specialised equipment.

How often should it be done?

The owner should be provided with advice on how frequently the system needs to be inspected and approximately how often it will require cleaning. The frequencies of both inspections and maintenance will be highly dependant on the nature of the development, amount of vegetation, location of the storage and the occurrence of major storms. Suggested frequencies are:

- Residential - inspect system every six months and after heavy rainfall;
  - clean system as required, generally at least once a year.
- Commercial/Industrial - inspect system every three months and after heavy rainfall;
  - clean system as required, generally at least once every six months.

4.3 Construction/final approval

The last stage in the approval process involves making sure that the system has been built correctly and that appropriate legal protection is in place to ensure long-term performance of the system. The design effort involved in preparing a concept plan or a detailed design submission is wasted unless the OSD system is built correctly and maintained. The constructed system should conform exactly to the approved design plans and particular attention is required to ensure that all critical levels are achieved. Figure 4.9 summarises the procedure for supervising, constructing and certifying an OSD system.

4.3.1 Objectives

The objectives of the construction supervision and certification arrangements are to:

- encourage supervision of critical stages of construction by the OSD designer to improve construction standards;
- minimise delays and additional expenditure on rectification works by ensuring adequate construction supervision;
- increase community acceptance of OSD by eliminating nuisances created by poor construction; and
- enable local Councils to inspect and insist on essential maintenance of the system.

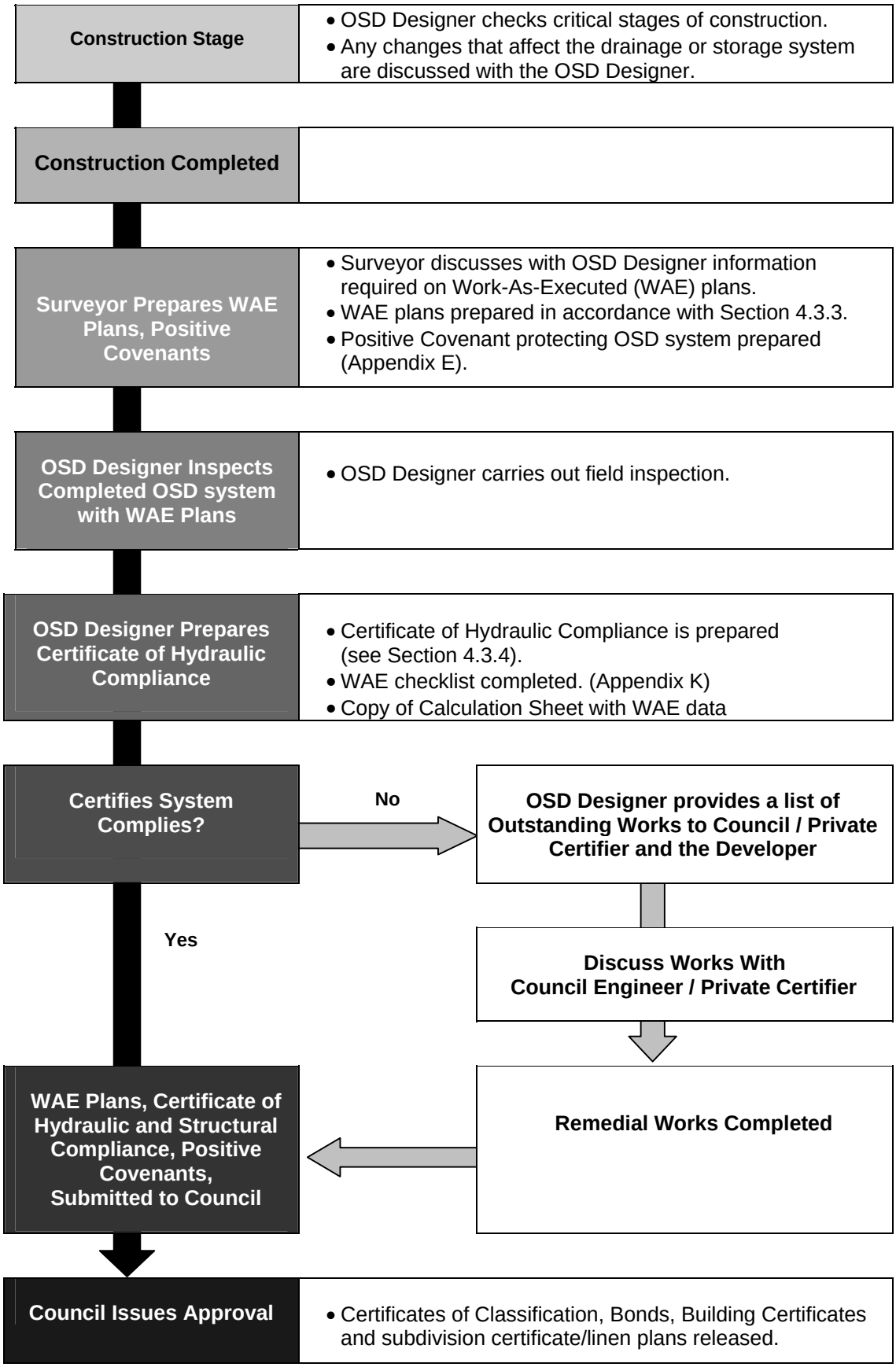
4.3.2 Construction supervision

Construction supervision is essential in achieving a properly working OSD system. OSD construction is often multi-disciplined with many tradesmen (such as bricklayers, landscapers and concrete finishers,) who may be unfamiliar with stormwater drainage, being responsible for constructing critical features of the system. OSD systems require closer attention to set-out and levels than a conventional drainage system. Without adequate supervision during construction (preferably by the designer or someone very familiar with the design intent), expensive and time consuming rectification works are often necessary before a Certificate of Hydraulic Compliance can be issued by the OSD designer.

4.3.3 Work-as-Executed Plans

Work-as-Executed (WAE) plans prepared by a Registered Surveyor or the OSD designer must be submitted. A general set of guidelines for preparation of WAE plans is provided below. However in some projects there will be site-specific features that will require additional details. The OSD designer should therefore be consulted before preparing these plans. It is important that the WAE plans provide the OSD designer with sufficient information to certify that the as-constructed system will function in accordance with the approved design. Note that any changes to the top water level in the storage or depth of storage may alter the required orifice diameter. Calculations should be submitted to show that the orifice diameter is correct if the approved design water level has been changed.

Figure 4.9 Construction, certification and final acceptance



Outlets

The following information on the outlets should be included:

Primary outlet:-

- the diameter of the primary orifice and verification that it has been fitted correctly;
- verification that a screen has been fitted, as well as its location, dimensions and the minimum distance from the orifice; and the
- internal diameter of the outlet pipe.

Secondary outlet:-

- internal pit dimensions;
- the diameter of the secondary orifice and verification that it has been fitted correctly, verification that a screen has been fitted, as well as its location, dimensions and the minimum distance from the orifice;
- levels on the top and invert of the pit and surface level; and the
- internal diameter of the outlet pipe.

Storage

The following details of the OSD storage should be provided:

- type of storage – roof, above ground, below ground, rainwater tank or combination
- detailed calculations of the actual volume achieved for each storage;
- level and location of any overflow structures (eg. spillways, weirs);
- sufficient levels and dimensions to verify storage volumes – as a minimum, WAE plans should give the constructed level of all design levels shown on approved plans;
- any changes to storage depth or top water level and whether the orifice size is affected; and
- where rainwater tanks have been installed as part of the OSD storage, the volume of the tank dedicated to airspace and/or the tank volume and certification that the tank is plumbed in for non-potable internal and external uses, as appropriate.

Internal drainage

The following information on the internal drainage system is to be included:

- pit surface levels;
- invert levels and diameters of pipes;
- location and levels of any floodways and/or overland flowpaths; and
- sufficient spot levels to show site gradings and extent of areas not draining to the storage(s).

Freeboards

The finished floor levels of adjacent structures on the property, such as garages and dwellings, are to be shown to ensure they are sufficiently above the maximum storage water surface levels and overland flowpaths. As stated in Section 4.2.6, a freeboard of 200 mm should be provided for habitable dwellings and a freeboard 100 mm for garages. The top water level should take into account the depth of water over the overflow weir. (refer Section 4.2.10).

4.3.4 Certificates of Hydraulic Compliance

Certificates of Hydraulic Compliance are required by all Councils within the catchment to confirm that the drainage and On-site Stormwater Detention (OSD) works have been carried out in accordance with the approved design. Since 1 May 1999, design and certification will only be accepted from persons having acceptable professional accreditation. The following are considered to be acceptable accreditation for the purpose of OSD design and certification:

- NPER in Civil Engineering (Engineers Australia);
- Surveyors Certificate of Accreditation in On Site Detention and Drainage Design (Institution of Surveyors NSW and the Association of Consulting Surveyors NSW);
- Accreditation as a certifier under the Environmental Planning and Assessment Act 1979 in the relevant discipline; and
- Stormwater Register (Association of Hydraulic Services Consultants Australia)

To avoid delays in obtaining certification, developers and builders are encouraged to have the OSD designer supervise the construction of these systems. Defects are expensive to repair once the development is completed.

Certificates of Hydraulic Compliance are to be attached to the Work-As-Executed plans and submitted to council or Private Certifier prior to the release of linen plans, certificates of occupation and/or final acceptance. A separate structural certification will be required for any structural elements. The Certificate of Hydraulic Compliance needs to:

- state that the system will function and can be maintained in accordance with the approved designs, subject to satisfactory maintenance;
- state what percentage of any rainwater tank contributes to the OSD storage and document that tank has been plumbed for non-potable uses inside and outside; and
- identify any variations from the approved design, and state that these variations will not impair the performance of the OSD system.

Alternatively, where variations are identified that impair the performance of the OSD system, the OSD designer will need to complete an Outstanding Works form. This form lists the variations from the approved design and the required remedial works. Where significant remedial works are necessary, discussions should be held with the relevant council officers or Private Certifier and arrangements made to have these works carried out prior to the issue of a Certificate of Hydraulic Compliance by the OSD designer or final acceptance by council.

The Certificate of Hydraulic Compliance is the principal means by which adequate construction standards are ensured and certification needs to be conducted in a professional manner. Whilst the Certificate will be based on the work-as-executed plans, the OSD designer will need to inspect the site to check critical design features.

Some of the important considerations to be addressed when certifying hydraulic compliance are that for:

Outlets

- plates with sharp-edged orifices of the correct diameter and the specified material have been securely fitted;
- discharge control pit (DCP) dimensions satisfy minimum parameters, eg. width, design head, and clearance from screen;
- the orifices are screened and the screens are properly fixed, located and able to be removed for cleaning;
- outlet pipes are the correct size, level and grade to ensure there is free discharge through the orifices;
- the levels of the water surface, storage invert and secondary DCP are such that the design discharge from the storage is achieved;

Storage

- actual storage volumes achieved are adequate;
- the actual top water surface level of the storage will not cause either unintended surcharge of the internal drainage system or inundation of/or inadequate freeboards to finished floor levels; nor will it alter the storage depth sufficiently to impact on the required orifice size(s);
- the base of the storage is well graded and drains to the primary outlet; and
- spillways and overflow paths are the correct level and free from obstructions.

Internal drainage

- site gradings are correct;
- the internal drainage lines are of a sufficient size, level and grade to convey flows to the storage;
- if a blockage occurs or the internal drainage lines cannot convey all runoff in a 100-year rainfall event, the site is graded to direct surcharging flows to the storages;
- storages cannot be by-passed by overflows from the internal drainage system or by overflows from any surface area designed to drain to the storages;
- flowpaths designed to divert upstream flows around the basin have been properly constructed and will function as designed; and
- general workmanship is adequate to prevent long-term failure of the system.

Freeboards

- the levels of structures (such as garages, factories, offices and dwellings) are sufficiently above the as-constructed maximum water surface levels in the storage (including the calculated depth of any weir overflow) and flowpaths; and
- an emergency spillway or overflow path is provided to ensure that surcharge of the drainage system and storage (even in the event of an extreme storm or accidental blockage of pits, pipes etc.) will not cause stormwater to enter buildings where significant damage would occur.

Standard Certificate of Hydraulic Compliance Forms and Outstanding Works forms are included in Appendices L and M.

4.3.5 Structural certification

Due to loadings, certain OSD storage components may require specific structural certification for design and construction. The following list is typical but not exhaustive. This certification should be provided by a qualified, practising structural engineer, except where the components match the standard designs provided in Appendix O.

Free standing walls

These are subject to hydrostatic loads when a storage is full or filling. The significance will depend on the maximum ponding depth.

Retaining walls

In addition to the normal earth and hydrostatic loadings, it may be necessary to consider the possibility of saturated sub-soil conditions.

Underground storages

These may be subject to a combination of earth pressures, hydrostatic loadings, traffic loadings and buoyancy forces.

4.3.6 Legal protection of OSD systems

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 the issue of final acceptance (eg. Building Certificate under Section 149 of the Environmental Planning and Assessment Act 1979 and/or the release of any subdivision certificate/linen plan) 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 the local council.

These can be imposed either by submitting a suitable Request Form to the Land Titles Office or in conjunction with the registration of a plan showing the new lots to be created. An explanation of the process involved, sample instruments, standard terms and conditions, a copy of the Department of Lands Information Bulletin 14 and sample forms 13PC and 13RPA, are included in the Appendices as listed below.

C Explanatory notes on the preparation and registration of Positive Covenants and Restrictions on Use of Land.

D Forms for use under Section 88E(3) of the Conveyancing Act where there is no subdivision of land involved and the covenant and restriction on use are being imposed on an existing parcel of land.

E Terms and conditions for Restriction on Use of Land and Positive Covenant.

F Sample Restriction on Use of Land and Covenant where a deposited plan is being registered together with a Section 88B instrument.

G A copy of Information Bulletin No 14 (dated September 1998), prepared by the Land Titles Office, *A Guide to the Preparation of a Section 88B Instrument to:*

- Create Easements, Profits à Prendre, Restrictions on the Use of Land or Positive Covenants
- Release Easements or Profits à Prendre

H Sample Covenant used where a deposited plan is being registered together with a Section 88B instrument and construction of the OSD system is being deferred.

Note: Council will only permit deferral of the construction of the OSD systems in exceptional circumstances. (See Section 4.0)

5. THE DESIGN PROCESS

This section outlines the calculations that are undertaken to determine the OSD parameters. In view of the added complexity that can arise if rainwater tanks are included as part of the development and if not all of the site area is discharged to the OSD storage an On-Site Detention Calculation spreadsheet has been prepared to ensure that calculations are undertaken in a manner consistent with the procedures described in Section 4.2 by all OSD designers.

The OSD Calculation spreadsheet:

- calculates the extended detention storage volume and the overall storage volume based on the total site area;
- calculates the volume of dedicated and dynamic airspace that can be credited against the required extended detention storage volume and the overall detention storage volume (based on a rainwater tank being installed for each dwelling);
- calculates the nett extended detention storage volume and the overall storage volume based on the total site area; and
- calculates the primary and secondary outlet discharges (based on the adjusted SRDs);

This OSD Calculation spreadsheet can be downloaded from the Trust's website at: www.uprct.nsw.gov.au

5.1 The OSD design process

The OSD design process encapsulated in the OSD Calculation spreadsheet is outlined as follows (refer also Figures 5.1, 5.2 and 5.3):

5.1.1 Site data

The site data to be entered by the OSD designer includes the:

- total site area (in ha);
- total roof area (in ha);
- area of the site draining to the OSD storage (in ha); and
- number of proposed dwellings on the site (to allow for multi-dwelling developments)

The OSD Calculation spreadsheet:

- calculates the residual site area – Total site area less total roof area (in ha). It is assumed that all roof runoff is directed to the OSD storage;
- calculates the area of the site bypassing the storage;
- checks that the area of the site bypassing the storage is less than 30% of the residual site area (bypasses greater than 30% are not allowed)[1];
- calculates the equivalent site area per dwelling (in ha); and
- calculates the average roof area per dwelling (in ha).

[1] Councils will still require a justification to allow any part of a site to bypass the OSD system.

Figure 5.1 Key Parameters for an On-Site Detention System

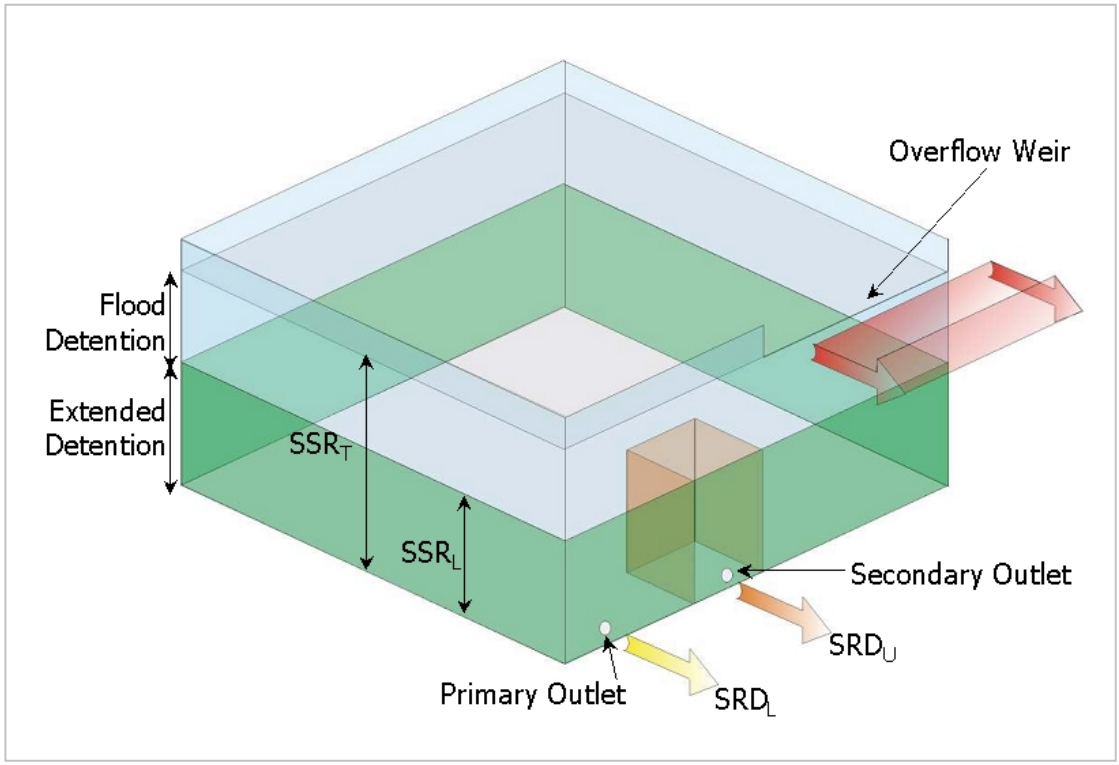
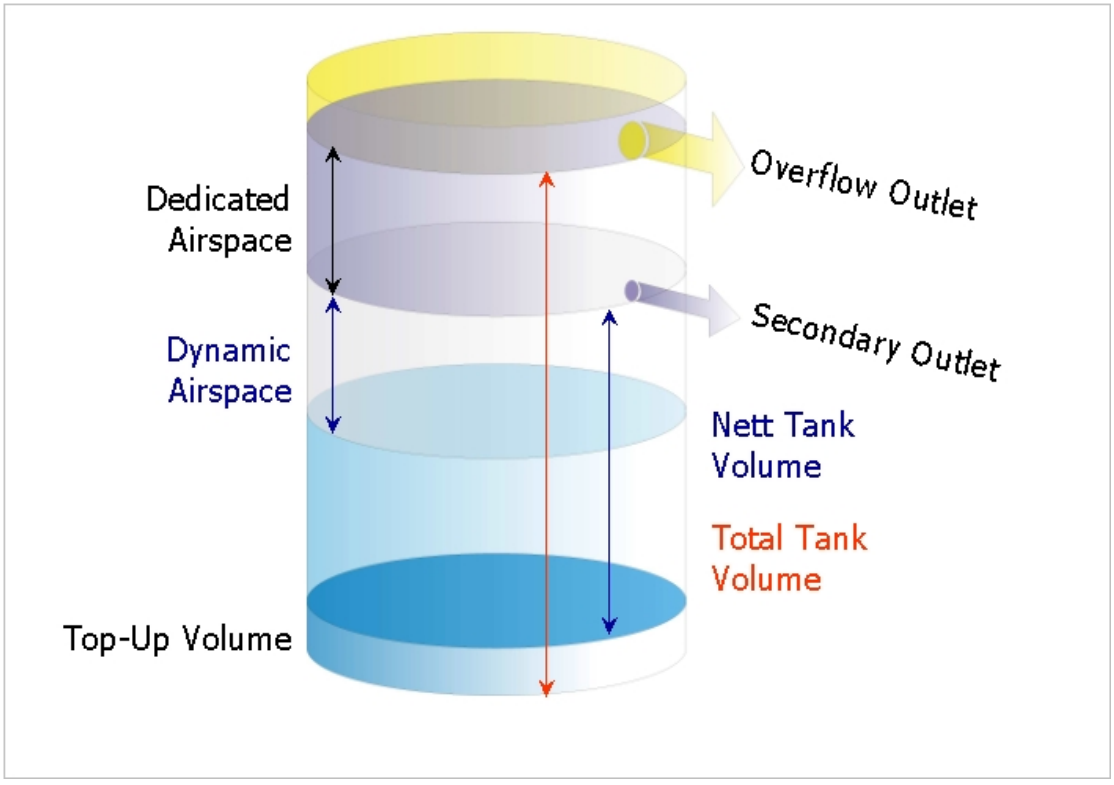


Figure 5.2 Key Parameters of a Rainwater Tank



5.1.2 Basic OSD parameters

The basic OSD parameters are reported in Sections 2.3.2, 3.5.1 and 3.5.2, namely

SRD_L = 40 L/s/ha
SSR_L = 300 m^3/ha

SRD_U = 150 L/s/ha
SSR_T = 455 m^3/ha

5.1.3 OSD storage bypass

The OSD Calculation spreadsheet:

- calculates the adjusted SRDs based on the calculated percentage of the residual lot area draining to the OSD storage and the tabulation given in Section 4.2.9.

5.1.4 OSD calculations

The OSD Calculation spreadsheet:

- calculates the extended detention storage volume and the overall storage volume based on the total site area;
- calculates the volume of dedicated and dynamic airspace that can be credited against the required extended detention storage volume and the overall detention storage volume (based on a rainwater tank being installed for each dwelling);
- calculates the nett extended detention storage volume and the overall storage volume based on the total site area; and
- calculates the primary and secondary outlet discharges (based on the adjusted SRDs);

The OSD designer enters:

- the RL of the top water level in the extended detention storage and the detention storage (in m);
- the RL of the orifice centre-line of the primary and secondary orifices
- selects the number of orifices to be installed (primary and/or secondary) ie. in the majority of cases a single primary and a single secondary orifice will be sufficient however it may be advantageous to install multiple orifices where the diameter of a single orifice is a significant proportion of the storage depth to ensure that efficient orifice flow occurs.

The OSD Calculation spreadsheet:

- calculates the maximum heads to the centre-lines of the orifices;
- calculates the required diameter of the primary orifice and checks that it is greater than a minimum 25 mm; and

- calculates the required diameter of the secondary orifice (based on the assumption that head adopted for calculation purposes is the RL of the top water level of the extended detention storage ie. the level at which spill into the secondary DCP occurs less the RL of the centre-line of the secondary orifice and that a HED of 150 L/s/ha is achieved soon after spill into the DCP commences) (see Figure 5.4).

5.1.5 Rainwater tank calculations (Optional)

Rainwater tank data is only entered if the OSD designer is claiming an airspace "credit" against the required OSD storage volumes. When claiming an airspace "credit" the rainwater tank data to be entered by the OSD designer includes (refer Figure 5.2):

- percentage of the roof area draining to a rainwater tank (ie. can include cases where not all of the roof can be drained to a rainwater tank) (Note: the percentage that is entered must be greater than the calculated minimum percentage – **the calculated minimum percentage changes if the maximum dynamic rainwater storage is changed**);
- the total volume of the rainwater tank volume (in kL); and
- the minimum volume in the rainwater tank at which top-up commences (in kL);

The OSD Calculation spreadsheet:

- calculates the minimum percentage of roof that must drain to the rainwater tank compatible with the maximum dynamic rainwater storage that is available; and
- calculates the rainwater tank volume less the minimum volume in the rainwater tank at which top-up commences (the minimum volume in the rainwater tank at which top-up commences can be set equal to 0 kL).

Dedicated Airspace

If part of the rainwater tank is to be dedicated to detention (by installing an orifice outlet in the side of the tank) then the OSD designer enters the:

- volume of airspace to be dedicated to detention (in kL) (Enter 0 if there is no dedicated airspace); and
- maximum head to the centre of the tank orifice outlet (in m).

The OSD Calculation spreadsheet:

- calculates the volume of dedicated airspace that could be credited against the required extended detention storage volume and the overall detention storage volume (in accordance with Section 4.2.8);
- calculates the maximum tank discharge for the dedicated airspace based on the maximum rainwater tank PSD of 40 L/s/ha and the site area per dwelling; and
- calculates the required orifice diameter (in mm) and checks that it is greater than a minimum 25 mm.

Dynamic Airspace

Dynamic airspace is created in a rainwater tank by the usage of stored water for external and/or internal uses. The OSD designer enters:

- the daily demand for water stored in the rainwater tank (in kL/day). Section 4.2.8 gives a method for the calculation of this daily demand.

The OSD Calculation spreadsheet:

- calculates the maximum available dynamic airspace ie. the rainwater tank volume less the minimum volume in the rainwater tank at which top-up commences less any volume of dedicated airspace;
- calculates the dynamic airspace at the start of a storm (based on the procedure given in Section 4.2.8);
- calculates the volume of dynamic airspace that could be credited against the required extended detention storage volume and the overall detention storage volume (in accordance with Section 4.2.8);
- calculates the overall volume of dedicated and dynamic airspace that could be credited against the required extended detention storage volume and the overall detention storage volume;
- calculates the maximum volume of rainwater tank airspace that can be credited against the required extended detention storage volume and the overall detention storage volume. This maximum is equal to the SSR times the roof area draining to the rainwater tank; and
- adopts the rainwater tank airspace credit as the smaller of the calculated combined credit or the maximum volume credit; and
- calculates the rainwater tank airspace credits for the site.

5.2 Worked example

The design process described in the previous section is illustrated in the following example. The calculations are presented in Figure 5.3.

Four units are to be constructed on a 0.24 hectare site. A grassed area at the rear comprising 10% of the site (0.024 hectares) falls steeply to the rear and cannot be drained to the OSD storage. Each unit will have a 5 kL rainwater tank that will collect runoff from 80% of each 150 m^2 roof with rainwater to be used for outdoor, toilet flushing and laundry in each 4 person household. An airspace “credit” is to be claimed against the OSD storage requirements. There will be no dedicated airspace. The minimum volume in the rainwater tank at which top-up commences is 0 kL ie. when it is empty.

Figure 5.3 On-Site Detention Calculation Sheet

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
HED Secondary Outlet

Project:	**UPRCT Handbook Demonstration Example**
Site Address	**A Place, South Wentworthville**
Job No:	**W4574-2**
Designer:	**JC**
Telephone:	**(02) 9891 4633**

Site Data

OSD Area:	**Upper Parramatta River Catchment**						
L.G.A	**Parramatta City Council**						
Site Area	**0.24**	ha	**2,400**	m^2			
Total Roof Area	**0.06**	ha	**600**	m^2			
Area of Site draining to OSD Storage	**0.216**	ha	**2,160**	m^2	**Satisfactory**		
Residual Site Area (Lot Area - Roof Area)	**0.180**	ha					
Area Bypassing Storage	**0.024**	ha					
Area Bypassing / Residual Site Area	**13.3%**				**Satisfactory**	**30% Max**	
No. of Dwellings on Site	**4**				**Satisfactory**		
Site Area per Dwelling	**0.060**	ha					
Roof Area per Dwelling	**0.015**	ha					

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	**300**	m^3/ha	Total Storage	**455**	m^3/ha
Basic SRDs	Primary Outlet	**40**	L/s/ha	Secondary Outlet	**150**	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	**87%**				
Adjusted SRDs	**36**	L/s/ha		**123**	L/s/ha

OSD Calculations

		Extended Detention			Detention	
Basic SSR Volume	Ext Detention Storage	**72.00**	m^3	Total Storage	**109.20**	m^3
Total Rainwater Tank Credits		**5.60**	m^3		**6.16**	m^3
Storage Volume				Total	**103.04**	m^3
Storage Volume	Ext Detention Storage	**66.40**	m^3	Flood Detention Storage	**36.64**	m^3
OSD Discharges	Primary Outlet	**8.64**	L/s	Secondary Outlet	**29.60**	L/s
RL of Top Water Level of Storage		**10.100**	m		**10.300**	m
RL of Orifice Centre-line		**9.100**	m		**9.000**	m
Number of Orifices		**1**			**1**	
Estimated Downstream Flood Level		**9.00**	1.5 yr ARI		**9.00**	100 yr ARI
Downstream FL - RL of Orifice Cente-line		**-0.10**	**Satisfactory**	**Satisfactory**	**0.00**	m
Design Head to Orifice Centre		**1.000**	m	TWL Ext Detn Storage - RL Orifice	**1.100**	m
Calculated Orifice Diameter		**64**	mm	**Satisfactory** **Satisfactory**	**116**	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		**10.600**	m
RL of Minimum Garage Floor Level		**10.500**	m
Length of Overflow Weir		**2.00**	m
Site Runoff Coefficient	**Parramatta City Council**	**0.75**	
Storm Intensity (5 min 100 yr ARI)		**206**	mm/h
Peak Flow over Weir		**92.7**	L/s
Depth of Flow over Weir		**93**	mm
Freeboard to Habitable Floor	**Satisfactory**	**207**	mm
Freeboard to Garage Floor	**Satisfactory**	**107**	mm

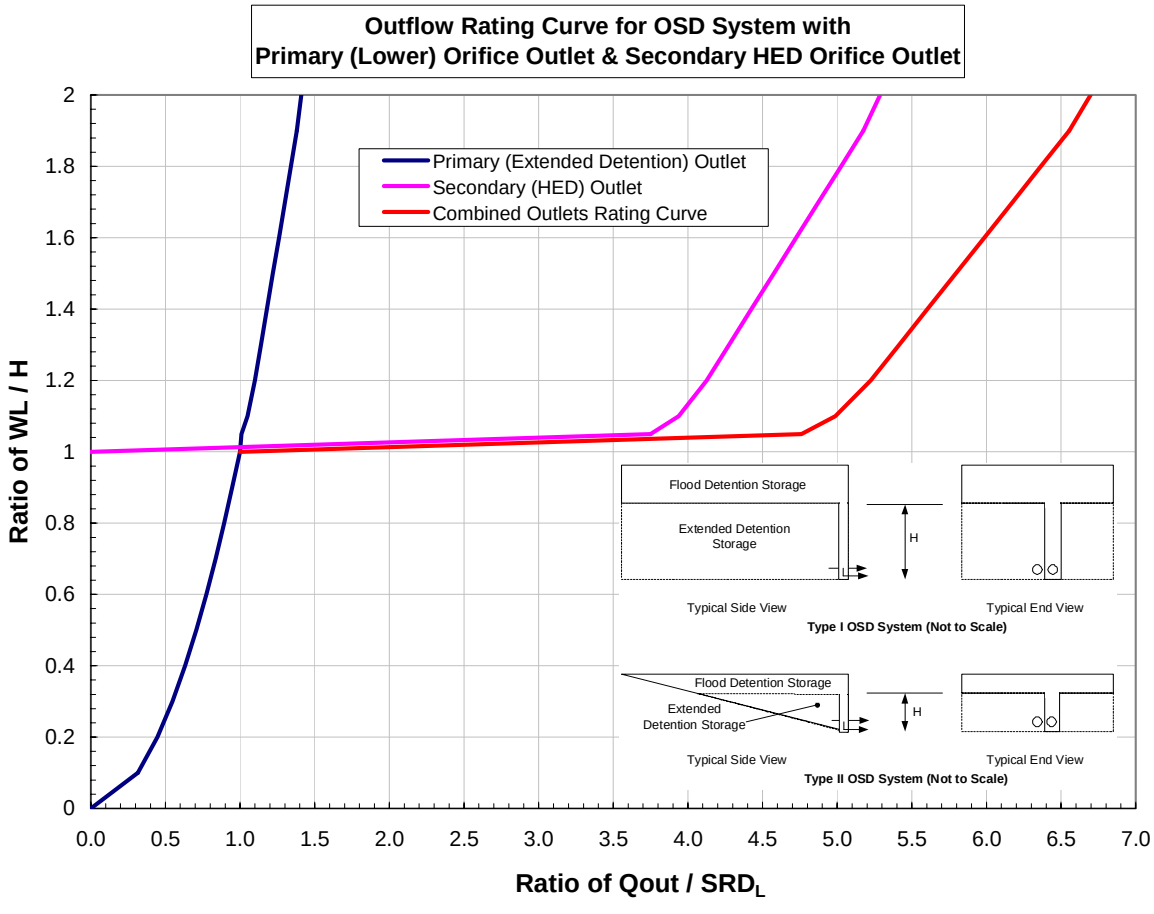
Rainwater Tank Calculations (per Dwelling)

Only Complete this Section if a Rainwater Tank Airspace Credit is Claimed

The calculations assume that the same size rainwater tank is installed on each dwelling

				Min	Max
% of Roof draining to Rainwater Tank	80.0%		Satisfactory	44.2%	100%
Total Rainwater Tank Volume	5.00	kL	Tank Volume OK		
Min Volume that triggers Top-up	0.00	kL	Note - Min Vol in Tank < 10% Total Tank Vol		
Total Tank Vol - Min Top-up Vol	5.00	kL			
Dedicated Airspace					
Dedicated Airspace	0.00	kL	Satisfactory		
	Extended Detention			Detention	
Dedicated Airspace Credit	0.00	kL		0.00	kL
Maximum Tank PSD	40	L/s/ha			
Maximum Tank Discharge	0.0	L/s			
Maximum Head to Centre of Tank Orifice	0.000	m	No Dedicated Airspace		
Calculated Orifice Diameter	0	mm	No Dedicated Airspace		
Dynamic Airspace					
Maximum Dynamic Storage (Nett Vol)	5.00	kL	Controls minimum % Roof to Rainwater Tank		
Daily Demand on Rainwater Tank	0.657	kL/d	Satisfactory		
Dynamic Airspace at start of Storm	3.72	kL			
	Extended Detention			Detention	
Dynamic Airspace Credit	1.40	kL		1.54	kL
Combined Rainwater Tank Credit	1.40	kL		1.54	kL
Maximum Rainwater Tank Credit	3.60	kL		5.00	kL
Rainwater Tank Credit per Dwelling	1.40	kL		1.54	kL
Rainwater Tank Credit for the Site	5.60	m^3		6.16	m^3

Figure 5.4 Non-dimensional Outlet Rating Curve for OSD Systems



6. TECHNICAL DISCUSSION

6.1 Frequency Staged Storage

Generally the most challenging task of the OSD designer is locating and distributing the storage (s) in the face of the following competing demands:

- making sure the system costs no more than necessary;
- creating storages that are attractive and complementary to the architectural design;
- avoiding unnecessary maintenance problems for future property owners;
- minimising personal inconvenience for property owners/residents.

These demands can be balanced by providing storage in accordance with a frequency staged storage approach. Under this approach, the depth of inundation and extent of area inundated increase with the storm magnitude so that the greatest inconvenience to owners/occupiers occurs very infrequently. The approach recognises that people are generally prepared to accept flooding which causes inconvenience, but no damage provided it does not happen too often. Conversely, the less the personal inconvenience the more frequently the inundation can be tolerated. Where use of private courtyards for storage is unavoidable, safety issues must be addressed and provision should be made to warn occupants and also to maintain a dry area for sheds or similar structures. Private courtyards that are less than 25 m^2 in area are not to be used for OSD storage nor flood storage on flood prone sites.

Table 6.1 Suggested Flood Frequencies for Storage Areas

Storage Area	Suggested Depth	Frequency of Inundation
Pedestrian areas	beginning to pond 50 mm	once in 20 years once in 100 years
Parking & driveways	beginning to pond 100 mm 200 mm	once in 10 years once in 20 years once in 100 years
Gardens	beginning to pond 200 mm 400 mm 600 mm	once a year once in 2 years once in 10 years once in 100 years
Private courtyards (where the area is between 25 m^2 - 60 m^2)	beginning to pond 300 mm 600 mm	once in 5 years once in 20 years once in 100 years
Paved recreation in common areas	beginning to pond	6 times per year

Recommendations for depth and frequency for inundation of different classes of storages are given in the Table 6.1 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 600 mm, and appropriate safety precautions should be made. This should include the provision of warning signs and fencing where depths exceed 600 mm near pedestrian traffic areas.

The indicative frequency of inundation can be estimated from Figure 6.1.

6.2 Site drainage techniques

A number of simple techniques can be employed to increase the efficiency of the OSD system, whilst reducing the impact on the site.

- Grade the site for surface drainage so that when the pipe system fails no serious consequences will occur. The surface flows on many sites are so small that there is no need for any underground drainage system, except for the roof drainage;
- Avoid filling the site with pits that are not needed. Pits rarely get any maintenance. As well, increased pit head loss through the drainage system can cause drainage failure due to blockage;
- Direct as much of the site as possible to the storage. A frequent failing of storage systems is that the driveways either discharge directly to the street or a grated drain on the boundary. These drains rarely perform adequately. A better approach is to introduce a speed hump or threshold that will more effectively divert surface flows to a storage or contain flows when the driveway forms part of the storage system. Figure 6.1 shows three profiles suitable for diverting driveway flows to a storage;
- When OSD storage is provided in a garden area, avoid placing the DCP in the centre where it will be an eyesore. Alterations to the grading of the floor of the storage will generally allow the DCP to be located unobtrusively in a corner next to shrubbery or some garden furniture. Allow for future garden sheds in determining the area available or storage; and
- Try to retain some informality in garden areas used for storage. Rectangular steep-sided basins unbroken by any features maximise the volume, but detract from the appearance of the landscaping. Steep sided basins also require safety issues to be addressed (see Section 3.5.5).

6.3 Common problems to avoid in OSD systems

Early OSD Systems

A field study of over 150 OSD systems throughout Sydney built between 1991 and 1994, when the OSD policy was quite new, revealed a high proportion with features that detracted from their effectiveness. The most commonly encountered problems are set out below.

- Deficient Storage Volume – this was particularly common in landscaped storages, and is often the result of incompetent construction, deficiencies or volume losses associated with landscape finishing, or furniture;
- Uncertain Discharge Control – a wide variety of discharge control devices were in use. The discharge rates from many outlets were impossible to predict with any confidence. Drowned outlets, skewed inlets and crudely fabricated outlets in unsuitable material were common;

Figure 6.1 Indicative Storage Frequency Curve

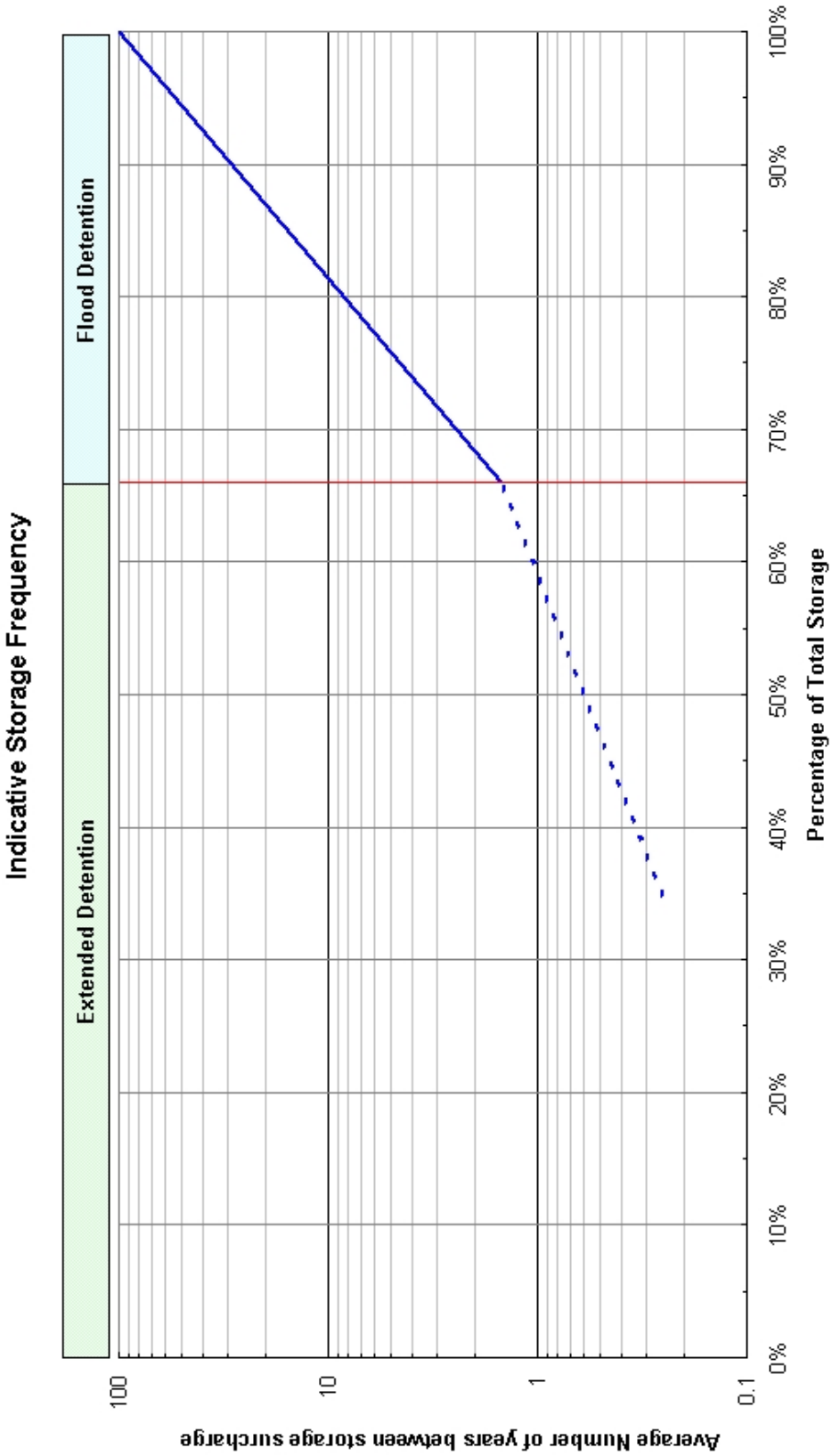
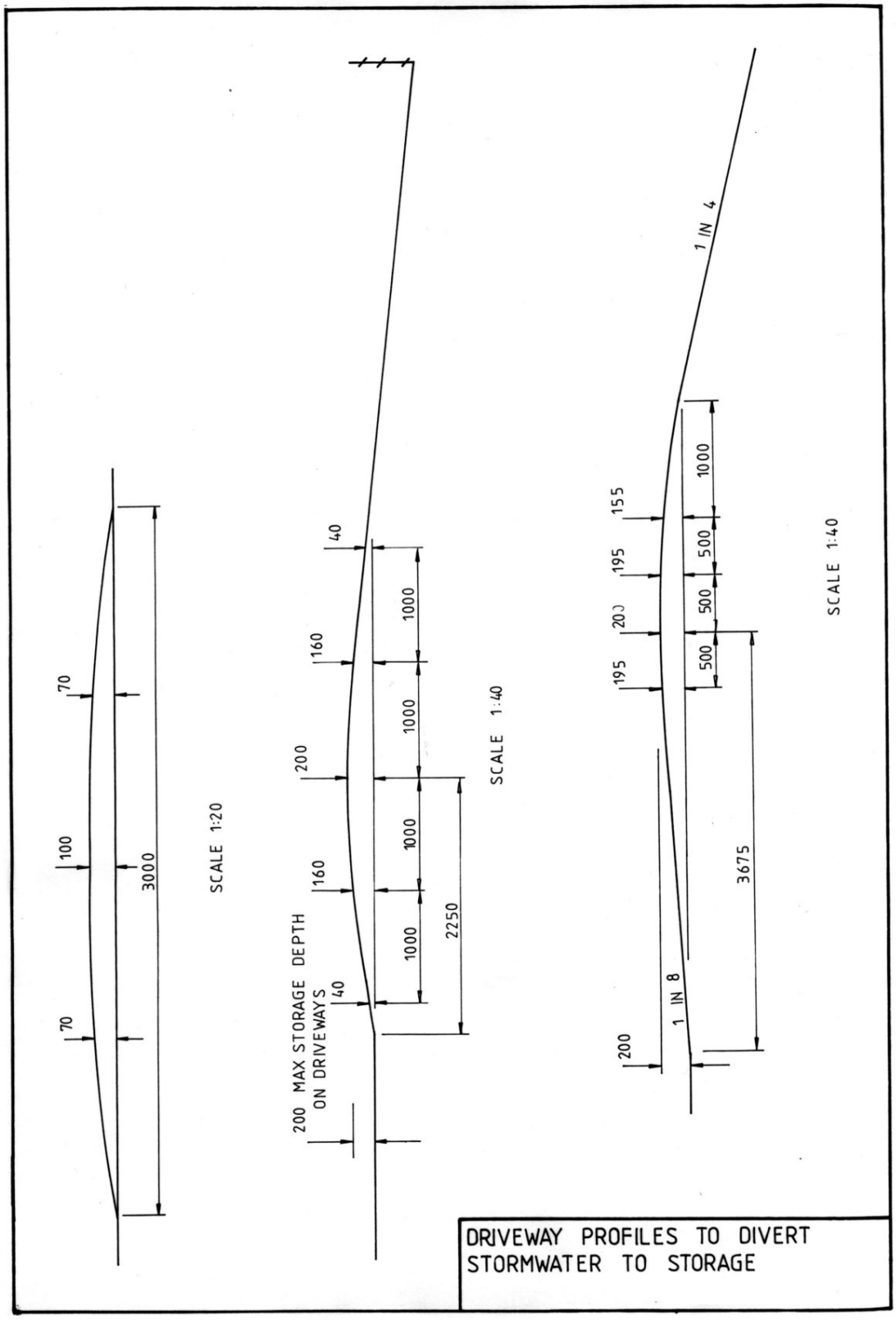


Figure 6.2 Driveway Profiles to Divert Stormwater to Storage



- Less than half the inspected systems had screens. When provided, screening was often poorly fabricated in corrodible material. Also, the screen area was often small in relation to the size of the orifice;
- Decomposing organic material in unvented structural storages was causing odour problems;
- Often costly structural storages had been constructed on sites where opportunities for low cost driveway and landscaped storage had not been used;
- The design of some storages had neglected the loadings of a full or partially full storage, and some walls were structurally deficient.

More Recent OSD Systems

Field inspections by Councils and the Trust and the OSD audits carried out by consultants on behalf of the Trust revealed the following deficiencies in OSD systems built from 1994 to 2004:

- Screens placed vertically in DCPs but not to the top of the DCP allowed debris to float over screen and obstruct the orifice. Other screens left gaps around the edges large enough to let debris through;
- Access to pits or underground storage was difficult because of the use of concrete lids or jammed grates;
- OSD systems did not cater sufficiently for inflow from off-site with the result that storages would be surcharge in large events less than the 100-year ARI event;
- Insufficient care was taken to grade surface of site to storage or DCP resulting in flows bypassing OSD system in larger events when roof gutters overflow or internal drainage lines surcharge;
- Deep pits constructed without safe access to underground storages;
- Failure to install subsurface drainage in landscaped surface storages;

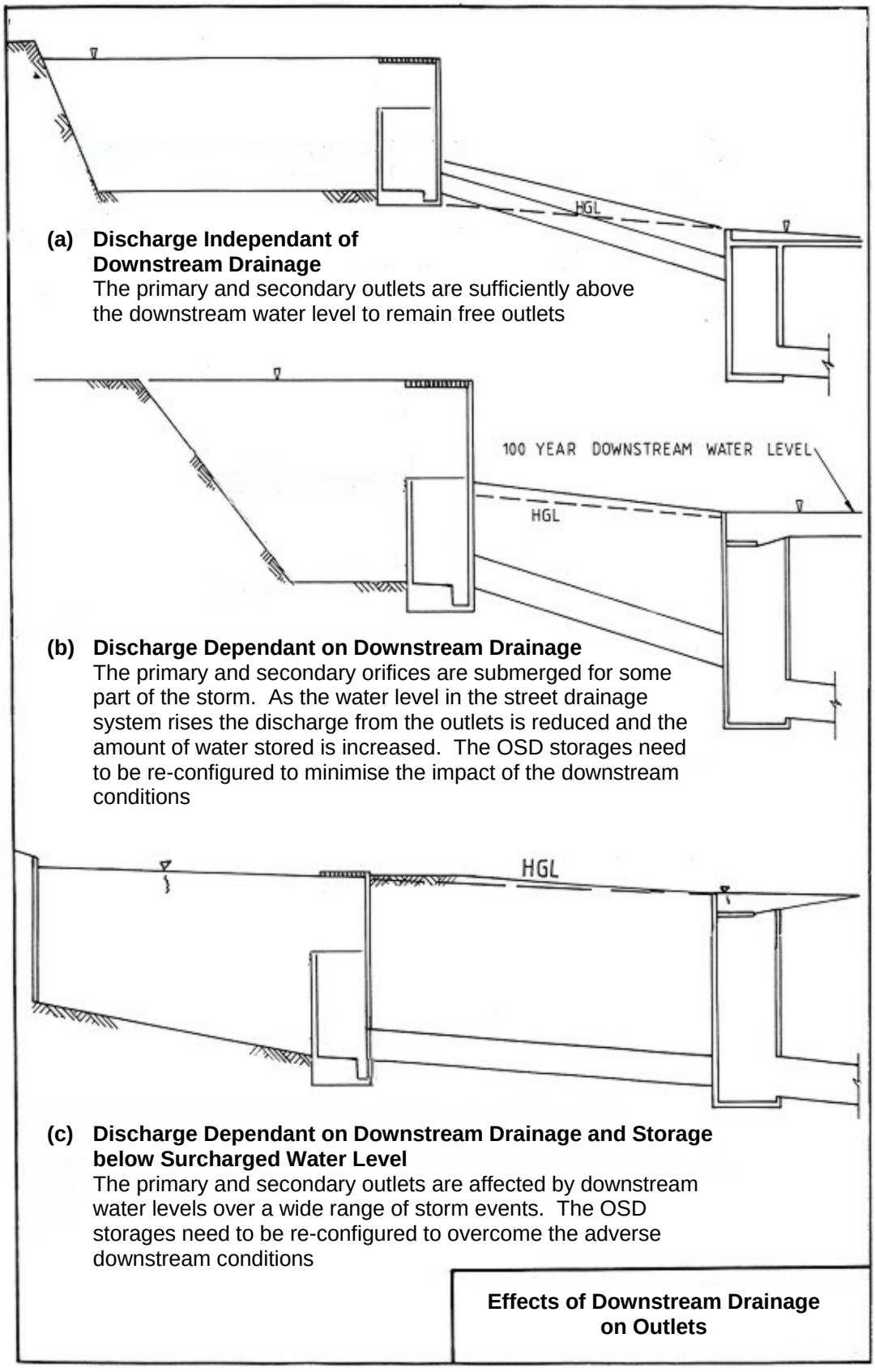
6.4 Drowned outlets

Even when care has been taken to ensure that the outlet pipe from the outlet is large enough, the assumption of free discharge from the outlets may be invalid if the outlets are drowned by the downstream drainage system.

An OSD system is designed to control flows in all storms up to and including the 100-year ARI event, while the downstream drainage system is often only able to cater for smaller storms (typically 5-year or 20-year ARI) without surcharging. The effect of this surcharging on the outlets of an in-ground OSD storage is shown in greater detail in Figure 6.3.

In the case of in-ground extended detention storage It is expected that the primary outlet that controls runoff in events up to a 1.5 yr ARI event will not be drowned by water levels in the downstream drainage system. If the downstream drainage system drowns the primary outlet in even small storms less than 1.5 yr ARI then above ground extended detention needs to be considered or the merits of developing a site subject to adverse downstream flooding in even small storms needs to be re-considered.

Figure 6.3 Effects of Downstream Drainage on Outlets



(a) Discharge Independant of Downstream Drainage
The primary and secondary outlets are sufficiently above the downstream water level to remain free outlets

(b) Discharge Dependant on Downstream Drainage
The primary and secondary orifices are submerged for some part of the storm. As the water level in the street drainage system rises the discharge from the outlets is reduced and the amount of water stored is increased. The OSD storages need to be re-configured to minimise the impact of the downstream conditions

(c) Discharge Dependant on Downstream Drainage and Storage below Surcharged Water Level
The primary and secondary outlets are affected by downstream water levels over a wide range of storm events. The OSD storages need to be re-configured to overcome the adverse downstream conditions

Effects of Downstream Drainage on Outlets

Figure 6.3 (a) shows a drainage system where the primary and secondary outlets are above the downstream water levels. The orifices will discharge freely, even in a severe storm event. This outlet arrangement gives the designer the most certain form of discharge control.

Figure 6.3 (b) shows a system where, due to site drainage constraints, the preferred location of the secondary outlet is below the surcharged water level downstream and the outlet is submerged. In this case the secondary orifice needs to be raised to a level where it is not submerged in severe storm events while still maintaining high early discharge (HED). If it is not possible to achieve high early discharge with a raised secondary outlet then a non-HED orifice outlet needs to be installed. Under conditions where a non-HED secondary outlet is installed the SSR_T needs to be increased to 520 m^3/ha to compensate for a less efficient secondary outlet.

Figure 6.3 (c) shows an in-ground storage located below the downstream water level. The outflow from the outlets is highly dependent on the water level in the downstream drainage system and the discharge is likely to vary over a wide range of storm events. In this case it is expected that it is not possible to achieve high early discharge with a raised secondary outlet. Consequently at the least above ground flood detention and a non-HED secondary orifice outlet needs to be installed. Under conditions where a non-HED secondary outlet is installed the SSR_T needs to be increased to 520 m^3/ha to compensate for a less efficient secondary outlet. Alternatively it may be possible to implement both extended detention and flood detention above ground and to construct an above ground HED secondary outlet.

In the case of non-HED secondary outlets a separate Non-HED Outlet OSD Calculation Sheet needs to be completed. This calculation sheet accounts for the adjusted SSR_T and the head over the secondary orifice outlet based on the overall water level in the flood detention storage (see example given in Figure 7.5).

6.5 Designing for maintenance

OSD systems are intended to regulate flows over the entire life of the development. This cannot be achieved without some regular maintenance. Councils are ultimately responsible for ensuring these systems are maintained through field inspections and enforcing the terms of the positive covenant covering OSD systems. The designer's task is to minimise the frequency of maintenance and make the job as simple as possible. The following points are suggestions. Site constraints will mean that they will not always be feasible.

- Surface storages are generally easier to maintain and should be specified where possible. If extended detention storage is to be provided on the surface then it should be in little used areas where inundation will not cause amenity problems;
- Attempt to locate access points to underground storages away from heavily trafficked areas. Manholes in the entrance driveway to a large villa and townhouse development can discourage property owners from regularly inspecting and maintaining the system;
- Use light duty covers and consider locating access points in areas not subject to vehicle traffic. Several manufacturers produce lightweight access covers that can be easily lifted by one person;
- Try to locate your outlet(s) in an accessible location, often a slight regrading of the storage floor will allow you to move an outlet from a private courtyard into a common open space. Common areas are more readily accessible to council inspectors or persons doing maintenance and help ensure the responsibility for maintenance lies with the joint owners rather than an individual.

- Every attempt should be made to locate primary storage in common open space because this is the storage most frequently filled and hence most likely to need maintenance;
- Manholes should be fitted with the same industry-standard lifting/keying system throughout the project to assist future property owners to replace missing keys;
- Consider using circular manholes, as they are often easier to remove and more difficult to drop into the storage when being replaced; and
- Use a guide channel inside the storage or DCP to fix the screen and put a handle on the screen to assist removal. The guide channel prevents debris from being forced between the wall of the pit and the screen, and allows the screen to be easily removed and replaced in the correct position.

6.6 Sumps

A sump below the invert of the orifice outlet has been previously encouraged to:

- avoid turbulence near the pit floor affecting the hydraulic performance of the orifice;
- allow simple installation of orifice plates and outlet pipes; and
- prevent silt and debris blocking the orifice outlet.

Hydraulic model studies have shown that the proximity of the pit floor does not significantly affect the discharge coefficient of any orifice tested. In addition, field studies of OSD systems have revealed that where a fine mesh screen is securely fitted to the walls and floor of the storage or DCP, (to prevent material being carried under or around the screen), any silt or sediment carried through the screen is carried through the orifice.

Various combinations of the following factors have led to odour and mosquito problems in the sumps of some DCPs:

- Excessively deep sumps;
- Poorly constructed underlying aggregate beds of insufficient depth;
- Poor infiltration rates of surrounding sub-soil;
- DCPs with underground storages founded on rock or shale; and
- Construction debris, (typically concrete slurry), blocking weep holes in the pit floor.

The requirement to install sumps at the outlets varies between Councils as follows:

- Parramatta City Council requires 2 x 90 mm diameter pipes to be installed through the base of each sump (refer Figures 4.3 and 4.4);
- Holroyd City Council requires 2 x 90 mm diameter pipes to be installed through the base of each sump (refer Figures 4.3 and 4.4);
- Baulkham Hills Shire Council requires that sumps be filled with a mortar mix to the invert of the orifice; while
- Blacktown City Council does not require sumps to be installed.

6.7 Multiple storages

In terms of construction and recurrent maintenance costs, it is preferable to provide fewer larger storages than a larger number of smaller storages. Multiple storages should be carefully treated when preparing a detailed design. The storages need to be designed separately with the catchment draining to each storage defined. When establishing the catchments draining to each storage, it is important to remember that flows up to and including the 100 year storm need to be directed to the storage. This will mean that, in addition to the piped drainage, surface gradings will need to be checked to ensure that overflows from roof gutters or pipes are directed to the appropriate storage.

In the case of rainwater tanks the overflows from any rainwater tank(s) must be discharged to the OSD system.

6.8 Construction tolerances

Because of the importance of OSD systems in protecting downstream areas from flooding, every effort should be made to avoid, or at least to minimise, construction errors. Whilst an OSD system with slightly less than the specified storage volume will mitigate flooding in most storm events, it will not be fully effective in a major storm. For this reason, the design should allow for a potential reduction in the storage volume due to common post-construction activities such as landscaping, top dressing and garden furniture.

Notwithstanding this, it is recognised that achieving precise levels and dimensions may not always be possible in practice. It is therefore considered that an OSD system could be certified as meeting the design intent where:

- the storage volume is at least 95% of the specified volume; and
- the discharges are within plus or minus 5% of the design SRDs.

7. CASE STUDIES

Where possible, the drainage system should be designed to direct runoff from the entire site to the OSD system. Sometimes, because of ground levels, the receiving drainage system or because of other circumstances eg. retention of major trees, this will not be feasible. In these cases up to 30% of the residual site area may be permitted to bypass the OSD systems, provided that as much as possible of the runoff from impervious site areas is drained to the OSD system and specific Council approval is obtained.

7.1 Development Type: - Proposed Dual Occupancy

24 River Road, Parramatta

A two storey dual occupancy development is proposed on an existing site containing a single residential dwelling. The existing site grades from the rear boundary to the front boundary and has a total site area of 700 m^2.

The proposed structure has been placed on the property ensuring compliance with Council's setback requirements. Due to Council height limitations and overshadowing problems with structures on the neighbouring property the ground floor level at the rear building line will be lower than the existing ground level thereby requiring retaining structures along the side boundaries and rear courtyard.

Drainage of the site is fairly straight forward however the provision of an above ground on site detention basin within the front setback area of the site is made difficult due to the existence of trees within both landscaped front setback areas which are required to be retained. As the local authority will not permit excavation within the protection zone of trees to be retained the only option for the provision of On Site Detention for this site will be a below ground tank beneath the driveway.

The overall site layout is given in Figure 7.1. The site and development data is:

Site area =	0.07 ha
Total roof area =	0.021 ha
Area of site draining to OSD Storage =	0.06 ha
No. of dwellings on the site =	2

Consideration was also given to installing a rainwater tank for each dwelling with rainwater to be used for outdoor, toilet flushing and laundry in each 4 person household. The data on the rainwater tanks includes:

% of roof draining to each rainwater tank =	60%
Volume of each rainwater tank =	3 kL
Volume of dedicated airspace =	0 kL
Minimum volume at which top-up commences =	0 kL
Daily demand on each rainwater tank =	0.657 kL/day

A solution

With the existence of trees within the landscaped front setback areas on either side of the proposed driveway the only alternative for the provision of On Site Detention is by way of a below ground tank. In order to obtain a reasonable internal depth within the tank that aids in accessibility and maintenance the tank has been positioned beneath the proposed concrete driveway near the garage entrances.

All pipes from the inlet pits provided on the site to collect surface run-off and downpipes are drained to the extended detention tank.

Water will commence to build up within the tank until the volume of the required extended detention is achieved. At this time water will commence cascading into the control chamber for the secondary outlet.

The water level will continue to rise until the required detention volume has been achieved. Any overflows caused by potential partial blockage of the primary or secondary outlets will occur at Pits 2 and 3.

The cross section detail of the On-site Detention tank is given in Figure 7.2.

Other Considerations

Upstream Overland Flows

As the property grades from the rear boundary to the front boundary it is likely that the same grade continues beyond the rear boundary and hence surface run-off from the upstream properties also currently flows through the site.

A check from Council's catchment plans and site visit reveals that only the area of the property at the rear is generating the overland flows that drain through the site.

As such the necessary calculations are carried out to determine the amount of overland flows and from these a channel size is able to be determined. The channel being provided along the rear of the property being developed.

The overland flow channel is drained to a pit that drains directly to the kerb and gutter, thereby bypassing the On Site Detention system provided on the site.

Results from On Site Detention calculations

The site and development data was entered into the HED On-Site Detention Calculation Sheet (see Figure 7.3). The HED calculation sheet gave the following results:

Extended Detention Required =	21 m^3
Orifice diameter for extended detention =	33 mm
Maximum Water level of Extended Detention =	R.L. 10.65
Extended Detention Volume Provided =	21.6 m^3
Overall Detention Required =	31.8 m^3
Orifice diameter for detention =	60 mm
Maximum Water level of Detention =	R.L. 11.00
Detention Volume Provided =	32.2 m^3

The reduction in storage requirements that would be achieved by installing 3 kL rainwater tanks on each dwelling was also calculated (see Figure 7.4).

The HED calculation sheet gave the following results:

Extended Detention Required =	18.3 m^3
Orifice diameter for extended detention =	33 mm
Maximum Water level of Extended Detention =	R.L. 10.65
Overall Detention Required =	29 m^3
Orifice diameter for detention =	60 mm
Maximum Water level of Detention =	R.L. 11.00

Figure 7.1 Example 1 – Overall Site Layout

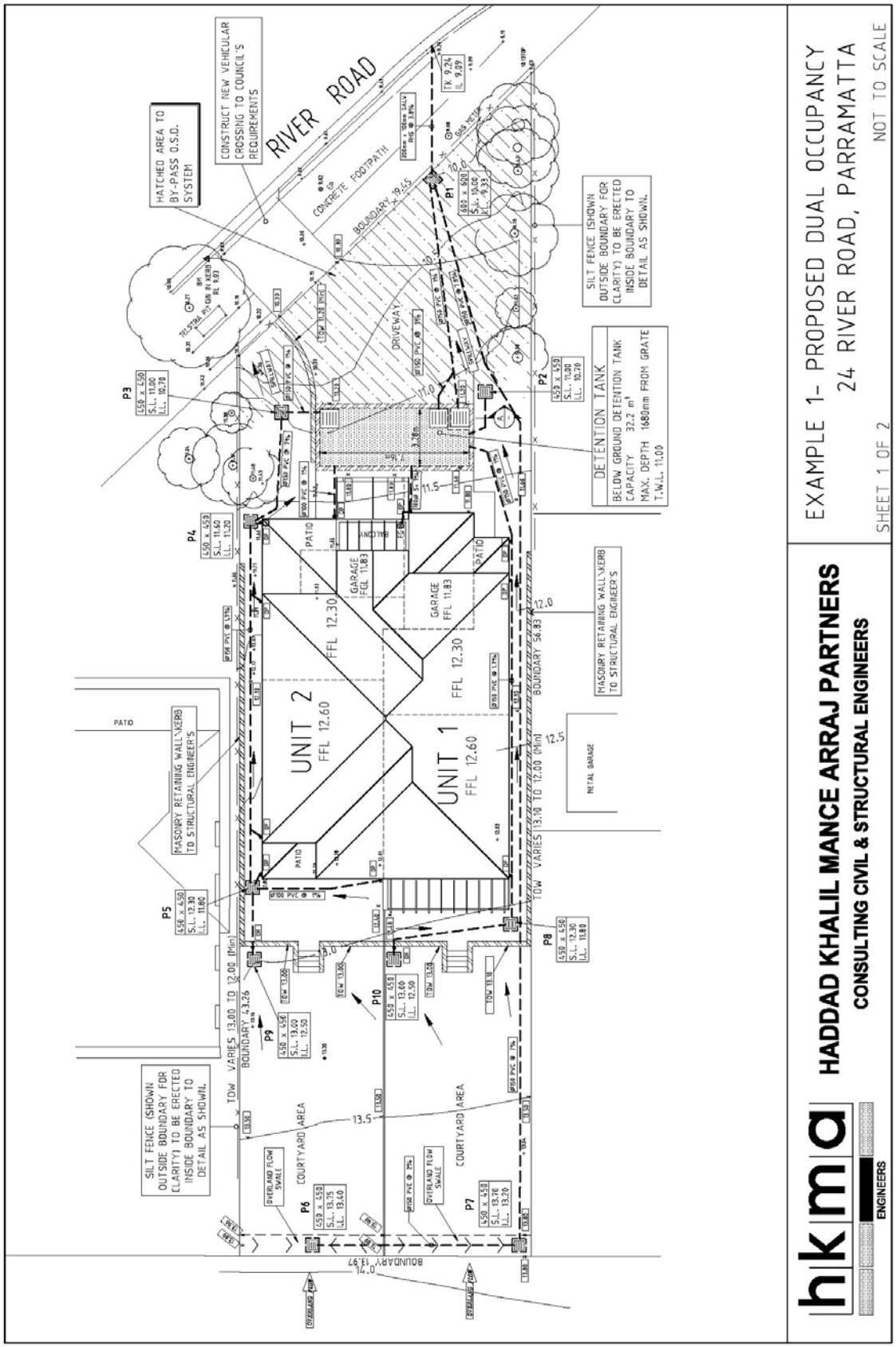


Figure 7.2 Example 1 – Concept On-Site Detention Tank Section Detail

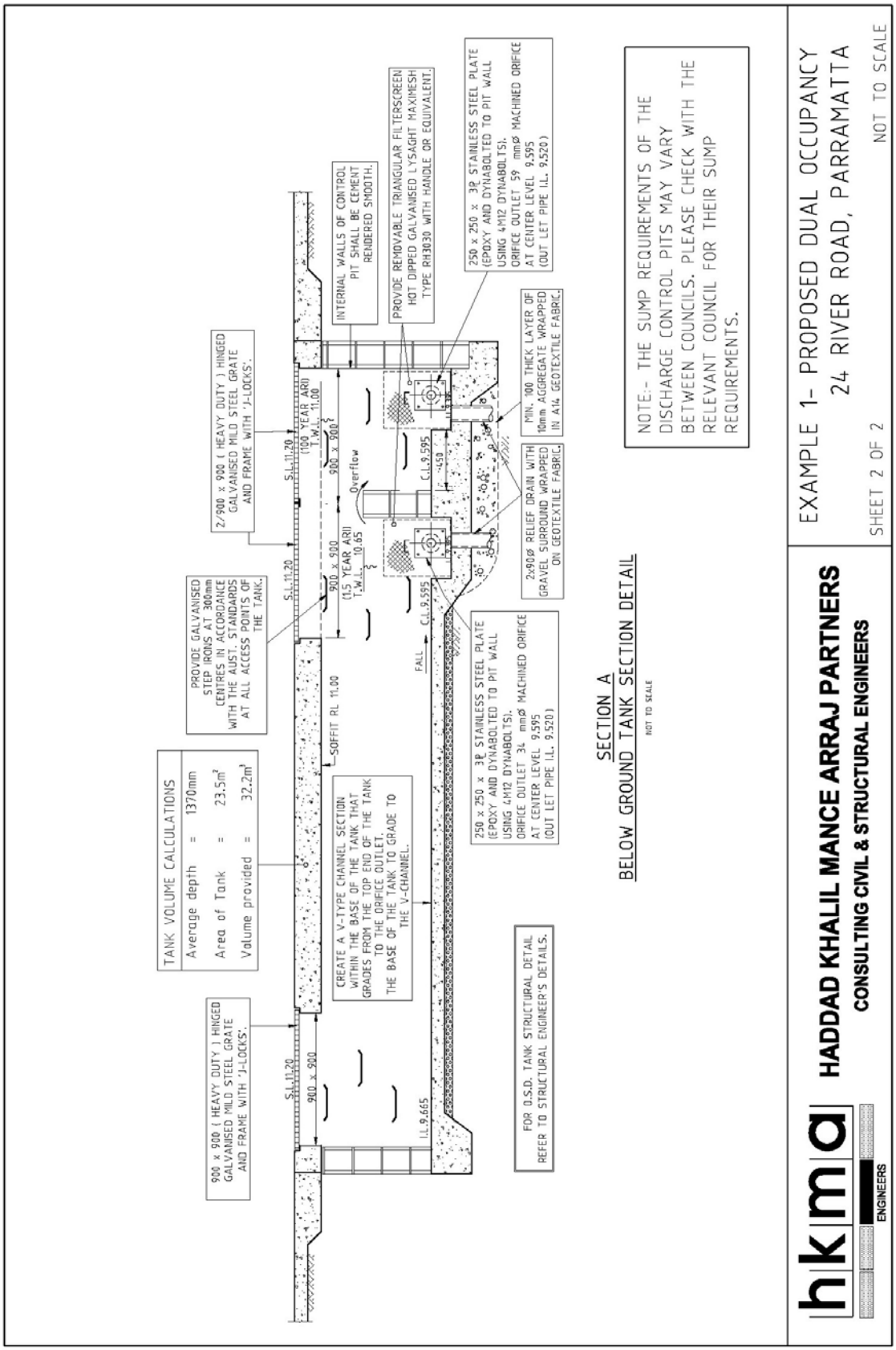


Figure 7.3 Example 1 - OSD Calculation Sheet without Rainwater Tanks

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
HED Secondary Outlet

Project:	**UPRCT Handbook Demonstration Example**
Site Address	**24 River Road, Parramatta**
Job No:	**1234**
Designer:	**Mr Engineer**
Telephone:	**(02) 9912 3456**

Site Data

OSD Area:	**Upper Parramatta River Catchment**						
L.G.A	**Parramatta City Council**						
Site Area	**0.07**	ha	**700**	m^2			
Total Roof Area	**0.021**	ha	**210**	m^2			
Area of Site draining to OSD Storage	**0.06**	ha	**600**	m^2	**Satisfactory**		
Residual Site Area (Lot Area - Roof Area)	**0.049**	ha					
Area Bypassing Storage	**0.01**	ha					
Area Bypassing / Residual Site Area	**20.4%**				**Satisfactory**		**30% Max**
No. of Dwellings on Site	**2**				**Satisfactory**		
Site Area per Dwelling	**0.035**	ha					
Roof Area per Dwelling	**0.011**	ha					

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	**300**	m^3/ha	Total Storage	**455**	m^3/ha
Basic SRDs	Primary Outlet	**40**	L/s/ha	Secondary Outlet	**150**	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	**80%**				
Adjusted SRDs	**34**	L/s/ha		**109**	L/s/ha

OSD Calculations

		Extended Detention			Detention	
Basic SSR Volume	Ext Detention Storage	**21.00**	m^3	Total Storage	**31.85**	m^3
Total Rainwater Tank Credits		**0.00**	m^3		**0.00**	m^3
Storage Volume				Total	**31.85**	m^3
Storage Volume	Ext Detention Storage	**21.00**	m^3	Flood Detention Storage	**10.85**	m^3
OSD Discharges	Primary Outlet	**2.37**	L/s	Secondary Outlet	**7.64**	L/s
RL of Top Water Level of Storage		**10.650**	m		**11.000**	m
RL of Orifice Centre-line		**9.600**	m		**9.600**	m
Number of Orifices		**1**			**1**	
Estimated Downstream Flood Level		**9.20**	1.5 yr ARI		**9.60**	100 yr ARI
Downstream FL - RL of Orifice Cente-line		**-0.40**	**Satisfactory**	**Satisfactory**	**0.00**	m
Design Head to Orifice Centre		**1.050**	m	TWL Ext Detn Storage - RL Orifice	**1.050**	m
Calculated Orifice Diameter		**33**	mm	**Satisfactory**	**Satisfactory**	**60**	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		**12.300**	m
RL of Minimum Garage Floor Level		**11.830**	m
Length of Overflow Weir		**0.90**	m
Site Runoff Coefficient	**Parramatta City Council**	**0.75**	
Storm Intensity (5 min 100 yr ARI)		**206**	mm/h
Peak Flow over Weir		**25.8**	L/s
Depth of Flow over Weir		**67**	mm
Freeboard to Habitable Floor	**Satisfactory**	**1233**	mm
Freeboard to Garage Floor	**Satisfactory**	**763**	mm

Figure 7.4 Example 1 - OSD Calculation Sheet with Rainwater Tanks

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
HED Secondary Outlet

Project:	**UPRCT Handbook Demonstration Example**
Site Address	**24 River Road, Parramatta**
Job No:	**1234**
Designer:	**Mr Engineer**
Telephone:	**(02) 9912 3456**

Site Data

OSD Area:	**Upper Parramatta River Catchment**						
L.G.A	**Parramatta City Council**						
Site Area	**0.07**	ha	**700**	m^2			
Total Roof Area	**0.021**	ha	**210**	m^2			
Area of Site draining to OSD Storage	**0.06**	ha	**600**	m^2	**Satisfactory**		
Residual Site Area (Lot Area - Roof Area)	**0.049**	ha					
Area Bypassing Storage	**0.01**	ha					
Area Bypassing / Residual Site Area	**20.4%**				**Satisfactory**		**30% Max**
No. of Dwellings on Site	**2**				**Satisfactory**		
Site Area per Dwelling	**0.035**	ha					
Roof Area per Dwelling	**0.011**	ha					

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	**300**	m^3/ha	Total Storage	**455**	m^3/ha
Basic SRDs	Primary Outlet	**40**	L/s/ha	Secondary Outlet	**150**	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	**80%**				
Adjusted SRDs	**34**	L/s/ha		**109**	L/s/ha

OSD Calculations

		Extended Detention				Detention	
Basic SSR Volume	Ext Detention Storage	**21.00**	m^3		Total Storage	**31.85**	m^3
Total Rainwater Tank Credits		**2.74**	m^3			**2.89**	m^3
Storage Volume					Total	**28.96**	m^3
Storage Volume	Ext Detention Storage	**18.26**	m^3		Flood Detention Storage	**10.70**	m^3
OSD Discharges	Primary Outlet	**2.37**	L/s		Secondary Outlet	**7.64**	L/s
RL of Top Water Level of Storage		**10.650**	m			**11.000**	m
RL of Orifice Centre-line		**9.600**	m			**9.600**	m
Number of Orifices		**1**				**1**	
Estimated Downstream Flood Level		**9.20**	1.5 yr ARI			**9.60**	100 yr ARI
Downstream FL - RL of Orifice Cente-line		**-0.40**	**Satisfactory**		**Satisfactory**	**0.00**	m
Design Head to Orifice Centre		**1.050**	m		TWL Ext Detn Storage - RL Orifice	**1.050**	m
Calculated Orifice Diameter		**33**	mm	**Satisfactory**	**Satisfactory**	**60**	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		**12.300**	m
RL of Minimum Garage Floor Level		**11.830**	m
Length of Overflow Weir		**0.90**	m
Site Runoff Coefficient	**Parramatta City Council**	**0.75**	
Storm Intensity (5 min 100 yr ARI)		**206**	mm/h
Peak Flow over Weir		**25.8**	L/s
Depth of Flow over Weir		**67**	mm
Freeboard to Habitable Floor	**Satisfactory**	**1233**	mm
Freeboard to Garage Floor	**Satisfactory**	**763**	mm

Rainwater Tank Calculations (per Dwelling)					
Only Complete this Section if a Rainwater Tank Airspace Credit is Claimed					
The calculations assume that the same size rainwater tank is installed on each dwelling					
				Min	Max
% of Roof draining to Rainwater Tank	60.0%		Satisfactory	60.0%	100%
Total Rainwater Tank Volume	3.00	kL	Tank Volume OK		
Min Volume that triggers Top-up	0.00	kL	Note - Min Vol in Tank < 10% Total Tank Vol		
Total Tank Vol - Min Top-up Vol	3.00	kL			
Dedicated Airspace					
Dedicated Airspace	0.00	kL	Satisfactory		
	Extended Detention			Detention	
Dedicated Airspace Credit	0.00	kL		0.00	kL
Maximum Tank PSD	40	L/s/ha			
Maximum Tank Discharge	0.0	L/s			
Maximum Head to Centre of Tank Orifice	0.000	m	No Dedicated Airspace		
Calculated Orifice Diameter	0	mm	No Dedicated Airspace		
Dynamic Airspace					
Maximum Dynamic Storage (Nett Vol)	3.00	kL	Controls minimum % Roof to Rainwater Tank		
Daily Demand on Rainwater Tank	0.657	kL/d	Satisfactory		
Dynamic Airspace at start of Storm	3.00	kL			
	Extended Detention			Detention	
Dynamic Airspace Credit	1.37	kL		1.44	kL
Combined Rainwater Tank Credit	1.37	kL		1.44	kL
Maximum Rainwater Tank Credit	1.89	kL		2.87	kL
Rainwater Tank Credit per Dwelling	1.37	kL		1.44	kL
Rainwater Tank Credit for the Site	2.74	m^3		2.89	m^3

Signature: _____ **Date:** _____

The increase in overall storage requirements that would result from an elevated downstream 100 yr ARI flood level that requires a non-HED secondary outlet to be adopted is demonstrated in Figure 7.5. In this case:

- 3 kL rainwater tanks are installed on each dwelling; and
- two secondary orifice outlets (installed at the same level) are adopted due to the significantly reduced head over the secondary orifices due to the need to raise the height of the orifices to overcome the potential drowning of the outlets in a 100 yr ARI event.

The Non-HED calculation sheet gave the following results:

Extended Detention Required = 18.3 m^3
Orifice diameter for extended detention = 33 mm
Maximum Water level of Extended Detention = R.L. 10.65

Overall Detention Required = 33.5 m^3
Orifice diameter for detention = 2 x 57 mm
Maximum Water level of Detention = R.L. 11.00

Figure 7.5 Example 1 - OSD Calculation Sheet with Rainwater Tanks and a Non-HED Secondary Outlet

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
Non-HED Secondary Outlet
(Due to Elevated Downstream 100 yr ARI Flood Level)

Project:	**UPRCT Handbook Demonstration Example**
Site Address	**24 River Road, Parramatta**
Job No:	**1234**
Designer:	**Mr Engineer**
Telephone:	**(02) 9912 3456**

Site Data

OSD Area:	Upper Parramatta River Catchment					
L.G.A	Parramatta City Council					
Site Area	0.07	ha	700	m^2		
Total Roof Area	0.021	ha	210	m^2		
Area of Site draining to OSD Storage	0.06	ha	600	m^2	Satisfactory	
Residual Site Area (Lot Area - Roof Area)	0.049	ha				
Area Bypassing Storage	0.01	ha				
Area Bypassing / Residual Site Area	20.4%				Satisfactory	30% Max
No. of Dwellings on Site	2				Satisfactory	
Site Area per Dwelling	0.035	ha				
Roof Area per Dwelling	0.011	ha				

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	300	m^3/ha	Total Storage	520	m^3/ha
Basic SRDs	Primary Outlet	40	L/s/ha	Secondary Outlet	150	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	80%				
Adjusted SRDs	34	L/s/ha		109	L/s/ha

OSD Calculations

		Extended Detention			Detention	
Basic SSR Volume	Ext Detention Storage	21.00	m^3	Total Storage	36.40	m^3
Total Rainwater Tank Credits		2.74	m^3		2.89	m^3
Storage Volume				Total	33.51	m^3
Storage Volume	Ext Detention Storage	18.26	m^3	Flood Detention Storage	15.25	m^3
OSD Discharges	Primary Outlet	2.37	L/s	Secondary Outlet	7.64	L/s
RL of Top Water Level of Storage		10.650	m		11.000	m
RL of Orifice Centre-line		9.600	m		10.680	m
Number of Orifices		1			2	
Estimated Downstream Flood Level		9.20	1.5 yr ARI		10.50	100 yr ARI
Downstream FL - RL of Orifice Cente-line		-0.40	Satisfactory	Satisfactory	-0.18	
Design Head to Orifice Centre		1.050	m	TWL Detn Storage - RL Orifice	0.320	m
Calculated Orifice Diameter		33	mm	Satisfactory Satisfactory	57	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		12.300	m
RL of Minimum Garage Floor Level		11.830	m
Length of Overflow Weir		0.90	m
Site Runoff Coefficient	Parramatta City Council	0.75	
Storm Intensity (5 min 100 yr ARI)		206	mm/h
Peak Flow over Weir		25.8	L/s
Depth of Flow over Weir		67	mm
Freeboard to Habitable Floor	Satisfactory	1233	mm
Freeboard to Garage Floor	Satisfactory	763	mm

Rainwater Tank Calculations (per Dwelling)

Only Complete this Section if a Rainwater Tank Airspace Credit is Claimed

The calculations assume that the same size rainwater tank is installed on each dwelling

				Min	Max
% of Roof draining to Rainwater Tank	60.0%		Satisfactory	60.0%	100%
Total Rainwater Tank Volume	3.00	kL	Tank Volume OK		
Min Volume that triggers Top-up	0.00	kL	Note - Min Vol in Tank < 10% Total Tank Vol		
Total Tank Vol - Min Top-up Vol	3.00	kL			
Dedicated Airspace					
Dedicated Airspace	0.00	kL	Satisfactory		
	Extended Detention			Detention	
Dedicated Airspace Credit	0.00	kL		0.00	kL
Maximum Tank PSD	40	L/s/ha			
Maximum Tank Discharge	0.0	L/s			
Maximum Head to Centre of Tank Orifice	0.000	m	No Dedicated Airspace		
Calculated Orifice Diameter	0	mm	No Dedicated Airspace		
Dynamic Airspace					
Maximum Dynamic Storage (Nett Vol)	3.00	kL	Controls minimum % Roof to Rainwater Tank		
Daily Demand on Rainwater Tank	0.657	kL/d	Satisfactory		
Dynamic Airspace at start of Storm	3.00	kL			
	Extended Detention			Detention	
Dynamic Airspace Credit	1.37	kL		1.44	kL
Combined Rainwater Tank Credit	1.37	kL		1.44	kL
Maximum Rainwater Tank Credit	1.89	kL		3.00	kL
Rainwater Tank Credit per Dwelling	1.37	kL		1.44	kL
Rainwater Tank Credit for the Site	2.74	m^3		2.89	m^3

Signature: _____ **Date:** _____

7.2 Development Type: - Proposed Unit Development

24 Catchment Avenue, Parramatta

A multi-storey unit development is proposed on an existing site containing 3 single residential dwellings. The existing site grades from the northern boundary to the southern boundary and has a total site area of 2,580 m^2.

The proposed structure comprises of 15 two bedroom units spread over 3 levels and has a basement which is below the natural ground level containing 15 garages and three visitor parking spaces. The building has approximately been centralised on the property ensuring compliance with Council's setback requirements. Due to the gradient of the existing site the floor level at the rear building line will be lower than the existing ground level thereby requiring retaining structures along the northern and eastern boundaries.

The overall site layout is given in Figure 7.6. The site and development data is:

Site area =	0.258 ha
Total roof area =	0.135 ha
Area of site draining to OSD Storage =	0.239 ha
No. of dwellings on the site =	15

Consideration was also given to installing a rainwater tank for each dwelling with rainwater to be used for outdoor, toilet flushing and laundry in each 3 person household. The data on the rainwater tanks includes:

% of roof draining to each rainwater tank =	65%
Volume of each rainwater tank =	3 kL
Volume of dedicated airspace =	0.6 kL
Daily demand on each rainwater tank =	0.56 kL/day

A Solution

The existence of a large landscaped setback area located at the south-eastern frontage of the site and a check of the required detention volume reveals that it is possible to provide an above ground detention basin with relatively minor excavation. As such the construction of a water tight retaining wall along the southern and eastern boundary at the required levels will permit water to pond in the landscape area which will not be utilised significantly by the future owners of the property. Maintenance of the detention area will also be straight forward and minor.

All downpipes and pipes from surface inlet pits will be drained directly to the extended detention storage and primary outlet. This will cause water to begin ponding within the above ground basin. Upon the volume of storage of the extended detention being achieved at RL 36.75 m, water will cascade into the adjoining secondary outlet pit. Finally at RL 36.90 m water will cascade over the weir located along the southern detention basin wall. The outlet pipes of each outlet pit are connected to the existing Council grated gully pit within Catchment Avenue.

The cross section details of the On-site Detention tank are given in Figures 7.7 and 7.8. A volume calculation check is given in Figure 7.9.

Other Considerations

Upstream Overland Flows

As the property grades from the northern boundary to the southern boundary it is likely that the same grade continues beyond the northern boundary and hence surface run-off from the upstream properties also currently flows through the site.

A check from Council's catchment plans and site visit reveals that only the area of the properties located north of the site are generating the overland flows that drain through the site.

As such the necessary calculations are carried out to determine the amount of overland flows and from these a channel size is able to be determined. The channel being provided along the northern boundary of the property conveys these overland flows through the property.

The overland flow channel is drained to a pit that drains directly to the kerb and gutter, thereby bypassing the On Site Detention system provided on the site.

Basement Drainage

The area of the driveway entrance will be draining directly to the basement level of the proposed development and will require a pump out drainage system to be designed in accordance with the requirements of the local Council and to the relevant Australian standards. Water pumped from the basement will be drained directly to the kerb and gutter and the area contributing to the basement pump out system is considered as bypassing the On Site Detention system.

Results from On Site Detention calculations

The site and development data was entered into the HED On-Site Detention Calculation Sheet (see Figure 7.10). The HED calculation sheet gave the following results:

Extended Detention Required =	77.4 m^3
Orifice diameter for extended detention =	64 mm
Maximum Water level of Extended Detention =	R.L. 36.75
Extended Detention Volume Provided =	80.3 m^3
Overall Detention Required =	117.4 m^3
Orifice diameter for detention =	117 mm
Maximum Water level of Detention =	R.L. 36.90
Detention Volume Provided =	129.5 m^3

The reduction in storage requirements that would be achieved by installing 3 kL rainwater tanks on each dwelling was also calculated (see Figure 7.11).

The HED calculation sheet gave the following results:

Extended Detention Required =	66.3 m^3
Orifice diameter for extended detention =	64 mm
Maximum Water level of Extended Detention =	R.L. 36.75
Overall Detention Required =	101.7 m^3
Orifice diameter for detention =	117 mm
Maximum Water level of Detention =	R.L. 36.90

Figure 7.6 Example 2 – Overall Site Layout

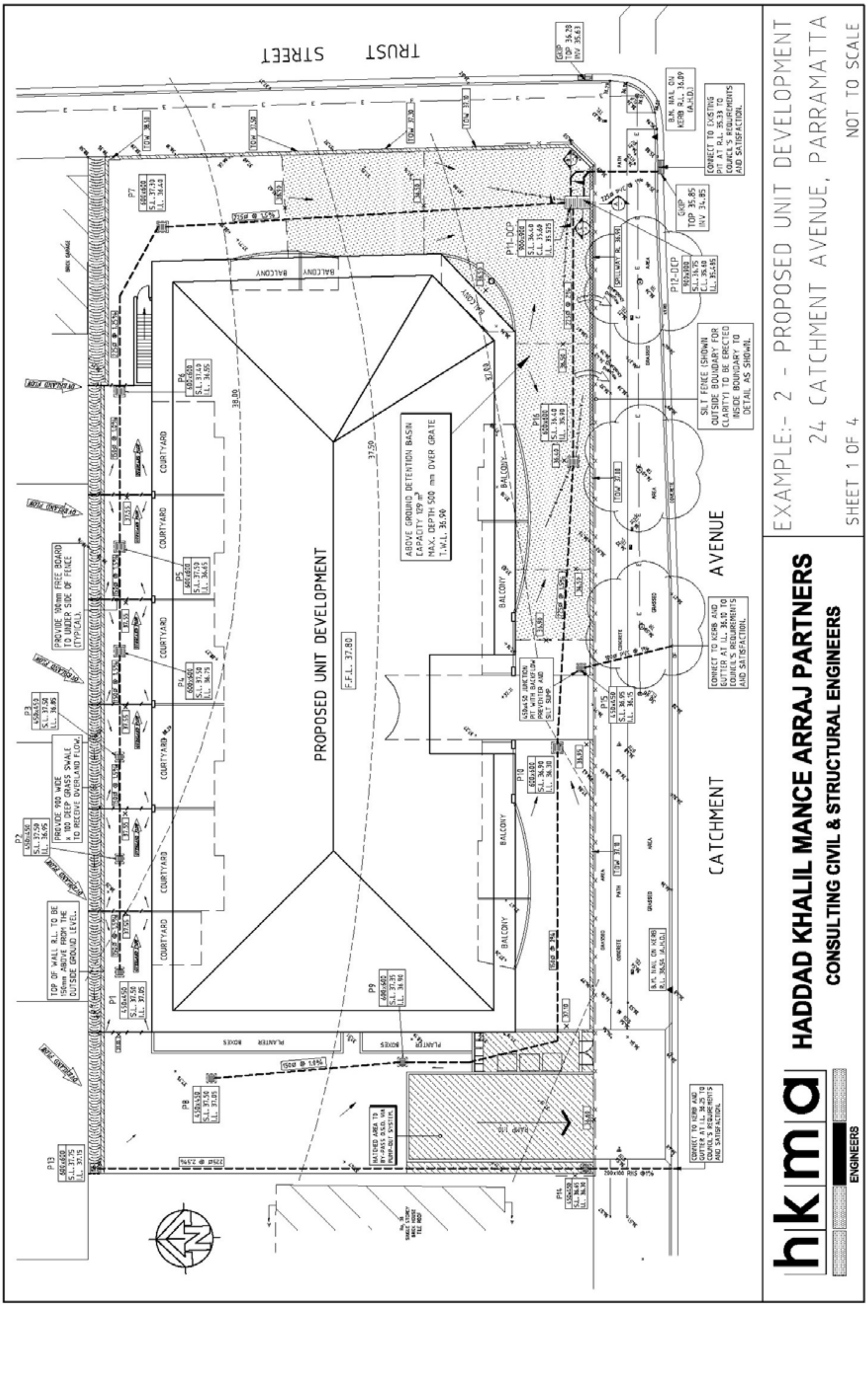


Figure 7.7 Example 2 – Concept Outlet Detail (Section A)

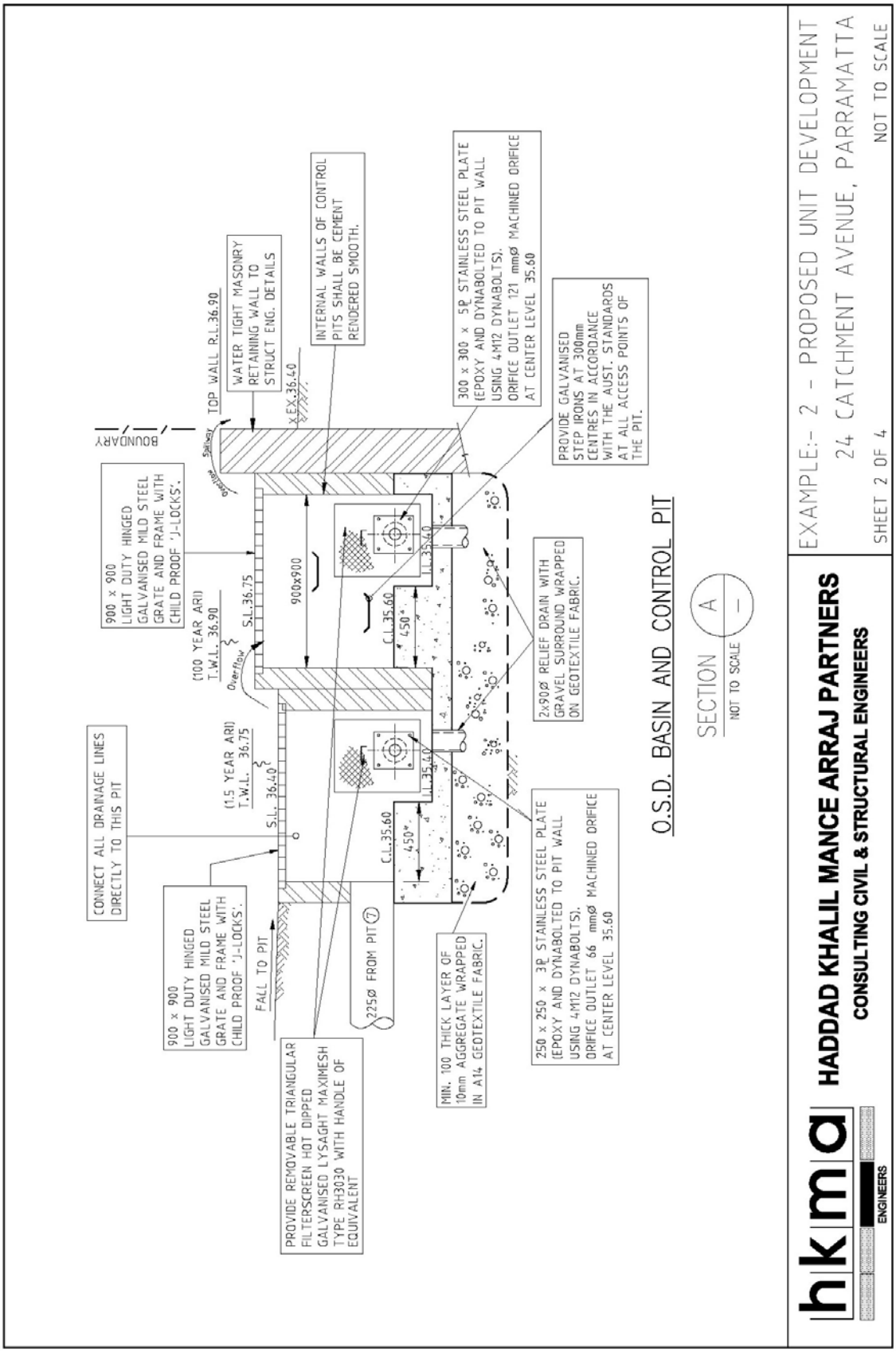


Figure 7.8 Example 2 – Concept Outlet Detail (Sections B and C)

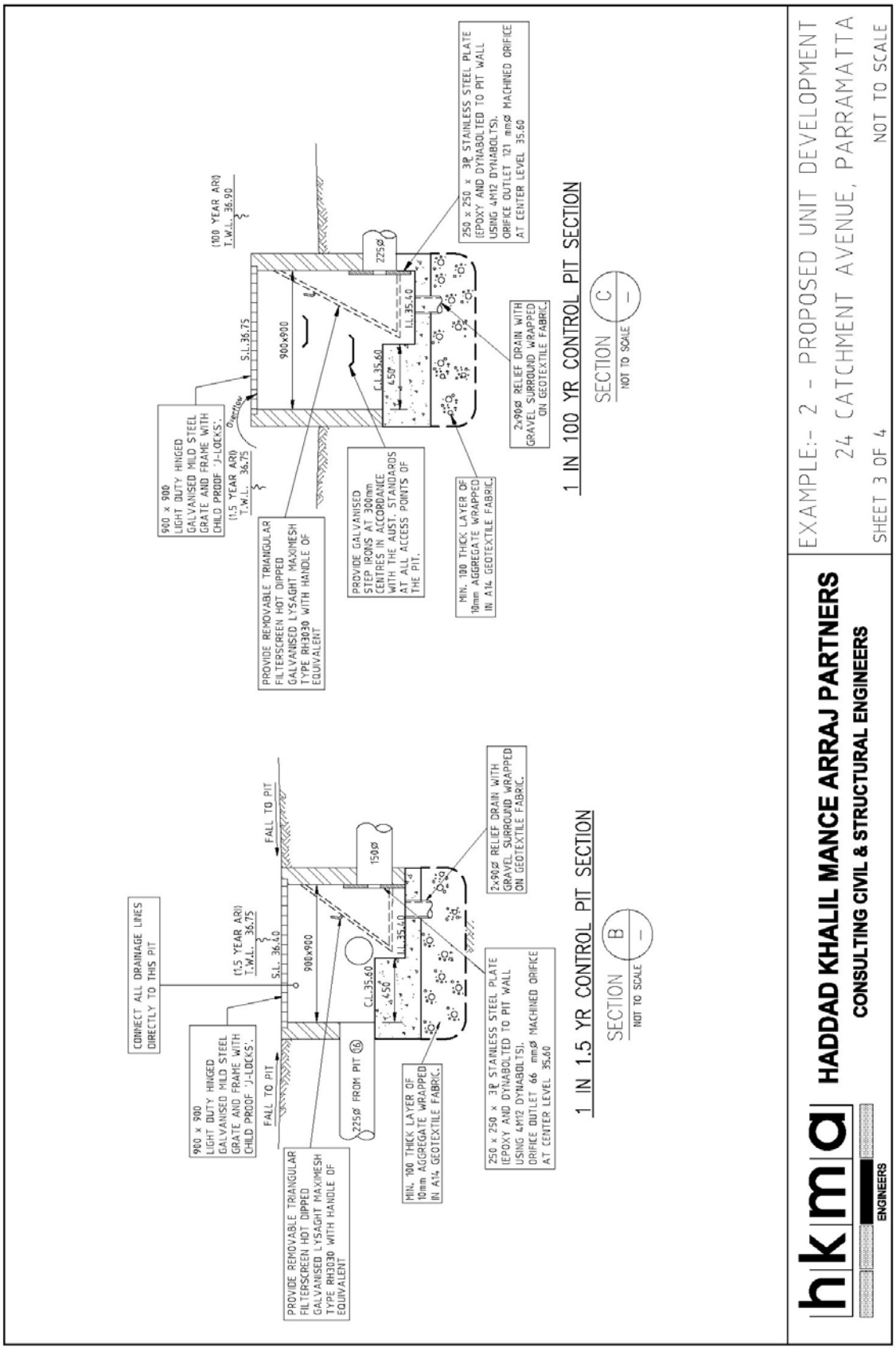


Figure 7.9 Example 2 – Concept On-Site Detention Volume Check

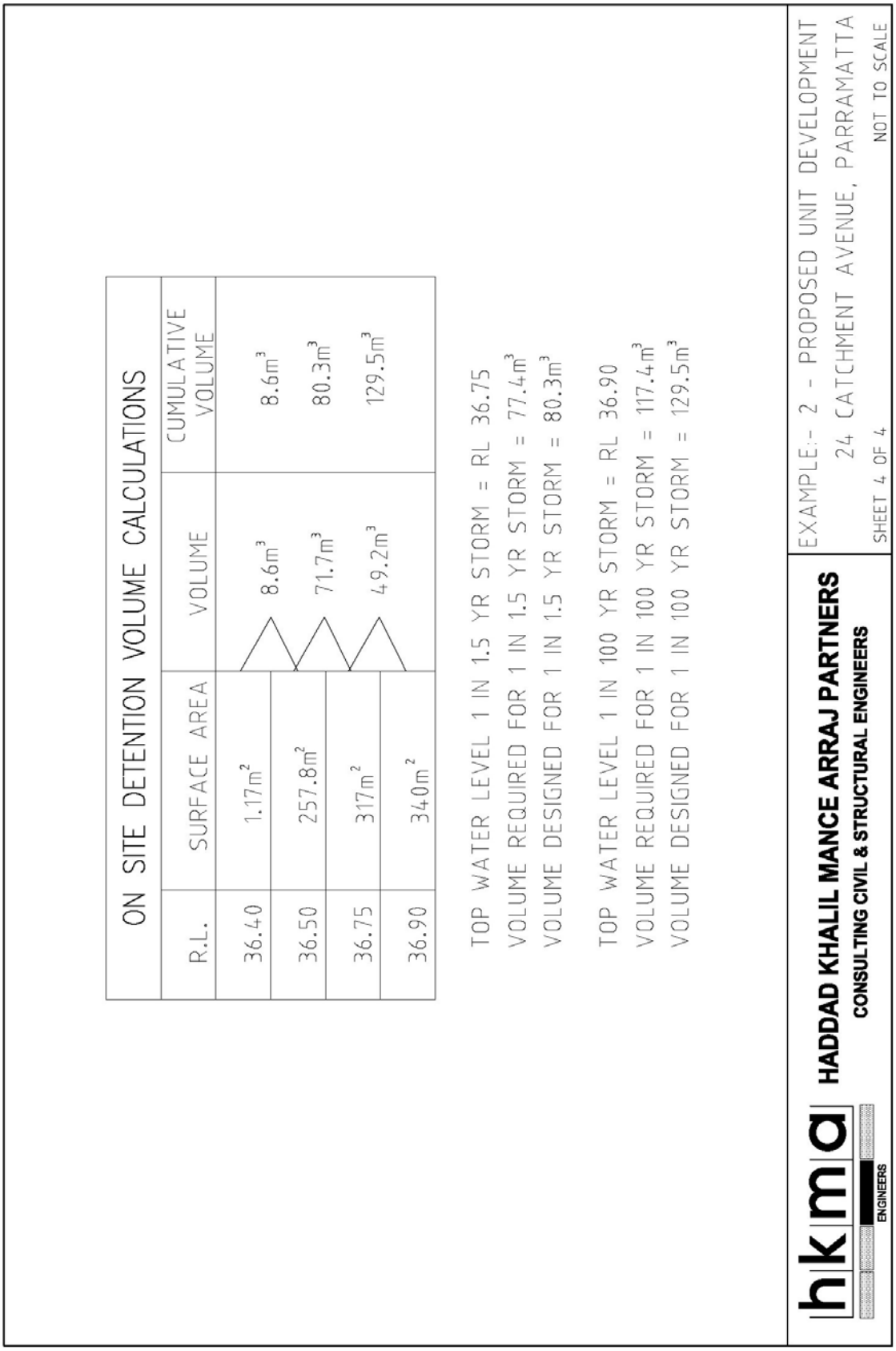


Figure 7.10 Example 2 - OSD Calculation Sheet without Rainwater Tanks

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
HED Secondary Outlet

Project:	**UPRCT Handbook Demonstration Example**
Site Address	**24 Catchment Avenue, Parramatta**
Job No:	**1234**
Designer:	**Mr Engineer**
Telephone:	**(02) 9912 3456**

Site Data

OSD Area:	Upper Parramatta River Catchment					
L.G.A	Parramatta City Council					
Site Area	0.258	ha	2,580	m^2		
Total Roof Area	0.135	ha	1,350	m^2		
Area of Site draining to OSD Storage	0.239	ha	2,390	m^2	Satisfactory	
Residual Site Area (Lot Area - Roof Area)	0.123	ha				
Area Bypassing Storage	0.019	ha				
Area Bypassing / Residual Site Area	15.4%				Satisfactory	30% Max
No. of Dwellings on Site	15				Satisfactory	
Site Area per Dwelling	0.017	ha				
Roof Area per Dwelling	0.009	ha				

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	300	m^3/ha	Total Storage	455	m^3/ha
Basic SRDs	Primary Outlet	40	L/s/ha	Secondary Outlet	150	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	85%			
Adjusted SRDs	35	L/s/ha	119	L/s/ha

OSD Calculations

		Extended Detention			Detention	
Basic SSR Volume	Ext Detention Storage	77.40	m^3	Total Storage	117.39	m^3
Total Rainwater Tank Credits		0.00	m^3		0.00	m^3
Storage Volume				Total	117.39	m^3
Storage Volume	Ext Detention Storage	77.40	m^3	Flood Detention Storage	39.99	m^3
OSD Discharges	Primary Outlet	9.12	L/s	Secondary Outlet	30.73	L/s
RL of Top Water Level of Storage		36.750	m		36.900	m
RL of Orifice Centre-line		35.600	m		35.600	m
Number of Orifices		1			1	
Estimated Downstream Flood Level		35.20	1.5 yr ARI		35.60	100 yr ARI
Downstream FL - RL of Orifice Cente-line		-0.40	Satisfactory	Satisfactory	0.00	m
Design Head to Orifice Centre		1.150	m	TWL Ext Detn Storage - RL Orifice	1.150	m
Calculated Orifice Diameter		64	mm	Satisfactory Satisfactory	117	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		37.800	m
RL of Minimum Garage Floor Level		37.800	m
Length of Overflow Weir		18.00	m
Site Runoff Coefficient	Parramatta City Council	0.75	
Storm Intensity (5 min 100 yr ARI)		206	mm/h
Peak Flow over Weir		102.6	L/s
Depth of Flow over Weir		23	mm
Freeboard to Habitable Floor	Satisfactory	877	mm
Freeboard to Garage Floor	Satisfactory	877	mm

Figure 7.11 Example 2 - OSD Calculation Sheet with Rainwater Tanks

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
HED Secondary Outlet

Project:	**UPRCT Handbook Demonstration Example**
Site Address	**24 Catchment Avenue, Parramatta**
Job No:	**1234**
Designer:	**Mr Engineer**
Telephone:	**(02) 9912 3456**

Site Data

OSD Area:	Upper Parramatta River Catchment						
L.G.A	Parramatta City Council						
Site Area	0.258	ha	2,580	m^2			
Total Roof Area	0.135	ha	1,350	m^2			
Area of Site draining to OSD Storage	0.239	ha	2,390	m^2	Satisfactory		
Residual Site Area (Lot Area - Roof Area)	0.123	ha					
Area Bypassing Storage	0.019	ha					
Area Bypassing / Residual Site Area	15.4%				Satisfactory		30% Max
No. of Dwellings on Site	15				Satisfactory		
Site Area per Dwelling	0.017	ha					
Roof Area per Dwelling	0.009	ha					

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	300	m^3/ha	Total Storage	455	m^3/ha
Basic SRDs	Primary Outlet	40	L/s/ha	Secondary Outlet	150	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	85%				
Adjusted SRDs	35	L/s/ha		119	L/s/ha

OSD Calculations

		Extended Detention				Detention	
Basic SSR Volume	Ext Detention Storage	77.40	m^3		Total Storage	117.39	m^3
Total Rainwater Tank Credits		11.13	m^3			15.65	m^3
Storage Volume					Total	101.74	m^3
Storage Volume	Ext Detention Storage	66.27	m^3		Flood Detention Storage	35.48	m^3
OSD Discharges	Primary Outlet	9.12	L/s		Secondary Outlet	30.73	L/s
RL of Top Water Level of Storage		36.750	m			36.900	m
RL of Orifice Centre-line		35.600	m			35.600	m
Number of Orifices		1				1	
Estimated Downstream Flood Level		35.20	1.5 yr ARI			35.60	100 yr ARI
Downstream FL - RL of Orifice Cente-line		-0.40	Satisfactory		Satisfactory	0.00	m
Design Head to Orifice Centre		1.150	m		TWL Ext Detn Storage - RL Orifice	1.150	m
Calculated Orifice Diameter		64	mm	Satisfactory	Satisfactory	117	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		37.800	m
RL of Minimum Garage Floor Level		37.800	m
Length of Overflow Weir		18.00	m
Site Runoff Coefficient	Parramatta City Council	0.75	
Storm Intensity (5 min 100 yr ARI)		206	mm/h
Peak Flow over Weir		102.6	L/s
Depth of Flow over Weir		23	mm
Freeboard to Habitable Floor	Satisfactory	877	mm
Freeboard to Garage Floor	Satisfactory	877	mm

Rainwater Tank Calculations (per Dwelling)					
Only Complete this Section if a Rainwater Tank Airspace Credit is Claimed					
The calculations assume that the same size rainwater tank is installed on each dwelling					
				Min	Max
% of Roof draining to Rainwater Tank	65.0%		Satisfactory	61.2%	100%
Total Rainwater Tank Volume	3.00	kL	Tank Volume OK		
Min Volume that triggers Top-up	0.00	kL	Note - Min Vol in Tank < 10% Total Tank Vol		
Total Tank Vol - Min Top-up Vol	3.00	kL			
Dedicated Airspace					
Dedicated Airspace	0.60	kL	Satisfactory		
	Extended Detention			Detention	
Dedicated Airspace Credit	0.30	kL		0.60	kL
Maximum Tank PSD	40	L/s/ha			
Maximum Tank Discharge	0.7	L/s			
Maximum Head to Centre of Tank Orifice	0.250	m	Satisfactory		
Calculated Orifice Diameter	26	mm	Satisfactory		
Dynamic Airspace					
Maximum Dynamic Storage (Nett Vol)	2.40	kL	Controls minimum % Roof to Rainwater Tank		
Daily Demand on Rainwater Tank	0.56	kL/d	Satisfactory		
Dynamic Airspace at start of Storm	2.33	kL			
	Extended Detention			Detention	
Dynamic Airspace Credit	0.44	kL		0.44	kL
Combined Rainwater Tank Credit	0.74	kL		1.04	kL
Maximum Rainwater Tank Credit	1.76	kL		2.66	kL
Rainwater Tank Credit per Dwelling	0.74	kL		1.04	kL
Rainwater Tank Credit for the Site	11.13	m^3		15.65	m^3

Signature: _____ **Date:** _____

7.3 Development Type: - Proposed Townhouse Development

24 Upper Parramatta Road, Parramatta

A Townhouse development is proposed on an existing site containing 2 single residential dwellings. The existing site grades steeply from the western boundary to the eastern boundary, diagonally traversing the site and has a total site area of 2,080 m^2.

The proposed development comprises of 7 mixed two and three bedroom townhouses positioned on either side of a central driveway access. A common open space area is proposed on the eastern side of the common driveway access between Units 1 and 7.

Trees requiring to be protected also exist on the site along the eastern front setback area that is the lowest point of the site.

Due to the gradient of the existing site provision of satisfactory access into all garages from the centrally positioned driveway requires that the garages of Units 4 and 5 be heavily excavated into the site. This also results in the floor levels of Units 4 and 5 to be stepped in order to accommodate the slope of the land and reduce the extent of required excavation. Retaining walls are necessary along the northern and western boundaries.

The overall site layout is given in Figure 7.12. The site and development data is:

Site area =	0.208 ha
Total roof area =	0.086 ha
Area of site draining to OSD Storage =	0.178 ha
No. of dwellings on the site =	7

Consideration was also given to installing a rainwater tank for each dwelling with rainwater to be used for outdoor, toilet flushing and laundry in each 3.5 person household. The data on the rainwater tanks includes:

% of roof draining to each rainwater tank =	60%
Volume of each rainwater tank =	5 kL
Volume of dedicated airspace =	0 kL
Daily demand on each rainwater tank =	0.62 kL/day

A solution

The existence of trees that are to be retained within the eastern front setback area, which is the natural low point of the site, removes the possibility of an above ground detention system in that location. An above ground detention basin may be provided within the proposed common open space area however this area on its own will not have adequate capacity to detain the required detention volume. As such it is proposed to provide a below ground detention tank beneath the common driveway adjacent to Units 1 and 2 in order to provide for the additional volume required to make up the full required detention volume. The control pits for the primary and secondary outlets will be constructed within the below ground tank. The outlet pipe of both control pits drains to Pit 1 that is connected to the kerb and gutter.

All downpipes and pipes from surface inlet pits will be drained to the extended detention storage and primary outlet. This will cause water to begin ponding within the below ground detention tank and then the above ground detention basin located in the common open area. Upon the volume of storage of the extended detention being achieved at RL 53.60 m, water will cascade into the secondary outlet pit (see Figure 7.13).

Finally when the required detention is achieved at RL 54.00 m water will cascade over the weir located along the eastern wall of the above ground detention basin wall and the grates over the discharge control pits.

Other Considerations

Upstream Overland Flows

As the property grades steeply from the western boundary to the eastern boundary it is likely that the same grade continues beyond the western boundary and hence surface run-off from the upstream properties also currently flows through the site.

A check from Council's catchment plans and site visit reveals that the crest of the upstream catchment area exists within the rear yard of the neighbouring properties. As such the catchment area generating the overland flows is relatively small. Also from the site visit, it is noted that a small retaining wall exists along the northern boundary that currently is above the ground level of the neighbouring properties. This wall will intercept and divert all upstream overland flows from the northern properties away from the property being developed. In this regard only overland flows entering the eastern boundary need to be treated.

The necessary calculations are carried out to determine the amount of overland flows and from these a channel size was able to be determined. The channel being provided along the western boundary of the property conveys these overland flows through the property. Pits 13 and 14 have been provided to collect and drain the overland flows to the kerb and gutter. Also in the event of pipe blockage from pit 14 the overland flows would be able to drain over the entire front setback area of Unit 3.

Results from On Site Detention calculations

The site and development data was entered into the HED On-Site Detention Calculation Sheet (see Figure 7.14). The HED calculation sheet gave the following results:

Extended Detention Required =	62.5 m^3
Orifice diameter for extended detention =	58 mm
Maximum Water level of Extended Detention =	R.L. 53.60
Extended Detention Volume Provided =	68.9 m^3
Overall Detention Required =	94.8 m^3
Orifice diameter for detention =	102 mm
Maximum Water level of Detention =	R.L. 54.00
Detention Volume Provided =	111.9 m^3

The reduction in storage requirements that would be achieved by installing 5 kL rainwater tanks on each dwelling was also calculated (see Figure 7.15).

The HED calculation sheet gave the following results:

Extended Detention Required =	46.9 m^3
Orifice diameter for extended detention =	58 mm
Maximum Water level of Extended Detention =	R.L. 53.60
Overall Detention Required =	76.1 m^3
Orifice diameter for detention =	102 mm
Maximum Water level of Detention =	R.L. 54.00

Figure 7.12 Example 3 – Overall Site Layout

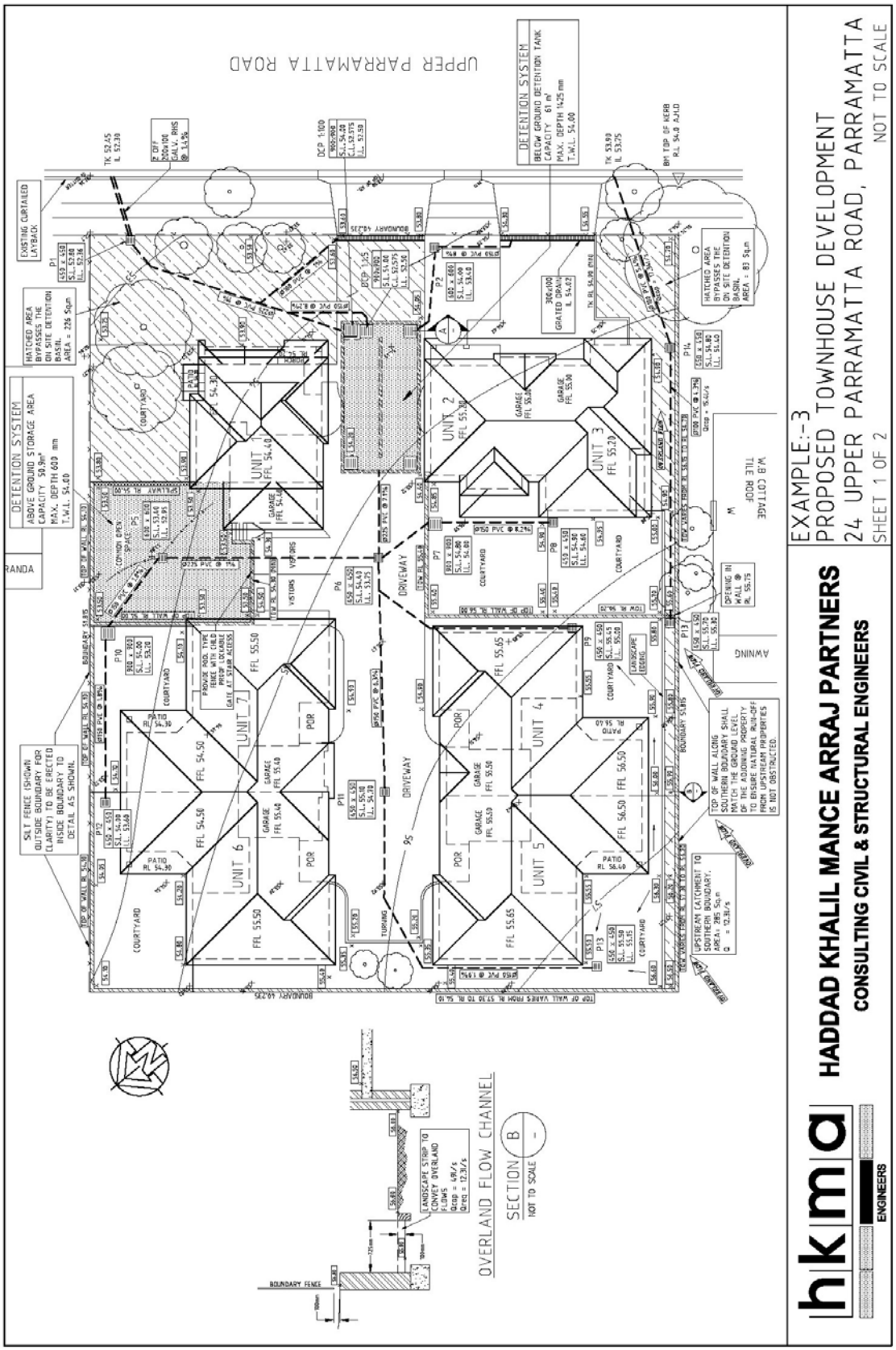


Figure 7.13 Example 3 – Concept On-Site Detention Tank Section Detail

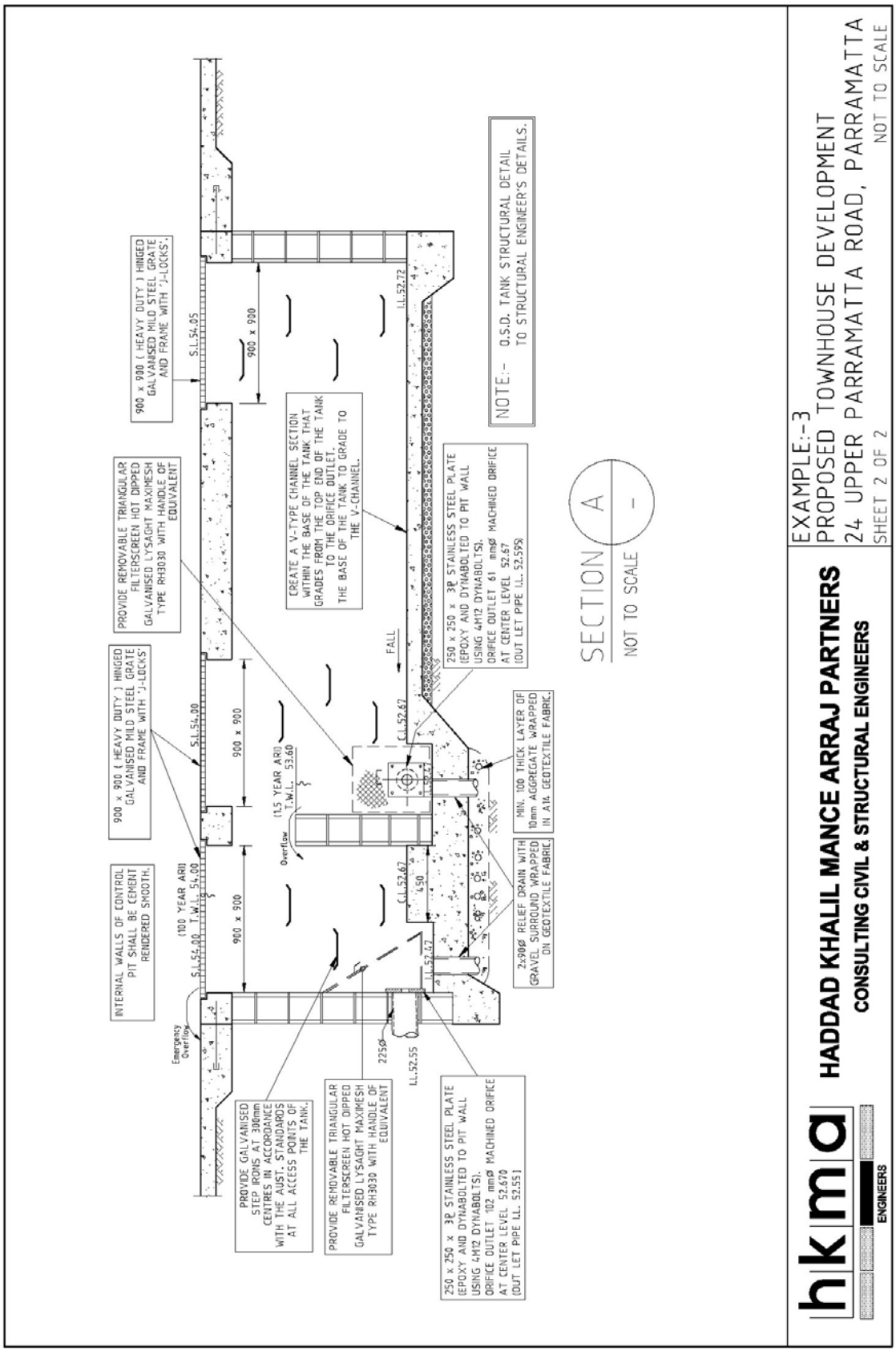


Figure 7.14 Example 3 - OSD Calculation Sheet without Rainwater Tanks

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
HED Secondary Outlet

Project:	UPRCT Handbook Demonstration Example
Site Address	24 Upper Parramatta Road, Parramatta
Job No:	1234
Designer:	Mr Engineer
Telephone:	(02) 9912 3456

Site Data

OSD Area:	Upper Parramatta River Catchment					
L.G.A	Parramatta City Council					
Site Area	0.208	ha	2,080	m^2		
Total Roof Area	0.086	ha	860	m^2		
Area of Site draining to OSD Storage	0.178	ha	1,780	m^2	Satisfactory	
Residual Site Area (Lot Area - Roof Area)	0.122	ha				
Area Bypassing Storage	0.03	ha				
Area Bypassing / Residual Site Area	24.6%				Satisfactory	30% Max
No. of Dwellings on Site	7				Satisfactory	
Site Area per Dwelling	0.030	ha				
Roof Area per Dwelling	0.012	ha				

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	300	m^3/ha	Total Storage	455	m^3/ha
Basic SRDs	Primary Outlet	40	L/s/ha	Secondary Outlet	150	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	75%				
Adjusted SRDs	33	L/s/ha		101	L/s/ha

OSD Calculations

		Extended Detention			Detention	
Basic SSR Volume	Ext Detention Storage	62.40	m^3	Total Storage	94.64	m^3
Total Rainwater Tank Credits		0.00	m^3		0.00	m^3
Storage Volume				Total	94.64	m^3
Storage Volume	Ext Detention Storage	62.40	m^3	Flood Detention Storage	32.24	m^3
OSD Discharges	Primary Outlet	6.79	L/s	Secondary Outlet	20.97	L/s
RL of Top Water Level of Storage		53.600	m		54.000	m
RL of Orifice Centre-line		52.670	m		52.670	m
Number of Orifices		1			1	
Estimated Downstream Flood Level		52.30	1.5 yr ARI		52.60	100 yr ARI
Downstream FL - RL of Orifice Cente-line		-0.37	Satisfactory	Satisfactory	-0.07	m
Design Head to Orifice Centre		0.930	m	TWL Ext Detn Storage - RL Orifice	0.930	m
Calculated Orifice Diameter		58	mm	Satisfactory Satisfactory	102	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		54.300	m
RL of Minimum Garage Floor Level		54.400	m
Length of Overflow Weir		7.00	m
Site Runoff Coefficient	Parramatta City Council	0.75	
Storm Intensity (5 min 100 yr ARI)		206	mm/h
Peak Flow over Weir		76.4	L/s
Depth of Flow over Weir		35	mm
Freeboard to Habitable Floor	Satisfactory	265	mm
Freeboard to Garage Floor	Satisfactory	365	mm

Figure 7.15 Example 3 - OSD Calculation Sheet with Rainwater Tanks

On-Site Detention Calculation Sheet for Upper Parramatta River Catchment
HED Secondary Outlet

Project:	**UPRCT Handbook Demonstration Example**
Site Address	**24 Upper Parramatta Road, Parramatta**
Job No:	**1234**
Designer:	**Mr Engineer**
Telephone:	**(02) 9912 3456**

Site Data

OSD Area:	**Upper Parramatta River Catchment**					
L.G.A	**Parramatta City Council**					
Site Area	**0.208**	ha	**2,080**	m^2		
Total Roof Area	**0.086**	ha	**860**	m^2		
Area of Site draining to OSD Storage	**0.178**	ha	**1,780**	m^2	**Satisfactory**	
Residual Site Area (Lot Area - Roof Area)	**0.122**	ha				
Area Bypassing Storage	**0.03**	ha				
Area Bypassing / Residual Site Area	**24.6%**				**Satisfactory**	**30% Max**
No. of Dwellings on Site	**7**				**Satisfactory**	
Site Area per Dwelling	**0.030**	ha				
Roof Area per Dwelling	**0.012**	ha				

Basic OSD Parameters

		Extended Detention			Detention	
Basic SSR Vols	Ext Detention Storage	**300**	m^3/ha	Total Storage	**455**	m^3/ha
Basic SRDs	Primary Outlet	**40**	L/s/ha	Secondary Outlet	**150**	L/s/ha

OSD Tank Bypass

Residual Lot Capture in OSD Tank	**75%**				
Adjusted SRDs	**33**	L/s/ha		**101**	L/s/ha

OSD Calculations

		Extended Detention			Detention	
Basic SSR Volume	Ext Detention Storage	**62.40**	m^3	Total Storage	**94.64**	m^3
Total Rainwater Tank Credits		**15.48**	m^3		**18.55**	m^3
Storage Volume				Total	**76.09**	m^3
Storage Volume	Ext Detention Storage	**46.92**	m^3	Flood Detention Storage	**29.17**	m^3
OSD Discharges	Primary Outlet	**6.79**	L/s	Secondary Outlet	**20.97**	L/s
RL of Top Water Level of Storage		**53.600**	m		**54.000**	m
RL of Orifice Centre-line		**52.670**	m		**52.670**	m
Number of Orifices		**1**			**1**	
Estimated Downstream Flood Level		**52.30**	1.5 yr ARI		**52.60**	100 yr ARI
Downstream FL - RL of Orifice Cente-line		**-0.37**	**Satisfactory**	**Satisfactory**	**-0.07**	m
Design Head to Orifice Centre		**0.930**	m	TWL Ext Detn Storage - RL Orifice	**0.930**	m
Calculated Orifice Diameter		**58**	mm	**Satisfactory** **Satisfactory**	**102**	mm

Overflow Weir & Freeboard Calculation

RL of Minimum Habitable Floor Level		**54.300**	m
RL of Minimum Garage Floor Level		**54.400**	m
Length of Overflow Weir		**7.00**	m
Site Runoff Coefficient	**Parramatta City Council**	**0.75**	
Storm Intensity (5 min 100 yr ARI)		**206**	mm/h
Peak Flow over Weir		**76.4**	L/s
Depth of Flow over Weir		**35**	mm
Freeboard to Habitable Floor	**Satisfactory**	**265**	mm
Freeboard to Garage Floor	**Satisfactory**	**365**	mm

Rainwater Tank Calculations (per Dwelling)

Only Complete this Section if a Rainwater Tank Airspace Credit is Claimed

The calculations assume that the same size rainwater tank is installed on each dwelling

				Min	Max
% of Roof draining to Rainwater Tank	60.0%		Satisfactory	51.8%	100%
Total Rainwater Tank Volume	5.00	kL	Tank Volume OK		
Min Volume that triggers Top-up	0.00	kL	Note - Min Vol in Tank < 10% Total Tank Vol		
Total Tank Vol - Min Top-up Vol	5.00	kL			
Dedicated Airspace					
Dedicated Airspace	0.00	kL	Satisfactory		
	Extended Detention			Detention	
Dedicated Airspace Credit	0.00	kL		0.00	kL
Maximum Tank PSD	40	L/s/ha			
Maximum Tank Discharge	0.0	L/s			
Maximum Head to Centre of Tank Orifice	0.000	m	No Dedicated Airspace		
Calculated Orifice Diameter	0	mm	No Dedicated Airspace		
Dynamic Airspace					
Maximum Dynamic Storage (Nett Vol)	5.00	kL	Controls minimum % Roof to Rainwater Tank		
Daily Demand on Rainwater Tank	0.62	kL/d	Satisfactory		
Dynamic Airspace at start of Storm	4.65	kL			
	Extended Detention			Detention	
Dynamic Airspace Credit	2.30	kL		2.65	kL
Combined Rainwater Tank Credit	2.30	kL		2.65	kL
Maximum Rainwater Tank Credit	2.21	kL		3.35	kL
Rainwater Tank Credit per Dwelling	2.21	kL		2.65	kL
Rainwater Tank Credit for the Site	15.48	m^3		18.55	m^3

Signature: _____ **Date:** _____

8. WATER QUALITY

8.1 Water sensitive urban design

Water sensitive urban design (WSUD) is the integration of Best Planning Practices (BPP) and Best Management Practices (BMP) for the sustainable management of the urban water cycle. WSUD is concerned with the design of urban environments to be more 'sustainable' by limiting the negative impacts of urban development on the total water cycle. In the context of urban development and renewal, WSUD is about:

- Trying to more closely match the predevelopment stormwater runoff regime, in both quantity and quality;
- Reducing the amount of water transported between the catchment, in both water supply import and wastewater export; and
- Optimising the use of rainwater that falls on the urban areas.

For more information on WSUD and how it can be incorporated into urban design and development the following manuals are recommended for additional information:

- *Water Sensitive Urban Design, Technical Guidelines for Western Sydney*, Upper Parramatta River Catchment Trust, May 2004
- *Australian Runoff Quality*, Engineers Australia, 2005
- *Urban Stormwater: Best Practice Environmental Management Guidelines*, Victorian Stormwater Committee, 1999
- *WSUD Engineering Procedures: Stormwater*, Melbourne Water, 2005

It should be noted that WSUD is an evolving area and there are new manuals and research being published and updated regularly. It is included in this Handbook to alert designers to the opportunities for OSD systems to assist with the implementation of WSUD measures on a lot eg. bio-filtration swales. Except for certain types of developments in some local government areas, water quality treatment measures at the outlet of an OSD system are desirable, but not yet mandatory. Contact your Council to find out any current requirements for water quality controls as part of development or re-development.

8.2 OSD and WSUD

On-site detention (OSD) offers an opportunity in the WSUD process by providing primary or pre-treatment to the treatment system and is an 'at source' control. The traditional OSD design has provided the following benefits to water quality:

- Temporary storage of runoff from the site;
- Sediment removal particularly coarse sediments, through sedimentation and filtration;
- Gross pollutant removal, via the screen over the outlet orifice.

The new configuration using the low and high flow orifices, allows the low flow from the OSD to be directed towards a water quality treatment system. This will allow for the more efficient sizing of downstream water quality improvement devices by reducing peak flows and volumes they have to cater for and minimising the opportunity for bypass.

The new OSD outlet configuration adopted in this edition provides greater benefits to the urban water cycle. The configuration with primary and secondary (HED) orifice outlet on the OSD storage provides greater control of runoff over a wider range of storms, especially in the critical 'bankfull' events (i.e. the range of 1.5 to 2 year ARI storm events). These are the storm events that can cause stability and scour problems in natural creek systems, particularly due to the increase in flows (both peak and volume) due to urbanisation.

The primary orifice outlet also allows small treatment systems to be added to the OSD system to further improve the quality of the discharge from the site and also allows for a wider choice in the type of treatment system.

The following discussion and methodology on a possible water quality treatment train would generally apply to single dwellings and small dual occupancies. For larger developments a determination of the pollutant loads and treatment system would be required, as per the relevant Council's policies and codes.

8.3 Water Quality Treatment Objectives

For new low density residential developments (i.e. single lots or dual occupancies) the key pollutants for treatment are litter and nutrients (nitrogen and phosphorus). The treatment objectives for the Upper Parramatta River catchment for these pollutants are 70% retention of the annual load for litter, and 45% retention of the annual load for nutrients. Although in this type of development course and fine particulates are not targeted pollutants, where OSD is provided, the treatment objectives of 80% and 50% of the annual average load could be met.

For other types of developments see Tables 2.6 and 2.7 in the *WSUD Technical Guidelines for Western Sydney* for details.

8.4 Water Quality Treatment Train

A possible water quality treatment train for small developments could comprise the following components:

- Rainwater tanks connected for use for toilet flushing and laundry and other non-potable outdoor uses. This will reduce the annual volume of runoff from the lot.
- OSD storage either above ground (preferable) or below ground. The OSD storage will provide the litter removal and some sediment removal. The performance of the OSD storage for sediment removal can be enhanced by using above ground storage and allowing the water to travel through grassed areas that act as filter strips. With an above ground storage, the performance of the OSD storage could be; litter 70%, sediment 50% and nutrients 30% removal, based on performance data from the sources noted previously.
- To meet the required water quality objectives, additional treatment needs to be provided downstream of the OSD storage. This treatment system may be either from proprietary or non-proprietary sources. Typical examples of treatment systems are:
    - bioretention or 'rain garden' systems
    - permeable paving
    - sand filters
    - other types of traps and filters.

8.5 Worked Example - Proposed Dual Occupancy

5 River Road, Parramatta

A single storey dual occupancy development is proposed on the rear portion of an existing site in Parramatta containing a single residential dwelling. The existing site grades from the rear boundary to the front boundary and is a corner block. The site has a total area of 810 m^2.

The proposed dwelling has been placed on the property ensuring compliance with Council's setback requirements. The existing dwelling on the site is to be maintained with the existing outbuildings and a previous extension to the dwelling being demolished to make way for the new dwelling.

Drainage of the site is to an above ground on-site detention basin within the front setback area of the site. With the way the site is located there is more room to provide the detention for the existing dwelling and allow the new dwelling to be constructed without detention. The total area of the front lot is 460m^2.

The overall site layout is given in Figure 8.1.

The site and development data is:

Total site area =	0.081 ha
Front lot area =	0.046 ha
Total roof area =	0.017 ha
Area of site draining to OSD Storage =	0.040 ha
No. of new dwellings on the lot =	1

Consideration was also given to installing a rainwater tank for each dwelling with rainwater to be used for outdoor, toilet flushing and laundry in each 4 person household. The data on the rainwater tanks includes:

% of roof draining to each rainwater tank =	60%
Volume of each rainwater tank =	3 kL
Volume of dedicated airspace =	0 kL
Daily demand on each rainwater tank =	0.657 kL/day

A solution

The existence of a large landscaped setback area located along the northern frontage of the site and a check of the required detention volume reveals that it is possible to provide an above ground storage with relatively minor excavation. As such the construction of a water tight retaining wall along the northern and eastern boundaries at the required levels will permit water to pond in the landscape area which will not be utilised significantly by the future owners of the property. It is expected that maintenance of the detention area will be also routine and minor.

All downpipes and pipes from surface inlet pits will be drained directly to the primary outlet pit. This will cause water to begin ponding within the above ground basin. Upon the volume of storage of the extended detention being achieved at RL 10.20 m, water will cascade into the adjoining secondary outlet pit. Finally at RL 10.50 m runoff will cascade over the weir located along the northern detention basin wall. The outlet pipes of each outlet pit are connected to the existing Council grated gully pit within River Road.

Figure 8.1 Example Overall Site Layout

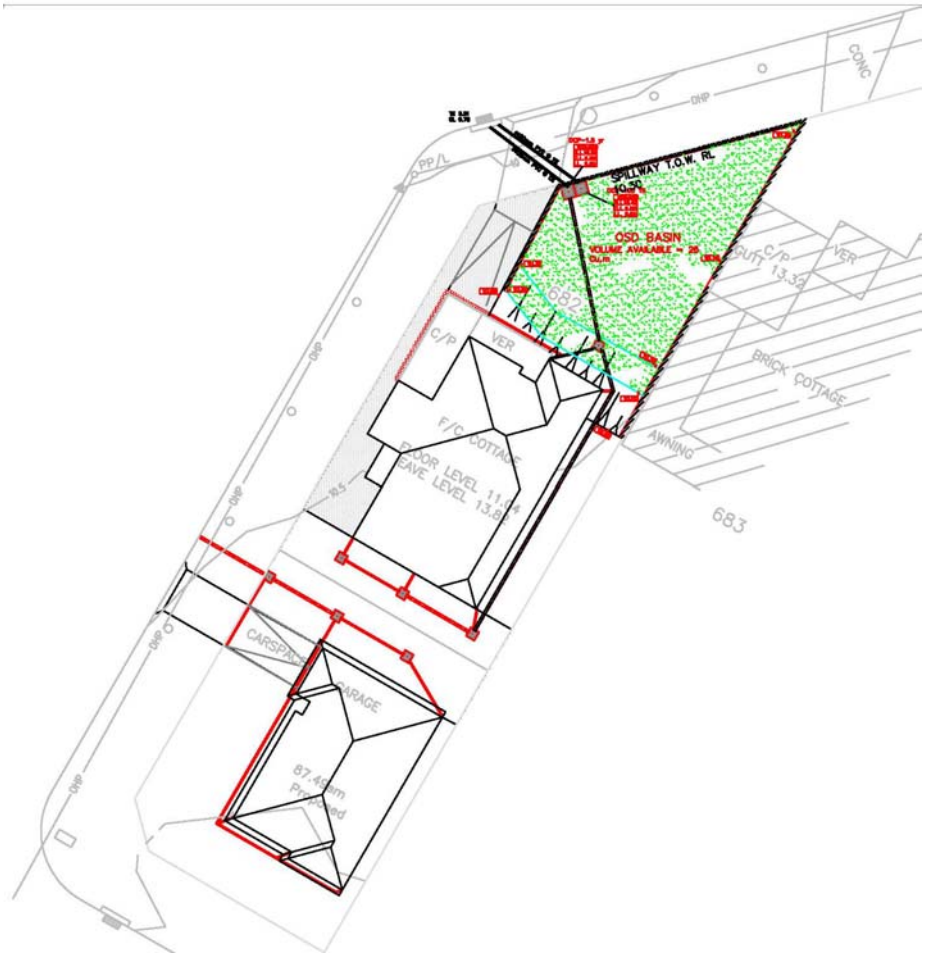


Figure 8.2 Layout of Example OSD system without Water Quality Control

Other Considerations

Upstream Overland Flows

As the property grades from the rear boundary to the front boundary and the site has road reserves on 3 of its 4 boundaries (including the upstream side), it is unlikely that the site is affected by overland flow.

Results from On-Site Detention calculations

The site and development data was entered into the HED On-Site Detention Calculation Sheet. The calculation sheet gave the following results:

Extended Detention Required =	14.1 m^3
Orifice diameter for extended detention =	38 mm
Maximum Water level of Extended Detention =	R.L. 10.20
Overall Detention Required =	21.4 m^3
Orifice diameter for detention =	70 mm
Maximum Water level of Detention =	R.L. 10.50

The reduction in storage requirements that would be achieved by installing a 3 kL rainwater tanks on the dwelling discharging to the OSD storage was also calculated.

The calculation sheet gave the following results:

Extended Detention Required =	13.6 m^3
Orifice diameter for extended detention =	38 mm
Maximum Water level of Extended Detention =	R.L. 10.20
Overall Detention Required =	20.8 m^3
Orifice diameter for detention =	69 mm
Maximum Water level of Detention =	R.L. 10.50

The layout of the example OSD system without water quality controls is given in Figure 8.2.

Revision of OSD design to incorporate water quality

The first two parts of the water quality treatment train have been provided by the use of the rainwater tank and detention basin. The impacts of these components are the:

- reduction in the annual runoff from the site;
- removal of gross pollutants; and
- removal of coarse sediments and some nutrients.

This then leaves the treatment of nutrients, fine sediments and hydrocarbons. It is proposed that this can be done by the provision of a ‘rain garden’ or bio-filtration basin located along the northern boundary of the site.

Typically, a garden bed is provided across the front of the property and with some reconfiguration of the bed a biofiltration basin can be readily incorporated into the design, with minimal additional cost.

Calculations for the bio-retention basin are shown in Figure 8.3.

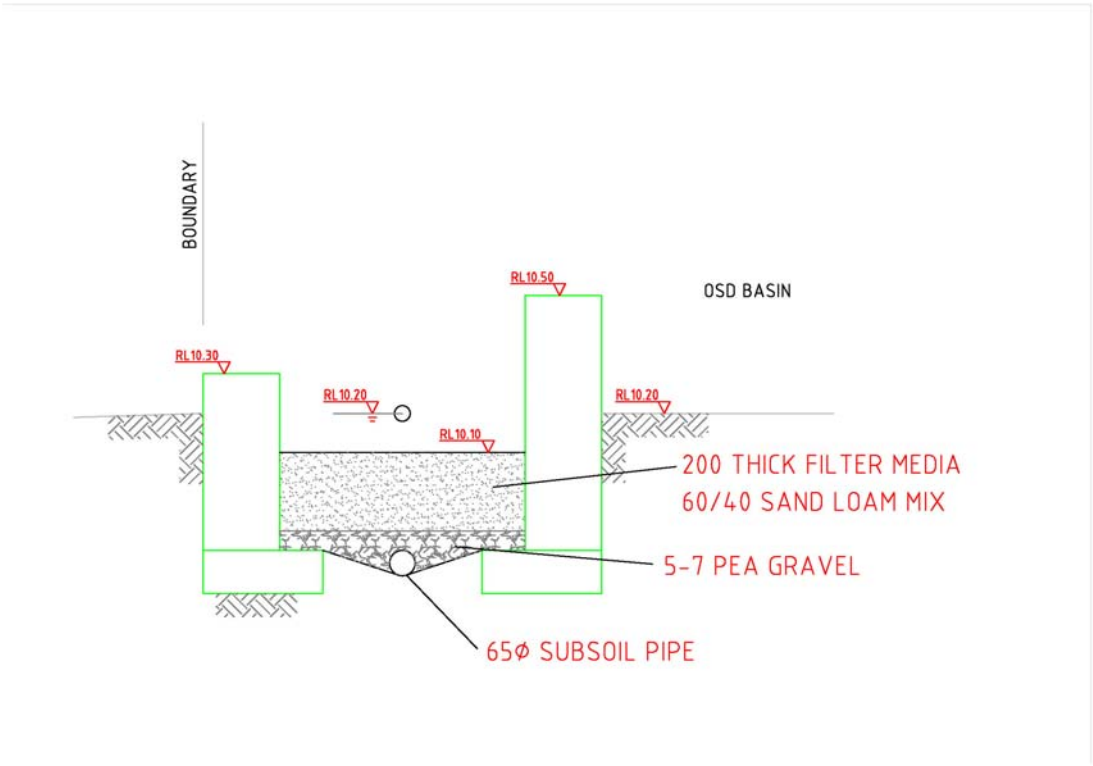
The proposed biofiltration basin is 10m long and 0.6m wide. A layout of the bio-filtration basin is shown in Figure 8.4. A typical section of the basin is shown in Figure 8.5. With the change in the design the low and high flow discharge control pits have to be separated. It is also recommended that a grated drain be provided across the driveway, at the boundary, to direct flow to the bio-filtration basin, although this area has been excluded from the OSD calculations.

Figure 8.3 Example sizing of Bio-filtration basin

Water Quality Design For Single Lot			
Treatable Volume Rate	150	m^3/ha	
Hydraulic Conductivity	0.8	m/day	Assumes 60/40 sand/loam mix
Treatable Flow Rate	1.99	L/s	
Hydraulic Retention Time	24	h	
Filter Media Depth	200	mm	Satisfactory
Max Ponding Depth	100	mm	
Average Depth of Ponding	50	mm	
Treatable Volume	6.56	m^3	
Filter Surface Area	6.56	m^2	
Max Discharge	0.091	L/s	

Figure 8.4 Example Revised Basin Layout with Water Quality Control

Figure 8.5 Typical Section of Example Bioretention Basin



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Appendices

A. Variations To OSD Policy

A.1 Varying control standards

Requests to change OSD parameters or to exclude particular developments will be considered by the relevant Council in consultation with the Trust. These requests will need to be supported by a report endorsed by a suitably qualified and experienced chartered professional engineer. The study needs to:

- use a calibrated hydrologic model acceptable to the Trust;
- assume development and/or redevelopment of a significant portion of the principal catchment containing the subject site;
- consider a range of storm durations and frequencies for all flood events, in particular the 1.5 year ARI and the 100 year ARI (1% AEP) storm event; and
- show that the flood peak discharges at all downstream locations are not increased.

For equity reasons, where OSD is waived for a particular site, an equivalent expenditure on measures providing environmental and/or community benefits from the development, such as water quality improvements, will be required.

A.2 Alternative application

When Council considers it impractical, or not in the community interest, to provide the required site storage within the property, Council **may** allow a developer to contribute to the cost of off-site flood storage works nearby. In these cases the volume of flood storage required may be greater than for on-site OSD because the same multi-stage outlets may not be implemented to control outflows. Contributions may be used for works and/or land purchase to create additional flood storage by means of retarding basins, off-stream storages, channel enlargements or channel improvements between the development site and the downstream off-site flood storage.

A.3 Tradeable On-site Stormwater Detention permits

A study of the feasibility of tradeable discharge control permits was completed in 1993. (Willing and Partners, 1993). The study concluded that it was possible for the owner of a development property, which could discharge at less than the PSD, to sell the unused discharge capacity to a nearby developer, but subject to strict limitations. These limitations are that the trading of excess discharge capacity can only occur in the downstream direction along the same drainage/creek line and over a distance of no more than 5km and not across a flood retarding basin.

To date there has been no trading of discharge permits. Should developers wish to investigate this option, further discussion would be required with the relevant Council and the Trust.

On-site Stormwater Detention Handbook

B. OSD Calculation Sheet

In view of the added complexity that can arise if rainwater tanks are included as part of the development and if not all of the site area is discharged to the OSD storage an On-Site Detention Calculation spreadsheet has been assembled to ensure that calculations are undertaken in a manner consistent with the procedures described in Section 4.2 by all OSD designers.

An example of the OSD Calculation Sheet is given in Figure 5.1.

This OSD Calculation spreadsheet can be downloaded from the Trust's website at: www.uprct.nsw.gov.au. This sheet must be filled in electronically because the various formulae described in Section 4 are included in the spreadsheet.

On-site Stormwater Detention Handbook

C. Explanatory Notes on the Preparation and Registration of Restrictions on Use of Land and Positive Covenants

Private developers within the upper Parramatta River catchment are required to construct On-site Stormwater Detention (OSD) facilities as part of their development consent to make sure that the development does not increase downstream flooding at any point for all storms up to the 100-year ARI event. OSD systems consist of a storage area, multiple outlets and a collection network. The collection network directs stormwater flow to the storage. The collection network includes those surfaces that are sloped so as to direct flow to the storage, as well as the more obvious devices such as roof gutters, downpipes, drainage lines and pits. If a rainwater tank is installed and its airspace is credited against the site volume requirements then this also forms part of the OSD storage and not just the collection network. In effect, the whole lot is part of the OSD system.

All the components of an OSD system need to be kept intact and maintained so that the overall system continues to function as it was intended for the life of the development. To ensure that the OSD system is not altered during the life of the development, a Restriction on Use of the land is created. This prevents owners making changes to any of the site drainage components including any rainwater tanks that would alter the way the facility works, without the permission of their local Council. To ensure that the OSD system is adequately maintained, a Positive Covenant is registered on the title of the property that places the responsibility for this maintenance on the owner of the land. By registering the covenant and restriction on the property title, the obligations can be transferred to future owners. The Positive Covenant will be stated to benefit the local Council.

A sketch plan showing the location of the different components of the OSD system and a copy of the Maintenance Schedule must be included as attachments to the Positive Covenant. This will ensure future owners are aware of their maintenance obligation. Figure C.2 shows a sample sketch plan of an OSD system for a residential development.

In a multi-lot development, there are a number of ways OSD can be provided. A complete OSD system can be installed on each lot; a single OSD system can be constructed to cater for all lots; or multiple facilities can be constructed catering for different lots. Whatever method is chosen for a development, it is important to ensure that the appropriate restrictions and covenants are applied. The storage and the outlets may be the most obvious components to protect, but each lot draining to those components is also important. If the stormwater flow from any lot is diverted away from the storage, part of the value of the OSD system is lost and additional flooding may occur.

Figure C.1 shows the steps to be followed to determine the appropriate statutory requirements for OSD systems.

If no new lot is being created, the cheapest and quickest way to register the Positive Covenant and Restriction on Use on the title of Torrens Title land is through:

- Form 13PC for a Positive Covenant, and
- Form 13RPA for a Restriction on Use,

Figure C.1 Steps to be followed to Create Legal Protection for OSD Systems

1. Are any new lots created by the development?

YES	Draw Plan with 88B Instrument.	Go to **2**
NO	Create Restriction on Use of Land with Form 13RPA Create Positive Covenant with Form 13PC.	Go to **5**

2. Do any of the new lots require a right to drain across other new or existing lots (including the common property in a Strata Title or Association property in a Community Title)?

YES	Use 88B Instrument to create appropriate easements for drainage for each lot	Go to **3**
NO		Go to **3**

3. Use 88B Instrument to:

Create Restriction on Use of Land for each lot
Create positive Covenant on each lot. Go to **4**

4. Are owners required to contribute to the maintenance costs of OSD systems on lots in which they do not have an interest?

YES	Add appropriate terms to the easement for drainage under the 88B instrument.	Go to **5**
NO		Go to **5**

5. End

For Old System land the covenant and restriction should be imposed with a suitable deed.

- A copy of forms 13PC and 13RPA is included in Appendix D.

The covenant and restriction on use may also be imposed under Section 88B of the Conveyancing Act, 1919 in conjunction with the creation of a new lot or lots. The Positive Covenant will be in favour of the local council but, because the land is privately owned, the covenant and restriction will be imposed through Section 88E of the Act.

A copy of Information Bulletin No 14, prepared by the Land Titles Office (LTO), *A Guide to the Preparation of a Section 88B Instrument to:*

- Create Easements, Profits à Prendre, Restrictions on the Use of Land or Positive Covenants
- Release Easements or Profits à Prendre

is included in Appendix G.

The terms and conditions of the covenant and restriction must be shown in Part 2 of the Section 88B Instrument or be attached to the forms 13PC and 13RPA. A copy of suitable wording for the terms and conditions is included in Appendix E. The local Council has the right to release, vary or modify the terms and conditions of the covenant and restriction.

C.1 Sample Maintenance Schedule

The On-Site Stormwater Detention (OSD) system is designed to temporarily store water during significant rainfall so that stormwater runoff from this property does not worsen flooding downstream. Ponding of water will occur but should not last for more than two hours in most storms. If ponding persists, it is likely that maintenance attention is required.

The following schedule (Figure C.3) provides a guide to the timing of typical maintenance actions for an On-Site Stormwater Detention (OSD) system as well as defining the person responsible and describing the actions required. It is only intended as a guide and should be tailored to suit the needs of each site. Although the schedule appears very detailed, there are similar actions detailed for the individual components of the OSD system. Most components of the system should be checked for blockages after each significant storm to ensure that they continue to function effectively. The build up of sludge and debris depends on the individual site and more frequent maintenance may be required where there are many trees, especially after windy conditions.

In general, owners could often maintain OSD systems where the depth of pits is less than 1.2 m. For deeper pits or where there is other confined spaces, such as tanks, experienced personnel should be used to ensure that the system is safely maintained. The maintenance schedule should include appropriate notes on the hazards of confined space entry where this is required.

Note: The schedule should be accompanied a sketch plan of the system such as that shown in Figure C.2.

Figure C.2 Sample Sketch Plan of an OSD System

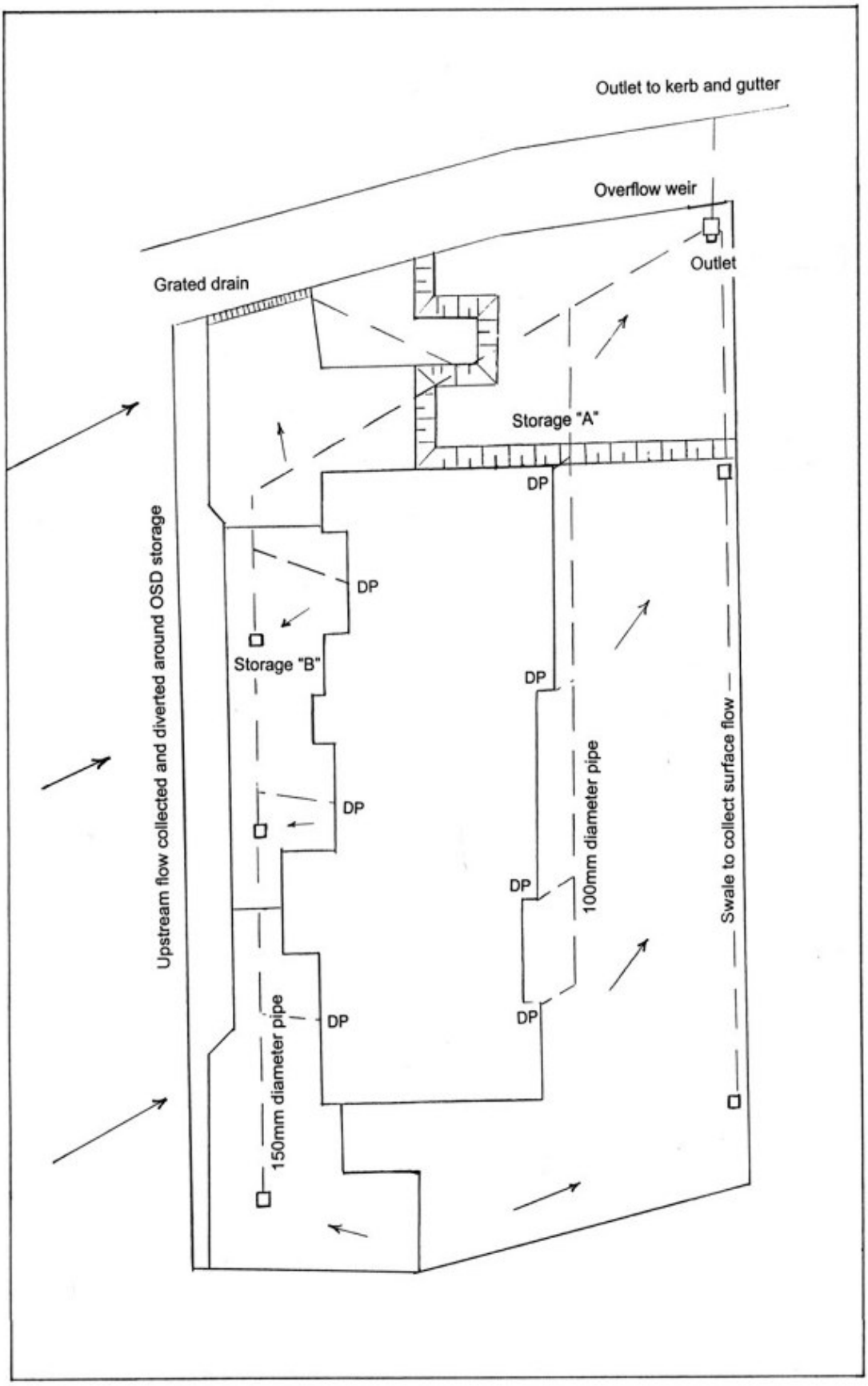


Figure C.3 Sample OSD Maintenance Schedule

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Outlets			
Inspect & remove any blockage of orifices	Six monthly	Owner	Remove grate & screen to inspect orifice. See plan for location of outlets
Check attachment of orifice plates to wall of chamber and/or pit (gaps less than 5 mm)	Annually	Maintenance Contractor	Remove grate and screen. Ensure plates are mounted securely, tighten fixings if required. Seal gaps as required.
Check orifice diameters are correct and retain sharp edges	Five yearly	Maintenance Contractor	Compare diameter to design (see Work-as-Executed) and ensure edge is not pitted or damaged.
Inspect screen and clean	Six monthly	Owner	Remove grate(s) and screens if required to clean them.
Check attachment of screens to wall of chamber or pit	Annually	Maintenance Contractor	Remove grate(s) and screen(s). Ensure screen fixings are secure. Repair as required.
Check screen(s) for corrosion	Annually	Maintenance Contractor	Remove grate(s) and examine screen(s) for rust or corrosion, especially at corners or welds.
Inspect walls (internal and external, if appropriate) for cracks or spalling	Annually	Maintenance Contractor	Remove grate(s) to inspect internal walls. Repair as required. Clear vegetation from external walls if necessary and repair as required.
Inspect outlet sumps & remove any sediment/sludge	Six monthly	Owner	Remove grate(s) and screen(s). Remove sediment/sludge build-up and check orifices are clear.
Inspect grate(s) for damage or blockage	Six monthly	Owner	Check both sides of a grate for corrosion, (especially corners and welds) damage or blockage.
Inspect outlet pipe & remove any blockage	Six monthly	Maintenance Contractor	Remove grate(s) and screen(s). Ventilate underground storage if present. Check orifices and remove any blockages in outlet pipe. Flush outlet pipe to confirm it drains freely. Check for sludge/debris on upstream side of return line.
Check step irons for corrosion	Annually	Maintenance Contractor	Remove grate. Examine step irons and repair any corrosion or damage.
Check fixing of step irons is secure	Six monthly	Maintenance Contractor	Remove grate(s) and ensure fixings are secure prior to placing weight on step iron.

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Storage			
Inspect storage & remove any sediment/sludge in pit	Six monthly	Owner	Remove grate(s) and screen(s). Remove sediment/sludge build-up.
Inspect internal walls of storage (and external, if appropriate) for cracks or spalling	Annually	Maintenance Contractor	Remove grate(s) to inspect internal walls. Repair as required. Clear vegetation from external walls if necessary and repair as required.
Inspect & remove any debris/litter/mulch etc blocking grates	Six monthly	Owner	Remove blockages from grate(s) and check if storage is blocked.
Inspect areas draining to the storage(s) & remove debris/mulch/litter etc likely to block screens/grates	Six monthly	Owner	Remove debris and floatable material likely to be carried to grates.
Compare storage volume to volume approved. (Rectify if loss > 5%)	Annually	Maintenance Contractor	Compare actual storage available with Work-as Executed plans. If volume loss is greater than 5%, arrange for reconstruction to replace the volume lost. Council to be notified of the proposal.
Inspect storages for subsidence near pits	Annually	Maintenance Contractor	Check along drainage lines and at pits for subsidence likely to indicate leakages.

D. Blank Copies of Forms 13RPA and 13PC

These forms for a Restriction on Use of Land and Positive Covenant are required by the Lands Titles Office where there is no subdivision of land, and the covenant and restriction are being imposed on an existing parcel of land.

A plan should be attached showing the location and various components of the On-site Stormwater Detention system. This should be accompanied by the Maintenance Schedule (See Appendix C).

Form: 13RPA
Licence: 98M111
Edition: 9906

RESTRICTION ON THE USE OF LAND BY A PRESCRIBED AUTHORITY

New South Wales
Section 88E(3) Conveyancing Act 1919

Land Titles Office use only
Do not affix additional pages here: use the left-hand corner

(A) **TORRENS TITLE**

(B) **LODGED BY**

LTO Box	Name, Address or DX and Telephone	CODE
	Reference (optional):	R

(C) **REGISTERED PROPRIETOR**

Of the above land

(D) **LESSEE MORTGAGEE or CHARGEE**

Of the above land agreeing to be bound by this restriction on land

Nature of Interest	Number of Instrument	Name

(E) **APPLICANT**

A prescribed authority

The applicant, being a prescribed authority within the meaning of section 88E(1) of the Conveyancing Act 1919, imposes on the above

(F) land a restriction on the use of land in the terms set out in annexure hereto, applies to have it recorded in the Register and

(G) certifies this application correct for the purposes of the Real Property Act 1900. **DATE:**

Signed in my presence by the an **authorised officer of the prescribed authority** who is personally known to me.

Signature of witness: Signature of authorised officer:

Name of witness: Name of authorised officer:

Address of witness: Position of authorised officer:

Signed in my presence by the **registered proprietor of the land** who is personally known to me.

Signature of witness: Signature of registered proprietor:

Name of witness:

Address of witness:

(H) I, the **lessee/mortgagee/chargee** under lease/mortgage/charge No. , agree to be bound by this restriction.

Signed in my presence by the above lessee/mortgagee/chargee who is personally known to me.

Signature of witness: Signature of lessee/mortgagee/chargee:

Name of witness:

Address of witness:

All handwriting must be in block capitals.
A set of notes on this form (13RPA-2) is available from the Land Titles Office.

Page 1 of ____

Checked by (LTO use):

13RPA-2 (9909)

Restriction on the Use of Land by a Prescribed Authority form 13RPA: Instructions for Completion

Note: This form is to be used only where the restriction is imposed by a prescribed authority on land in private ownership.

1. Complete the form in dense black or dark blue ink. If handwriting, use block capitals only.
2. Do not use an eraser or correction fluid to make alterations: rule through rejected material and initial the left-hand margin.
3. If the space provided at any point is insufficient, insert "See Annexure" at that point and include the required material on sheets of white A4 paper at least 80gsm (ordinary copier paper satisfies these requirements) using one side only. Insert a heading beginning "Annexure to ..." and specifying the type of form, the date and the parties to the transaction. Identify the material included, where possible by referring to the relevant marginal heading on the form. In the case of signatures which could not be fitted in the space provided, reproduce the text and layout used on the form. Number all pages in sequence with the form using the format "Page ... of ...", the number to be placed at the foot of the form in the centre. The first and last pages must be signed by the parties and any witness. Securely attach the additional pages to the upper left-hand corner of the form: a Nalclip is preferred; stapling should be avoided.
4. Insert the total number of pages, including any additional pages (see above), in the space provided at the foot of the form.
5. Lodge the completed form by hand at the Land Titles Office, Queens Square, Sydney (adjacent to Hyde Park Barracks). Lodgment of the certificate of title is optional.
6. The following instructions relate to the marginal letters on the form.

(A) TORRENS TITLE
Insert the number of the folio of the Register for the property affected. If the restriction affects only part of the land, add a description of the part, for example, "... part formerly comprised in Lot 1 in DP123456".

(B) LODGED BY
This section must be completed by the person or firm lodging the form at the Land Titles Office. If the party lodging does not have a Land Titles Office delivery box, leave this panel blank. Provision of a reference is optional.

(C) REGISTERED PROPRIETOR
Insert the full name of the registered proprietor of the land subject to the restriction. Address and occupation are not required.

(D) LESSEE, MORTGAGEE or CHARGEE
Insert the details of any lessee, mortgagee or chargee who agrees to be bound by the restriction.

(E) APPLICANT
The applicant must be a prescribed authority within the meaning of section 88E(1) of the Conveyancing Act 1919.

(F) Specify the annexure containing the terms of the restriction.

(G) EXECUTION
The completed form must be executed by an authorised officer of the prescribed authority, and by or on behalf of the registered proprietor of the land and any lessee, mortgagee or chargee who agrees to be bound by the restriction. Any witness must be an adult who is not a party to the application and knows the person executing. Where the form is executed—
By an individual on his/her own behalf The signature must be witnessed.
By an attorney The power of attorney must be registered at the Land Titles Office. In addition to the attorney's signature, a statement in the following format must be added: "John Smith by his attorney Jane Smith pursuant to power of attorney Book 1234 No. 567". The signature must be witnessed.
By a receiver or delegate Use the format given in "By an attorney" suitably modified. The signature must be witnessed.
By a corporation The form of execution must include reference to the power or authority relied on by the signatories, for example, "Executed by ABC Pty Ltd ACN 123456 by a director and secretary".
Note The application may not be executed by a solicitor or licensed conveyancer on behalf of the registered proprietor of the land or any lessee, mortgagee or chargee who agrees to be bound by the restriction.

(H) Rule through the inapplicable words and insert the number of the relevant instrument. If this section of the form does not apply rule it through.

If you have any questions, please call Land Titles Office Client Services on 02 9228 6713.

Page 1 of 1

Form: 13PC
Licence: 98M111
Edition: 9909

POSITIVE COVENANT

New South Wales
Section 88E(3) Conveyancing Act 1919

Land Titles Office use only
Do not affix additional pages here: use the left-hand corner

(A) **TORRENS TITLE**

(B) **LODGED BY**

LTO Box	Name, Address or DX and Telephone	CODE
	Reference (optional):	PC

(C) **REGISTERED PROPRIETOR**

Of the above land

(D) **LESSEE MORTGAGEE or CHARGEE**

Of the above land agreeing to be bound by this positive covenant

Nature of Interest	Number of Instrument	Name

(E) **APPLICANT**

A prescribed authority

The applicant, being a prescribed authority within the meaning of section 88E(1) of the Conveyancing Act 1919, imposes on the
(F) above land a positive covenant in the terms set out in annexure hereto, applies to have it recorded in the Register and
(G) certifies this application correct for the purposes of the Real Property Act 1900. **DATE:**

Signed in my presence by the **authorised officer of the prescribed authority** who is personally known to me.

Signature of witness: Signature of authorised officer:

Name of witness: Name of authorised officer:

Address of witness: Position of authorised officer:

Signed in my presence by the **registered proprietor of the land** who is personally known to me.

Signature of witness: Signature of registered proprietor:

Name of witness:

Address of witness:

(H) I, the **lessee/mortgagee/chargee** under lease/mortgage/charge No. , agree to be bound by this positive covenant.

Signed in my presence by the above lessee/mortgagee/chargee who is personally known to me.

Signature of witness: Signature of lessee/mortgagee/chargee:

Name of witness:

Address of witness:

All handwriting must be in block capitals.
A set of notes on this form (13PC-2) is available from the Land Titles Office.

Page 1 of ____

Checked by (LTO use):

13PC-2 (9909)

Positive Covenant form 13PC: Instructions for Completion

1. Complete the form in dense black or dark blue ink. If handwriting, use block capitals only.
2. Do not use an eraser or correction fluid to make alterations: rule through rejected material and initial the left-hand margin.
3. If the space provided at any point is insufficient, insert "See Annexure" at that point and include the required material on sheets of white A4 paper at least 80gsm (ordinary copier paper satisfies these requirements) using one side only. Insert a heading beginning "Annexure to …" and specifying the type of form, the date and the parties to the transaction. Identify the material included, where possible by referring to the relevant marginal heading on the form. In the case of signatures which could not be fitted in the space provided, reproduce the text and layout used on the form. Number all pages in sequence with the form using the format "Page … of …", the number to be placed at the foot of the form in the centre. The first and last pages must be signed by the parties and any witness. Securely attach the additional pages to the upper left-hand corner of the form: a Nalclip is preferred; stapling should be avoided.
4. Insert the total number of pages, including any additional pages (see above), in the space provided at the foot of the form.
5. Lodge the completed form by hand at the Land Titles Office, Queens Square, Sydney (adjacent to Hyde Park Barracks). Lodgment of the certificate of title is optional.
6. The following instructions relate to the marginal letters on the form.

(A) TORRENS TITLE
Insert the number of the folio of the Register for the property affected. If the positive covenant affects only part of the land, add a description of the part, for example, "… part formerly comprised in Lot 1 in DP123456".

(B) LODGED BY
This section must be completed by the person or firm lodging the form at the Land Titles Office. If the party lodging does not have a Land Titles Office delivery box, leave this panel blank. Provision of a reference is optional.

(C) REGISTERED PROPRIETOR
Insert the full name of the registered proprietor of the land subject to the positive covenant. Address and occupation are not required.

(D) LESSEE, MORTGAGEE or CHARGEE
Insert the details of any lessee, mortgagee or chargee who agrees to be bound by the positive covenant.

(E) APPLICANT
The applicant must be a prescribed authority within the meaning of section 88E(1) of the Conveyancing Act 1919.

(F) Specify the annexure containing the terms of the positive covenant.

(G) EXECUTION
The completed form must be executed by an authorised officer of the prescribed authority, and by or on behalf of the registered proprietor of the land and any lessee, mortgagee or chargee who agrees to be bound by the positive covenant. Any witness must be an adult who is not a party to the application and knows the person executing. Where the form is executed—
By an individual on his/her own behalf The signature must be witnessed.
By an attorney The power of attorney must be registered at the Land Titles Office. In addition to the attorney's signature, a statement in the following format must be added: "John Smith by his attorney Jane Smith pursuant to power of attorney Book 1234 No. 567". The signature must be witnessed.
By a receiver or delegate Use the format given in "By an attorney" suitably modified. The signature must be witnessed.
By of a corporation The form of execution must include reference to the power or authority relied on by the signatories, for example, "Executed by ABC Pty Ltd ACN 123456 by a director and secretary".
Note The application may not be executed by a solicitor or licensed conveyancer on behalf of the registered proprietor of the land or any lessee, mortgagee or chargee who agrees to be bound by the positive covenant.

(H) Rule through the inapplicable words and insert the number of the relevant instrument. If this section of the form does not apply rule it through.

If you have any questions, please call Land Titles Office Client Services on 02 9228 6713.

Page 1 of 1

E. Terms and Conditions for Restriction on Use of Land and Positive Covenant

Appendix E1 contains standard recitals for the Terms and Conditions to be applied in Restrictions on Use of Land and or Positive Covenants in relation to OSD systems.

Appendix F contains a sample instrument that shows how these terms and conditions are applied.

Both the Restriction on Use and the Positive Covenant will normally be required, however in cases where only the Positive Covenant is used, the definition of the OSD system and the details of the Council file number (given in clause 1 of the Restriction on Use) should be included in the Positive Covenant.

Appendix E2 contains the OSD related recitals for use in the City of Blacktown. Council also has a booklet of Standard Recitals for Terms of Easements, Covenants and Restrictions Commonly Imposed by Instrument under Section 88B of the Conveyancing Act, 1919 as Amended.

E1 Restrictions on Use of Land for OSD Systems

1. The registered proprietor shall not make or permit or suffer the making of any alterations to any on-site stormwater detention system which is, or shall be, constructed on the lot(s) burdened without the prior consent in writing of ……. (*Insert name of Council).*

   The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins, rainwater tanks (if an airspace "credit" is claimed against the storage volumes) and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage. The on-site stormwater detention system is detailed on the plans approved by ……. as Construction Certificate No……. on …….
   (Include the following for privately certified Construction Certificates only:)
   A copy of this Construction Certificate is held on Council file No. …….

   Any on-site stormwater detention system constructed on the lot(s) burdened is hereafter referred to as "the system".

   Name of Authority having the power to release, vary or modify the Restriction ……. referred to is …….. (*Insert name of Council).*

2. The registered proprietor shall not erect or suffer the erection of any dwelling house or other structure on the lot(s) hereby burdened unless the registered proprietor has first constructed or has made provision for the construction of an on site stormwater detention system on the said lot(s), in accordance with the design, construction and/or provision requirements of the ……(*Insert name of Council)* and to the satisfaction of the …….. (*Insert name of Council)*. The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins, rainwater tanks (if an airspace "credit" is claimed against the storage volumes) and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage.

   Note: Clause 2 is only necessary when construction of the OSD system is being deferred, which will only be permitted by Council in exceptional circumstances.

Positive Covenants

1. The registered proprietor of the lot(s) hereby burdened will in respect of the system:

   (a) keep the system clean and free from silt, rubbish and debris;

   (b) maintain and repair at the sole expense of the registered proprietors the whole of the system so that if functions in a safe and efficient manner;

   (c) permit the Council or its authorised agents from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter and inspect the land for the compliance with the requirements of this covenant; and

(d) comply with the terms of any written notice issued by the Council in respect of the requirements of this covenant within the time stated in the notice.

2. Pursuant to Section 88F(3) of the Conveyancing Act 1919 the Council shall have the following additional powers:

(a) in the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above the Council or its authorised agents may enter the land with all necessary materials and equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in part 1(d) above; and

(b) the Council may recover from the registered proprietor in a Court of competent jurisdiction:

(i) any expense reasonably incurred by it in exercising its powers under sub-paragraph (a) hereof. Such expense shall include reasonable wages for the Council's employees engaged in effecting the work referred to in (a) above, supervising and administering the said work together with costs, reasonably estimated by the Council, for the use of materials, machinery, tools and equipment in conjunction with the said work.

(ii) legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs and expenses of registration of a covenant charge pursuant to section 88F of the Act or providing any certificate required pursuant to section 88G of the Act or obtaining any injunction pursuant to section 88H of the Act.

Name of Authority having the power to release vary or modify the Positive Covenant …….. referred to is ……(*Insert name of Council).*

E2 Standard Recital for Use in the City of Blacktown

Terms of Restriction on Use of Land

1. For constructed works

The registered proprietor(s) covenant as follows with the Authority benefited in respect to the on-site stormwater detention system (hereinafter referred to as "the system") constructed on the burdened lot(s) that they will not, without the prior and express written consent of the Authority benefited:

a. Do any act, matter or thing which would prevent the system from operating in a safe and efficient manner.
b. Make or permit or suffer the making of any alterations or additions to the system.
c. Allow any development within the meaning of the Environmental Planning and Assessment Act 1979 to encroach upon the system.

This restriction shall bind all persons who are or claim under the registered proprietor(s) as stipulated in Section 88E(5) of the Conveyancing Act 1919.

For the purposes of this restriction, "the system" means the on-site stormwater detention system constructed on the land as detailed on the plans approved by ……. as Construction Certificate No. ……. on ……., including all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater, as well as all surfaces graded to direct stormwater to the temporary storage. *(Include the following for Private CC's only)* A copy of this Construction Certificate is held on Council File No. ……

2. For deferred works

This following version is only used when construction of the OSD system is being deferred, which will only be permitted by Council in **exceptional** circumstances.

"The registered proprietor shall not erect or suffer the erection of any dwelling house or other structure on the lot(s) hereby burdened unless the registered proprietor has first constructed or has made provision for the construction of an on site stormwater detention system on the said lot(s), in accordance with the design, construction and/or provision requirements of, and to the satisfaction of Blacktown City Council.

The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage."

Terms of Positive Covenant……

1. The registered proprietor(s) covenant as follows with the Authority benefited in respect to the on-site stormwater detention system (hereinafter referred to as "the system") constructed on the burdened lot(s), that they will:

    a) Keep the system clean and free from silt, rubbish and debris;

    b) Maintain and repair at the sole expense of the registered proprietor(s) that part of the system contained within the registered proprietor's own lot, so that it functions in a safe and efficient manner, in accordance with the "On-Site Detention Maintenance Schedule" as approved by …… on ……, a copy of which is held on Council File …….. A copy of this Schedule is available to all owners and occupiers of the burdened lot(s);

    c) For the purpose of ensuring observance of this covenant, permit Blacktown City Council or its authorised agents (hereinafter referred to as "the Council") from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter the land and inspect the condition of the system and the state of construction, maintenance or repair of the system, for compliance with the requirements of this covenant ; and

    d) Comply with the terms of any written notice issued by the Council to attend to any matter and carry out such work within the time stated in the notice, to ensure the proper and efficient performance of the system and to that extent Section 88F(2)(a) of the Conveyancing Act 1919 (hereinafter referred to as "the Act") is hereby agreed to be amended accordingly.

2. Pursuant to Section 88F (3) of the Act the Council shall have the following additional powers pursuant to this covenant:

    a) In the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above, the Council may enter the land with all necessary equipment and carry out any work considered by Council to be reasonable to comply with the said notice referred to in 1(d) above; and

    b) The Council may recover from the registered proprietor in a court of competent jurisdiction:

        I. Any expense reasonably incurred by it in exercising its powers in sub-paragraph 2(a) above. Such expense shall include reasonable wages for employees engaged in effecting, supervising and administering the said work, together with costs, reasonably estimated by Council, for the use of materials, machinery, tools and equipment used in conjunction with the said work; and

        II. Legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs, charges, and expenses of registration of a covenant charge pursuant to Section 88F of the Act or providing any certificate required pursuant to Section 88G of the Act or obtaining any injunction pursuant to Section 88H of the Act.

3. This covenant shall bind all persons who are or claim under the registered proprietor(s) as stipulated in Section 88E(5) of the Act.

For the purposes of this covenant, “the system” means the on-site stormwater detention system constructed on the land as detailed on the plans approved by ……. as Construction Certificate No. …… on ……, including all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater, as well as all surfaces graded to direct stormwater to the temporary storage. *(Include the following for Private CC’s only)* A copy of this Construction Certificate is held on Council File No. ……

F. Sample Restriction on Use of Land and Covenant where a Deposited Plan is being registered together with a Section 88B instrument.

In this case the On-Site Detention system is provided with Development Approval involving subdivision of land.

A copy of the Maintenance Schedule should be attached to the Instrument.

(ON-SITE DETENTION SYSTEM PROVIDED WITH DEVELOPMENT APPROVAL INVOLVING SUBDIVISION)

INSTRUMENT SETTING OUT TERMS OF RESTRICTION ON THE USE OF LAND AND POSITIVE COVENANT INTENDED TO BE CREATED PURSUANT TO SECTION 88E OF THE CONVEYANCING ACT 1919.

(Sheet .. of … sheets)

Plan: Subdivision of Lot …….D.P…….
Covered by Council Clerk's
Certificate No. ……..
Of ……

Full name and address
Of proprietor of the land ……
……
……

PART 1

( ) Identity of restriction…….. referred to in abovementioned plan — Restriction on use under Section 88E of the Conveyancing Act 1919

SCHEDULE OF LOT(S), ETC. AFFECTED

Lot(s) Burdened	Authority Benefited
…….	*Insert name of Council*

( ) Identity of Positive Covenant …….. referred to in above-mentioned plan — Positive Covenant under Section 88E of the Conveyancing Act 1919

SCHEDULE OF LOT(S), ETC. AFFECTED

Lot(s) Burdened	Authority Benefited
…….	*Insert name of Council*

INSTRUMENT SETTING OUT TERMS OF RESTRICTION ON THE USE OF LAND AND POSITIVE COVENANT INTENDED TO BE CREATED PURSUANT TO SECTION 88E OF THE CONVEYANCING ACT 1919.

(Sheet .. of … sheets)

Plan: Subdivision of Lot …….D.P…….
Covered by Council Clerk's
Certificate No. ……..
Of ……

Full name and address
Of proprietor of the land ……
……
……

PART 2

TERMS OF RESTRICTION ON USE …….. REFERRED TO IN THE ABOVE-MENTIONED PLAN

The registered proprietor shall not make or permit or suffer the making of any alterations to the on-site stormwater detention system which is constructed on the lot(s) burdened without the prior consent in writing of ……(*Insert name of Council.* The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins, rainwater tanks (if an airspace "credit" is claimed against the storage volumes) and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage. Any on-site stormwater detention system constructed on the lot(s) burdened is hereafter referred to as "the system". The on-site stormwater detention system is detailed on the plans approved by ……. as Construction Certificate No……. on ……,. (Include the following for privately certified Construction Certificates only:) A copy of this Construction Certificate is held on Council file No. ……

Name of Authority having the power to release, vary or modify the Restriction ……. referred to is ……(*Insert name of Council).*

PART 2 (Continued)

TERMS OF POSITIVE COVENANT ……..……..REFERRED TO IN THE ABOVE-MENTIONED PLAN

1. The registered proprietor of the lot(s) hereby burdened will in respect of the system:

(a) keep the system clean and free from silt, rubbish and debris

(b) maintain and repair at the sole expense of the registered proprietors the whole of the system so that if functions in a safe and efficient manner

(c) permit the Council or its authorised agents from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter and inspect the land for the compliance with the requirements of this covenant

(d) comply with the terms of any written notice issued by the Council in respect of the requirements of this covenant within the time stated in the notice.

INSTRUMENT SETTING OUT TERMS OF RESTRICTION ON THE USE OF LAND AND POSITIVE COVENANT INTENDED TO BE CREATED PURSUANT TO SECTION 88E OF THE CONVEYANCING ACT 1919.

(Sheet .. of … sheets)

Plan: Subdivision of Lot …….D.P…….
Covered by Council Clerk's
Certificate No. ……..
Of …….

Full name and address …….
Of proprietor of the land ……
…..……

2. Pursuant to Section 88F(3) of the Conveyancing Act 1919 the Council shall have the following additional powers:

(i) in the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above the Council or its authorised agents may enter the land with all necessary materials and equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in part 1(d) above

(ii) The Council may recover from the registered proprietor in a Court of competent jurisdiction:

(a) any expense reasonably incurred by it in exercising its powers under sub-paragraph (i) hereof. Such expense shall include reasonable wages for the Council's employees engaged in effecting the work referred to in (i) above, supervising and administering the said work together with costs, reasonably estimated by the Council, for the use of materials, machinery, tools and equipment in conjunction with the said work.

(b) legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs and expenses of registration of a covenant charge pursuant to section 88F of the Act or providing any certificate required pursuant to section 88G of the Act or obtaining any injunction pursuant to section 88H of the Act.

Name of Authority having the power to release vary or modify the Positive Covenant …….. referred to is ……(*Insert name of Council).*

G. A copy of Information Bulletin No 14 (dated September 1998)

Land Titles Office **Information Bulletin Number: 14** September 1998

A Guide to the preparation of a Section 88B Instrument to:

- **Create Easements, Profits à Prendre, Restrictions on the Use of Land or Positive Covenants**
- **Release Easements or Profits à Prendre**

Note: This bulletin should be read in conjunction with the following:

- **Information Bulletin No. 43** – 'Creating an Easement over a Track in Use'
- **Information Bulletin No. 56** – 'Property Legislation (Easements) Amendment Act 1995.'

1. Introduction:

A Section 88B Instrument is the part of a deposited plan which upon registration

- creates Easements, Profit à Prendre, Restrictions on the Use of Land, and Positive Covenants [clause 27 Conveyancing (General) Regulation 1998]
- releases Easements and Profits à Prendre [clause 28 Conveyancing (General) Regulation 1998]

Note: Restrictions on the use of land and Positive Covenants cannot be varied or released by a Section 88B instrument.

The Instrument must be drawn in accordance with Approved Form 10 (**Annexures 2 and 3**).

The original instrument must be lodged as part of the plan. Stamp Duty is not payable.

Identification of easements:

Easements must be identified on the face of the plan using 'alpha' symbols. A specimen plan is attached as **Annexure 1.**

It is necessary to identify easements with the same expression:

- in the statements of intention panel on the plan
- in the Section 88B Instrument and
- on the face of the plan

Note: Where a Section 88B Instrument, includes height limitations to define the stratum of an easement, profit à prendre, restriction or positive covenant, the accompanying deposited plan must comply with clause 47 of the Surveyors (Practice) Regulation 1996.

2. Preparation of a Section 88B Instrument:

A Section 88B instrument comprises three parts:

- **Part 1**: Identifies each easement, profit à prendre, restriction or positive covenant to be created.
- **Part 1A**: Identifies each easement or profit à prendre to be released.
  Examples of the Schedules of lots burdened and benefited in Parts 1 and 1A are shown in **Annexure 4**
- **Part 2**: Sets out the terms and conditions of easements profits à prendre, restrictions or positive covenants referred to in Part 1. Part 2 may not be required see **Para.3.1**

3. Creating easements:

Easements may be created with or without terms and conditions shown in Part 2 of the section 88B instrument.

3.1 Terms and conditions not required:

In order to simplify the creation of easements, the statutory form of easements may be used. Statutory easements adopt the terms and conditions specified in Schedule 4A (easements in gross) and Schedule 8 (easements having a dominant tenement) Conveyancing Act 1919.

The terms and conditions of an easement cannot refer to persons empowered to release vary or modify the easement. (see sec. 88[1](c) Conveyancing Act 1919).

Following is a list of statutory easements (referred to as short form easements) set out in the Schedules that do not require terms and conditions to be included in Part 2 of the instrument:

- Right of Carriage Way
- Right of Foot Way
- Easement to Drain Water
- Easement to Drain Sewage
- Easement for Repairs
- Easement for Batter
- Easement for Drainage of Sewage
- Easement for Drainage of Water
- Easement for Electricity Purposes
- Easement for Overhang
- Easement for Services
- Easement for Water Supply
- Easement to permit Encroaching Structure to remain
- Right of Access

Note: The use of these expressions does not prevent the inclusion in Part 2 of variations of the terms and conditions referred to in the Schedules. Such variations may be by way of addition, exception, qualification or omission.

3.2 Terms and conditions required

Alternatively, an easement may be created for another purpose. In this case relevant terms and conditions must be shown in Part 2 of the instrument

4. Creating Profits à Prendre, Restrictions on Use of Land.

Terms and conditions of profits à prendre and restrictions on the use of land must always be shown in Part 2 of the instrument.

The terms and conditions of a Restriction on the Use of Land may state the person(s) empowered to release, vary or modify the restriction. (sec. 88[1](c) Conveyancing Act 1919)

Note: The sites of Restrictions and Profits à Prendre and are only identified on the face of the plan if they affect part of a lot.

5. Creating Positive Covenants

Terms and conditions of Positive Covenants must always be shown in Part 2 of the instrument. They may be created in favour of:

- prescribed authorities (sections 88D & 88E Conveyancing Act 1919) or
- privately owned land, where the covenant relates to maintenance or repair of an easement to be created by the instrument.

The site of the Positive Covenant is only shown on the face of the plan if it affects part of a lot.

Note: A Section 88B Instrument cannot be used to create a Positive Covenant over an existing easement

To record an interest relating to maintenance and repair of the site of an **existing easement** over:

- Torrens title land, a Request (97-11R) should be registered containing the terms of the covenant or
- Old System land, a deed containing the terms of the covenant should be registered in the General Register of Deeds.

6. Releasing Easements or Profits à Prendre

Section 88B Conveyancing Act 1919 provides for the release of easements and profits à prendre by the registration of a plan.

The identity of easements and Profits à Prendre to be released must be set out in:

- Part 1A of the instrument and
- the statement of intention panel of the plan.

An example is shown in **Annexure 3.**

7. Signatures and Consents

Where an easement, profit à prendre, restriction or positive covenant is being created the plan and Section 88B instrument must be signed by:

- the registered proprietor
- mortgagee
- chargee or
- covenant chargee and

Written consents must be furnished by any

- caveator,
- lessee, or
- judgement creditor under any writ

in accordance with Section 195D Conveyancing Act 1919.

Note: Written consents may be dispensed with if the caveator, lessee or judgement creditor signs the plan and instrument.

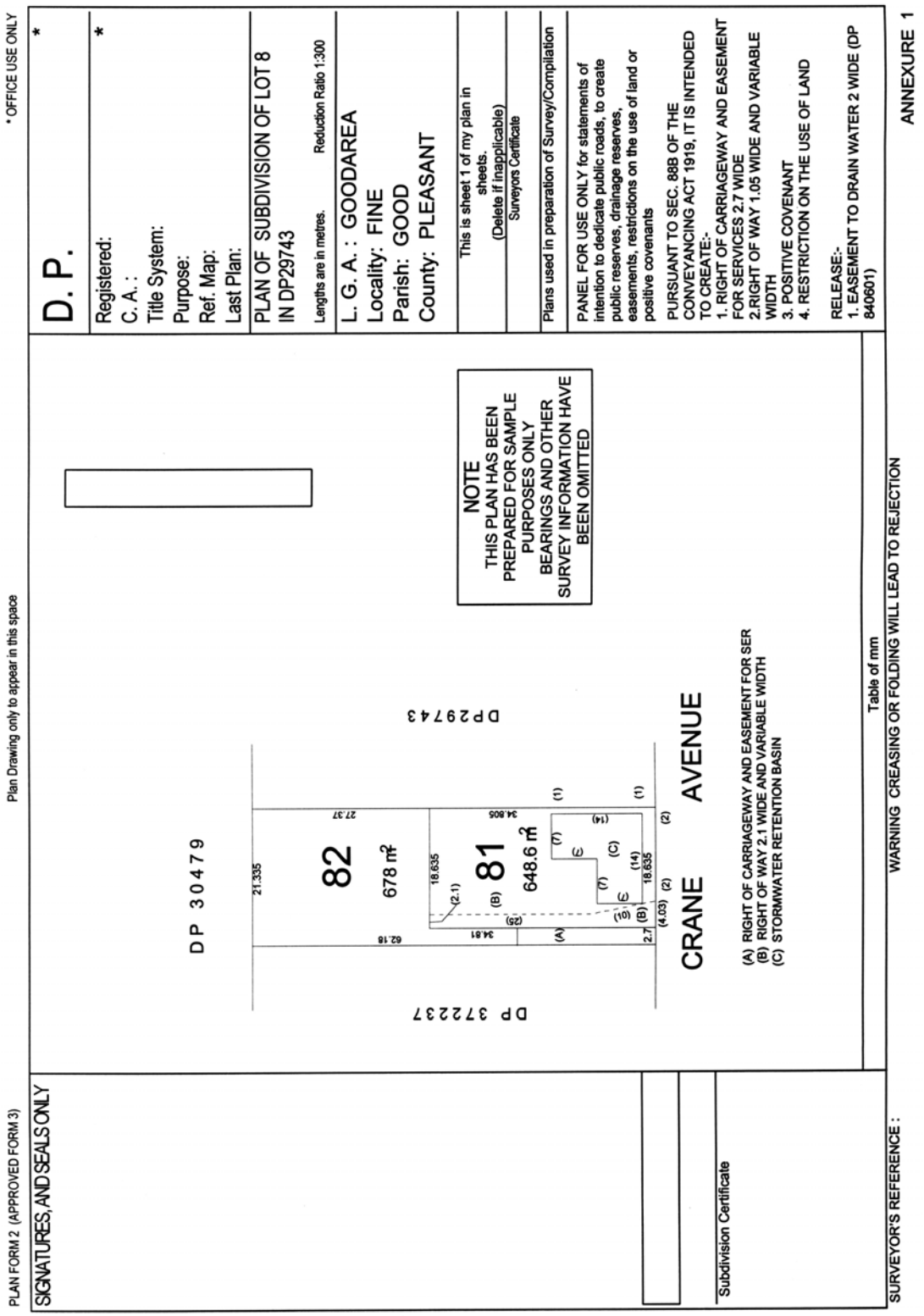
Where an Easement or Profit à Prendre is being released:

The signatures and consents of all the parties relating to the dominant tenement should be furnished.

Inquiries on all matters related to plans and associated dealings should initially be made in person at Customer Services Branch, second level, Land Titles Office, Queens Square, Sydney or by contacting the Telephone Inquiry Service on (02) 9228 6713.

David Mulcahy
Director of Land Titles and Registrar General First issued July 1987

Annexure 1


PLAN FORM 2 (APPROVED FORM 3)
Plan Drawing only to appear in this space
* OFFICE USE ONLY
SIGNATURES, AND SEALS ONLY
D. P.
*
Registered:
C. A. :
Title System:
Purpose:
Ref. Map:
Last Plan:
PLAN OF SUBDIVISION OF LOT 8 IN DP29743
Lengths are in metres. Reduction Ratio 1:300
L. G. A. : GOODAREA
Locality: FINE
Parish: GOOD
County: PLEASANT
This is sheet 1 of my plan in sheets.
(Delete if inapplicable)
Surveyors Certificate
Plans used in preparation of Survey/Compilation
PANEL FOR USE ONLY for statements of intention to dedicate public roads, to create public reserves, drainage reserves, easements, restrictions on the use of land or positive covenants
PURSUANT TO SEC. 88B OF THE CONVEYANCING ACT 1919, IT IS INTENDED TO CREATE:-
1. RIGHT OF CARRIAGEWAY AND EASEMENT FOR SERVICES 2.7 WIDE
2.RIGHT OF WAY 1.05 WIDE AND VARIABLE WIDTH
3. POSITIVE COVENANT
4. RESTRICTION ON THE USE OF LAND
RELEASE:-
1. EASEMENT TO DRAIN WATER 2 WIDE (DP 840601)
ANNEXURE 1
NOTE
THIS PLAN HAS BEEN PREPARED FOR SAMPLE PURPOSES ONLY
BEARINGS AND OTHER SURVEY INFORMATION HAVE BEEN OMITTED
DP 30479
DP 372237
DP297243
82
678 m²
81
648.6 m²
CRANE AVENUE
(A) RIGHT OF CARRIAGEWAY AND EASEMENT FOR SER
(B) RIGHT OF WAY 2.1 WIDE AND VARIABLE WIDTH
(C) STORMWATER RETENTION BASIN
Subdivision Certificate
Table of mm
SURVEYOR'S REFERENCE :
WARNING CREASING OR FOLDING WILL LEAD TO REJECTION

Annexure 2

Instrument setting out Terms of Easements/Profits à Prendre intended to be created or released and of Restrictions on the Use of Land and Positive Covenants intended to be created pursuant to Section 88B of the Conveyancing Act 1919.

Plan:	Subdivision of Lot 8 D.P.29743 covered by Subdivision Certificate No. 98/200 of 9/7/1998
Full name and address of the owner of the land	Grace Mary Brothers 4 Crane Avenue Fine NSW 2775

PART 1

1. Identity of easement, profit à prendre, restriction or positive covenant to be created and firstly referred to in the plan — Right of Carriage Way and Easement for Services 2.7 wide

Schedule of Lots etc. Affected

Lots Burdened	Lots Benefited
82	81

2. Identity of easement to be created and secondly referred to in the plan — Right of Way 2.1 wide and variable width

Schedule of Lots etc. Affected

Lots Burdened	Lots Benefited
81	82

3. Identity of positive covenant thirdly referred to in the plan — Positive Covenant

Schedule of Lots etc. Affected

Lots Burdened	Lots Benefited
81	Goodarea Council

4. Identity of restriction fourthly referred to in the plan — Restriction on the Use of Land

Schedule of Lots etc. Affected

Lots Burdened	Lots Benefited
81	Goodarea Council
82	Goodarea Council

Annexure 2

Instrument setting out Terms of Easements/Profits à Prendre intended to be created or released, and of Restrictions on the Use of Land and Positive Covenants intended to be created pursuant to Section 88B of the Conveyancing Act 1919.

Plan: Subdivision of Lot 8 D.P.29743 covered by Subdivision Certificate No. 98/200 of 9/7/1998

Part 1A

1. **Identity of easement to be released and firstly referred to in the plan** Easement to Drain Water 2 wide (DP 840601)

Schedule of Lots etc. Affected

Lots Burdened	Lots Benefited
8/29743	9/29743

Part 2

Note: The terms for the positive covenant and restriction on the use of land, set out in Part 2, are included for the purposes of illustration only.

1. **Terms of Right of Way 2.1 wide and variable secondly referred to in the plan.**

   (Insert terms and conditions).

2. **Terms of Positive Covenant thirdly referred to in the plan**

   The Proprietor of the land hereby burdened (herein called 'the Proprietor') shall at all times in respect of the land hereby burdened, identified on the plan as 'stormwater retention basin' (herein called 'the basin'): ..... (Insert terms and conditions).

3. **Terms of Restriction on the Use of Land fourthly referred to in the plan**

a. Not to erect or suffer to permit any building, structure or erection on the whole or in part of the land hereby burdened identified on the plan as 'stormwater retention basin' (herein called 'the basin') except: ..... (Insert terms of restrictions).

b. No alteration is to be made to the retention levels ..... (Insert terms of restrictions).

Name of authority empowered to release, vary or modify positive covenant and restriction thirdly and fourthly referred to in the plan.

Goodarea Council.

Annexure 2

Instrument setting out Terms of Easements/Profits à Prendre intended to be created or released, and of Restrictions on the Use of Land and Positive Covenants intended to be created pursuant to Section 88B of the Conveyancing Act 1919.

Plan: Subdivision of Lot 8 D.P.29743 covered by Subdivision Certificate No. 98/200 of 9/7/1998

Signed in my presence by Grace Mary Brothers who is personally known to me.

Signature of witness — Grace Mary Brothers

Name of Witness (Block Letters)

Address and Occupation of Witness

Signed in my presence by Francis Richard Drake (registered proprietor of dominant tenement 9/29743) who is personally known to me.

Signature of Witness — Francis Richard Drake

Name of Witness (Block Letters)

Address and occupation of Witness

Annexure 3

Copy of Approved Form 10

Instrument setting out Terms of Easements/Profits à Prendre intended to be created or released and of Restrictions on the Use of Land and Positive Covenants intended to be created pursuant to Section 88B of the Conveyancing Act 1919.

Plan: *(Please leave 26 mm to allow for plan number and heading of plan)* Plan of (heading of plan) covered by Subdivision Certificate No. (add reference as appropriate)

Full name and address of the owner of the land:

Part 1

1.	**Identity of easement, profit à prendre, restriction or positive covenant to be created and firstly referred to in the plan.**	*(Brief description in same terms as used in relevant statement in the plan).*

Schedule of Lots etc. affected

Lots burdened	**Lots, relevant roads, bodies or prescribed authorities benefited.**

(Set out vertically in numerical sequence of lot numbers. Title details should be added if the land referred to is outside the plan).

(Continue above pattern until all easements, profits à prendre, restrictions, or positive covenants to be created and referred to in the plan have been dealt with).

Part 1A

1.	**Identity of easement, profit à prendre to be released and firstly referred to in the plan.**	*(Brief description in same terms as used in relevant statement in the plan).*

Lots burdened by existing easement, , profit à prendre	**Lots, relevant roads, bodies or prescribed authorities benefited by existing easement.**

(Set out vertically in numerical sequence of lot numbers. Title details should be added if the land referred to is outside the plan).

(Continue above pattern until all easements or profits à prendre to be released and referred to in the plan have been dealt with).

Annexure 3

Part 2

Terms of easement, profit à prendre, restrictions or positive covenant("firstly", or as the case may be) referred to in the plan

(Continue the above pattern until all easements, profits à prendre, restrictions or positive covenants to be created and referred to in the plan have been dealt with)

Instrument setting out Terms of Easements/ profits à prendre intended to be created or released and of Restrictions on the Use of Land and Positive Covenants intended to be created pursuant to Section 88B of the Conveyancing Act 1919.

Plan: (Please leave 26 mm to allow for number and plan heading)	Plan of (heading of plan) covered by Subdivision Certificate No. (add reference as appropriate)

Name of person empowered to release, vary or modify restriction or positive covenant ("firstly", or as the case may be) referred to in the plan:

(Not required where it is intended that the restriction may only be released, varied or modified by the owners for the time being of all lots benefited, or by order of the Supreme Court)

Annexure 4

Examples of the Schedule of Lots Burdened and Benefited

The following examples show recommended formats for the scheduling of lots burdened and benefited in Parts 1 and 1A of a Section 88B Instrument.

Lots burdened	**Lots benefited**
1	2, 3 & 4
2	3 & 4
3	4
or	or
Each lot except lot 6 **(see note)**	Every other lot except lot 6 **(see note)**
or	or
Each of the lots 1 to 4 inclusive the part of lot 5 designated (A) in the plan and lot 6	Every other lot and the Council of .....
or	or
Each lot	Any prescribed authority

Note: This format should be used only for Restrictions on the Use of Land.

The current title details and parcel identity must be shown for each lot or parcel of land burdened and/or benefited by the easement, profit à prendre, restriction, or positive covenant. The reference to title need only be referred to once throughout the instrument.

H. Sample Covenant used where a Deposited Plan is being registered together with a Section 88B instrument and construction of the OSD system is being deferred

Sample instrument when OSD is deferred

Sample 88B Instrument for use when the On-Site Detention system is not provided at the time of subdivision but is deferred until construction of a building development on the land.

This situation has caused considerable difficulties for new home builders in the past and will only be permitted by Council in exceptional circumstances. The provision of OSD can be deferred for subdivisions of up to 7 lots, if it is proven there are site restrictions. Note however, that any easements or inter allotment drainage must be created/installed at the time of subdivision and cannot be deferred.

(NO ON-SITE DETENTION SYSTEM PROVIDED AT DEVELOPMENT APPLICATION STAGE)

INSTRUMENT SETTING OUT TERMS OF RESTRICTION ON THE USE OF LAND INTENDED TO BE CREATED PURSUANT TO SECTION 88E OF THE CONVEYANCING ACT 1919.

(Sheet … of … sheets)

Plan: Subdivision of Lot …….D.P…….
Covered by Council Clerk's
Certificate No. ……..
of ……

Full name and address
Of proprietor of the land …….
…….
…….

PART 1

( ) Identity of restriction…….. referred to in abovementioned plan — Restriction on use under Section 88E of the Conveyancing Act 1919

SCHEDULE OF LOT(S), ETC. AFFECTED

Lot(s) Burdened	Authority Benefited
…….	*Insert name of Council*

( ) Identity of Positive Covenant …….. referred to in above-mentioned plan — Positive Covenant under Section 88E of the Conveyancing Act 1919

SCHEDULE OF LOT(S), ETC. AFFECTED

Lot(s) Burdened	Authority Benefited
…….	*Insert name of Council*

PART 2

TERMS OF RESTRICTION ON USE ……REFERRED TO IN THE ABOVE-MENTIONED PLAN

(i) The registered proprietor shall not erect or suffer the erection of any dwelling house or other structure on the lot(s) hereby burdened unless the registered proprietor has first constructed or has made provision for the construction of an on site stormwater detention system on the said lot(s), in accordance with the design, construction and/or provision requirements of the ……(*Insert name of Council)* and to the satisfaction of the …… (*Insert name of Council)*. The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins, rainwater tanks (if an airspace "credit" is claimed against the storage volumes) and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage.

INSTRUMENT SETTING OUT TERMS OF RESTRICTION ON THE USE OF LAND INTENDED TO BE CREATED PURSUANT TO SECTION 88E OF THE CONVEYANCING ACT 1919.

(Sheet .. of … sheets)

Plan: Subdivision of Lot …….D.P…….
Covered by Council Clerk's
Certificate No. ……..
Of ……

Full name and address
Of proprietor of the land …….
…….
…….

PART 2 (Continued)

(ii) The registered proprietor shall not make or permit or suffer the making of any alterations to any on-site stormwater detention system which is, or shall be, constructed on the lot(s) burdened without the prior consent in writing of ……..(*Insert name of Council)* . The expression "on-site stormwater detention system" shall include all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins, rainwater tanks (if an airspace "credit" is claimed against the storage volumes) and surfaces designed to temporarily detain stormwater as well as all surfaces graded to direct stormwater to the temporary storage. Any on-site stormwater detention system constructed on the lot(s) burdened is hereafter referred to as "the system".

Name of Authority having the power to release, vary or modify the Restriction ……. referred to is ……(*Insert name of Council).*

TERMS OF POSITIVE COVENANT ……..……..REFERRED TO IN THE ABOVE-MENTIONED PLAN

1. The registered proprietor of the lot(s) hereby burdened will in respect of the system:

   (a) keep the system clean and free from silt, rubbish and debris

   (b) maintain and repair at the sole expense of the registered proprietors the whole of the system so that if functions in a safe and efficient manner

   (c) permit the Council or its authorised agents from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter and inspect the land for the compliance with the requirements of this covenant

   (d) comply with the terms of any written notice issued by the Council in respect of the requirements of this covenant within the time stated in the notice.

2. Pursuant to Section 88F(3) of the Conveyancing Act 1919 the Council shall have the following additional powers:

   (i) in the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above the Council or its authorised agents may enter the land with all necessary materials and equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in part 1(d) above

INSTRUMENT SETTING OUT TERMS OF RESTRICTION ON THE USE OF LAND INTENDED TO BE CREATED PURSUANT TO SECTION 88E OF THE CONVEYANCING ACT 1919.

(Sheet .. of … sheets)

Plan: Subdivision of Lot …….D.P…….
Covered by Council Clerk's
Certificate No. ……..
Of …….

Full name and address
Of proprietor of the land …….
…….
…….

PART 2 (Continued)

(ii) The Council may recover from the registered proprietor in a Court of competent jurisdiction:

(a) any expense reasonably incurred by it in exercising its powers under sub-paragraph (i) hereof. Such expense shall include reasonable wages for the Council's employees engaged in effecting the work referred to in (i) above, supervising and administering the said work together with costs, reasonably estimated by the Council, for the use of materials, machinery, tools and equipment in conjunction with the said work.

(b) legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs and expenses of registration of a covenant charge pursuant to section 88F of the Act or providing any certificate required pursuant to section 88G of the Act or obtaining any injunction pursuant to section 88H of the Act.

Name of Authority having the power to release vary or modify the Positive Covenant …….. referred to is ……(*Insert name of Council).*

I. Checklists for Stormwater Concept Plan

Stormwater Concept Plan Submission

The following checklists have been provided to assist designers to confirm that all necessary issues have been addressed. The first Stormwater Concept Plan (SCP) checklist (I.1) is a shorter version of the second. The first list is to be completed by the stormwater consultant and submitted to Council together with the plan/s and any necessary attachments.

The second more comprehensive checklist (I.2) may be used by less experienced designers as an aid to ensure that all relevant information has been provided. It may be submitted to Council instead of the shorter form if desired.

Note: Holroyd City Council does not accept SCPs and a detailed OSD design is to be submitted with the development application. Council also requires consultants to complete a detailed design checklist, which is available from Council, which incorporates both the SCP checklist (Appendix I.1) and the Detailed Design checklist (Appendix J.1).

I.1 OSD Stormwater Concept Plan Submission – Short Form

This form is to be completed by the stormwater designer and submitted to Council together with the plan(s), any necessary attachments and a completed OSD Calculation Sheet.

PROJECT ADDRESS: _____

OSD DESIGNER DETAILS:

Company Name:_____

Address: _____

Telephone No.: _____ **Fax No**: _____

Accreditation Organisation: _____ **Accreditation Reference**: _____

Name of designer: _____ **Date**: _____
(Print Name)

Council Reviewer's Name: _____ **Date**: _____

CHECKLIST	Complies to Handbook Yes	Complies to Handbook No	Council Agrees Yes	Council Agrees No
1. Flooding:				
Is the site (whole or partly) below the 100 year ARI flood level?	☐	☐	☐	☐
If yes, does the OSD system reflect the flood affectation?	☐	☐	☐	☐
Have floodplain issues been addressed (eg storage, obstructed flow etc)?	☐	☐	☐	☐
2. External catchment: (refer Section 4.1.3)				
Is there an external catchment draining into the site?				
If Yes, have calculations of 100 year ARI flow been submitted & full area of catchment shown?	☐	☐	☐	☐
3. OSD Storage: (refer Sections 4.1.4, 4.1.5 & 6.5)				
Was the storage volume calculated using the UPRCT Calculation Sheet?	☐	☐	☐	☐
Is the area bypassing the OSD storage less than 30% of the residual area?	☐	☐	☐	☐
Is there free discharge at the outlet or provision made for a drowned outlet?	☐	☐	☐	☐
Has the storage been located at the lowest point of the site to collect surface and roof gutter overflow	☐	☐	☐	☐
4. Site information:				
Has the following information has been shown on the plans:	☐	☐	☐	☐
- scaled site layout showing all buildings, roadways and landscaped areas				
- spot levels and contours (including adjoining properties)				
- location, dimensions and extent of detention storages	☐	☐	☐	☐
- location of any floodways or flowpaths through the site	☐	☐	☐	☐
- location of any other constraints, e.g. easements, sewer and other services or Water Sensitive Urban Design (WSUD) features	☐	☐	☐	☐
5. OSD Calculation Sheet is attached	☐	☐	☐	☐

I.2 OSD Stormwater Concept Plan Submission – Comprehensive

This form may be completed by the stormwater consultant and submitted to Council together with the plan/s and any attachments and a completed OSD Calculation Sheet if Form I.1 is not used.

PROJECT ADDRESS: _____

PROJECT APPLICANT:_____

STORMWATER DESIGNER DETAILS:

Company Name:_____

Address: _____

Telephone No.: _____ **Fax No**: _____

Accreditation Organisation: _____

Accreditation Reference: _____

Name and signature of Designer: _____
(Print Name)

_____ **Date**: _____
(Signature)

Items submitted: **

Stormwater Concept Plan		Yes / No
Stormwater Concept Plan Checklist		Yes / No
– Attachment A:	Flood Affectation Information	Yes / No
– Attachment B:	External Catchment Assessment	Yes / No
– Attachment C:	Completed OSD Calculation Sheet	Yes / No
– Attachment D:	Outlet Hydraulic Assessment	Yes / No

COUNCIL REVIEW DETAILS:

Council Review Officer's Name: _____

Review officer's comments: _____

_____

Signature of Review Officer: _____**Date**:_____

** The above items are to be submitted in a single bound form — a 'loose leaf' format is unacceptable.

STORMWATER CONCEPT PLAN CHECKLIST

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
1. Is the site (whole or partly) defined as floodprone?				
If Yes, see Plan No. ..... and reference flood level information in Attachment A.				
2. Is there an external catchment draining into the site?				
If Yes, see Plan No. ..... and calculations of 100 year ARI flow in Attachment B				
3. Plan No. ..... has been prepared in accordance with Section 4.1.2 showing:				
- site layout showing all buildings, roadways and landscaped areas;				
- site spot levels and contours (with extensions into adjoining properties);				
- location, levels and extent of detention storages;				
- location and levels of collecting stormwater system and any rainwater tank (if an airspace "credit" is claimed against the storage volumes);				
- location and approximate extent of any floodways or flowpaths through the site (based on flows defined in Attachment B);				
- location and area of any portion of the site unable to drain to the storages;				
- location of any other constraints, e.g. easements and services; and				
- datum and scale				
4. The storage volume has been estimated using the UPRCT Calculation Sheet (refer Section 5)				
If Yes, see attached Calculation Sheet in Attachment C.				
5. The area of the site to be drained has been determined (refer Section 4.1.4)				
If Yes, see Plan No.				
If Yes, the undrained percentage of the residual lot area is .....% (to be not more than 30%).				
6. The approximate dimensions of the storage area, including invert level, are provided				
If Yes, see Plan No.				
7. Invert level of storage is not less than ground level (or top of kerb) at point of connection to external stormwater system (refer Section 6.5)				
If Yes, see Plan No.				
If No, see calculations in Attachment D				

J. Checklists for Detailed Design

OSD Detailed Design Submission

The following checklists have been provided to assist designers to confirm that all necessary issues have been addressed. The first detailed Design checklist (J.1) is a shorter version of the second. The first list is to be completed by the stormwater consultant and submitted to Council together with the plan/s and any necessary attachments[1].

The second more comprehensive checklist (J.2) may be used by less experienced designers as an aid to ensure that all relevant information has been provided. It may be submitted to Council instead of the shorter form if desired.

[1] Holroyd City Council requires consultants to complete a detailed design checklist which is available from Council and which incorporates both the SCP Checklist (Appendix I.1) and the Detailed Design Checklist (Appendix J.1).

J.1 OSD Detailed Design Submission – Short Form

This form is to be completed by the stormwater consultant and submitted to Council/Principal Certifying Authority (PCA) together with the plan(s), any necessary attachments and a completed and signed OSD Calculation Sheet.

PROJECT ADDRESS: _____

STORMWATER DESIGNER DETAILS:

Company Name: _____

Address:

_____

Telephone No.: _____ **Fax No**: _____

Accreditation Organisation: _____**Accreditation Reference**: _____

Name of designer: _____

(Print Name)

Reviewer's Name: _____ **Date**:_____

DETAILED DESIGN SUMMARY CHECKLIST	DESIGNER Yes	DESIGNER No	COUNCIL AGREES: Yes	COUNCIL AGREES: No
1. Stormwater Concept Plan (SCP) (refer Section 4.1)				
Has a SCP been approved previously? If not please submit SCP checklist	☐	☐	☐	☐
Is the detailed design consistent with the approved SCP?	☐	☐	☐	☐
Is this design consistent with all conditions of development consent affecting the OSD design (eg trees to be retained)?	☐	☐	☐	☐
2. Design information				
Do the plans show all information required by Section 4.2.2 of the Handbook? (Including calculations for weir and by-pass flows, final site/lot layout, etc)	☐	☐	☐	☐
Does the entire drained area grade to the storage, including roof gutter overflows?	☐	☐	☐	☐
If No, do all drainage components have 100 year ARI capacities?	☐	☐	☐	☐
3. OSD System				
Is the catchment for each OSD storage clearly shown on the plans?	☐	☐	☐	☐
Has a copy of the UPRCT Calculation Sheet (refer Appendix B) been submitted for each OSD system?	☐	☐	☐	☐
Are the outlets consistent with the principles in Section 4.2, Figures 4.2 and 4.3 and Council's design standards?	☐	☐	☐	☐
4. OSD Storage:				
Does depth of storages comply with Table 6.1 & Section 4.2.5 to 4.2.10?	☐	☐	☐	☐
Has a cross-section of the storage been provided?	☐	☐	☐	☐
Is there the required freeboard for all buildings on site?	☐	☐	☐	☐
Have structural details been provided?	☐	☐	☐	☐
Have access/ maintenance issues been addressed (eg. Section 4.2.7)?	☐	☐	☐	☐
Are any walls and footings of the storage completely within the property? (Section 4.2.5 to 4.2.7)	☐	☐	☐	☐
4. OSD Calculations:				
A completed and signed Calculation Sheet is attached	☐	☐	☐	☐

J.2 OSD Detailed Design Submission – comprehensive

This form may be completed by the stormwater designer and submitted to Council/Principal Certifying Authority (PCA) together with the design plan/s and any necessary attachments if Form J.1 is not used.

PROJECT ADDRESS: _____

PROJECT APPLICANT:_____

OSD DESIGNER DETAILS:

Company Name:_____

Address: _____

Telephone No.: _____**Fax No**: _____

Accreditation organisation: _____

Accreditation Reference: _____

Name and signature of designer: _____
(Print Name)
_____ **Date**: _____
(Signature)

Items submitted: ******

OSD Design Plan/s			Yes / No
OSD Detailed Design Checklist			Yes / No
–	Attachment A:	Flood Affectation Information	Yes / No
–	Attachment B:	External Catchment Assessment	Yes / No
–	Attachment C:	On-line System Calculations	Yes / No
–	Attachment D:	Weir, Overflow and Surcharge Pathway Calculations	Yes / No
–	Attachment E:	Site Drainage Calculations	Yes / No
–	Attachment F:	Outlet Hydraulic Assessment	Yes / No
–	Attachment G:	Site Storage Details	Yes / No
–	Attachment H:	OSD Calculation Sheet	Yes / No

COUNCIL REVIEW DETAILS:

Council Review Officer's Name: _____

Review officer's comments: _____

_____

_____

Signature of Review Officer: _____ **Date**:_____

** The above items are to be submitted in a single bound form — a 'loose leaf' format is unacceptable.

OSD DETAILED DESIGN CHECKLIST

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
1. A Stormwater Concept Plan (SCP) has been approved previously (refer Section 4.1)				
2. The site (whole or partly) is defined as floodprone in a 100 year ARI event				
If Yes, see Plan No. ..... in Attachment A				
2(a) Has any floodplain storage been lost?				
If Yes, see Plan No. ..... in Attachment A				
2(b) Has the floodprone area been excluded from the OSD calculations?				
2(c) Is the OSD system performance adversely affected by the 100 year ARI flood level?				
3. Is there an external catchment draining into the site?				
If Yes, see Plan No. ..... and calculations of 100 year ARI flow in Attachment B				
4. The location and extent of any floodway/flowpath has been determined, (refer Sections 4.1.3 & 4.2.2)				
If Yes, see Plan No .....and accompanying 100 yr ARI event hydraulic calculations in Attachment B. Buildings are not inundated (and have the required freeboard) nor are flows concentrated on an adjoining property (refer Sections 4.1.3, 4.2.6 & 4.2.10)				
5. The detailed design submission is consistent with the approved SCP				
6. Are there any conditions on the development approval that may affect the drainage design (for example, trees to be retained)?				
7. The detailed design submission addresses the drainage-related conditions of the development approval				
8. A site layout plan with accompanying ground levels/contours which extend into adjoining properties is submitted				
If Yes, see Plan No.				
9. Have other constraints, e.g. easements, services, been defined?				
If Yes, see Plan No.				
10. How many OSD storage systems are there?.....				
11. Are the storage system/s on-line (refer Section 4.2.6)? Refer calculations included in Attachment C				
12. State the type of discharge control devices (i.e. orifice or……...? Where the device is not an orifice, has specific Trust approval been obtained?				
13. The area of the site to be drained by each OSD storage has been determined, (refer Section 4.2.2)				
If Yes, see Plan No.				
If Yes, the uncommanded site percentage is ....% (to be less than 30% of the residual lot area) unless specific approval has been granted).				
14. The plan/s identify the maximum water levels, and the levels and locations of each storage's discharge point (refer Section 4.2.2)				
If Yes, see Plan No				
15. The location of overflow structures and surcharge pathways have been determined, (refer Sections 4.2.2 & 4.2.10)				
If Yes, see Plan No ..... and calculations in Attachment D				
Buildings are not inundated nor are flows concentrated on an adjoining property (refer Sections 4.2.6 & 4.2.10)				
16. The drainage plans have been checked for consistency against the Architectural and landscaping plans				
17. A maintenance schedule has been prepared (ref Section 4.2.11)				

Where there is more than one OSD system, Questions 18 to 26 are to be answered separately for each OSD storage system.

OSD Storage system identifier.....

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
18. The design explicitly shows how all the drained area grades to the storage, including roof gutter overflows (refer Section 6.2)				
If Yes, see Plan No				
If No, see calculations in Attachment E showing how all drainage system components (including all roof gutters, downpipes, collecting pits and pipe systems, etc) have 100 yr ARI capacities with 50% blockage factor				
19. The invert level of storage is not less than ground level (or top of kerb) at point of connection to external stormwater system				
If Yes, see Plan No.				
If No, see explanatory notes in Attachment F				
20. The outlet design is consistent with the principles shown in Figs 4.3-4.6				
20(a) The outlet(s) has an open grating type lid (for ease of inspection)				
20(b) The outlet(s) minimum dimensions are consistent with Section 4.2.3				
20(c) The floor of the outlet(s) has a localised sump adjacent to the orifice with level at least 150 mm below the return pipe, (refer Section 4.2.3)				
20(d) Are the orifices consistent with the requirements set out in Section 4.2.3?				
If Yes, see: Plan No. ..... for stainless steel plate specification, thickness and fixing to chamber or pit walls				
20(e) The secondary DCP characteristics are consistent with the requirements set out in Section 4.2.3				
20(f) The screen design is consistent with Section 4.2.4				
If Yes, see: Plan No..... for screen type, area and orientation				
Plan No..... for fabrication note re aperture orientation				
Plan No..... for fixing and handle details				
Plan No..... showing how all inflows to the storage are on the upstream side of the screens protecting the orifices				
20(g) The outlet pipe(s) from the storage(s) has a capacity at least twice the SRD (refer Section 4.2.3)				
If Yes, see calculations in Attachment E				
21. If an above ground/landscaped storage is specified, answer Q 21(a) to Q 21(g), otherwise move to Q 22.				
21(a) The extended detention storage is provided in an area or areas able to tolerate frequent inundation (refer Section 4.2.6)				
21(b) Where the depth of ponding exceeds 600 mm, consideration has been given to whether there are steep drops, and/or a need for steps or 'walk-in' 'walk-out' batters, etc. when deciding if fencing and/or warning signs are required (refer Sections 3.5.6, 3.5.7 & 6.2)				
21(c) The landscaping treatment within the storage area does not limit storage volumes nor provide a significant source of debris loading				
21(d) The minimum surface slope is consistent with Section 4.2.6				
21(e) Subsoil drainage is provided in areas subject to frequent ponding and around the primary outlet (refer Section 4.2.6)				
21(f) If the design includes a retaining wall, has it been structurally checked?				
21(g) Does the system have the correct extended detention and flood detention storage volumes?				
If Yes, see stage-storage calculations in Attachment G and H				

22. If a driveway/car-park storage is specified, answer Q 22(a) to Q 22(c), otherwise move to Q 23				
22(a) The maximum depth is less than or equal to 200mm (refer Section 4.2.6)				
22(b) The minimum transverse slope is 0.7% (refer Section 4.2.6)				
22(c) The system has the correct storage				
If Yes, see stage-storage calculations in Attachment G				
23. If a structural/underground storage is specified, answer Q 23(a) to Q 23(f), otherwise move to Q24				
23(a) The dimensions of openings are consistent with Section 4.2.5				
23(b) The storage floor has a minimum slope of 0.7% (refer Section 4.2.5)				
23(c) There are sufficient access points for flushing purposes (refer Section 4.2.5)				
23(d) There are sufficient grated openings for ventilation purposes (refer Section 4.2.5)				
23(e) All access points have light weight covers				
23(f) The system has the correct extended detention and flood detention storage volumes				
If Yes, see stage-storage calculations in Attachment G				
24. The distribution of storage minimises inconvenience (refer Section 4.2.7)				
25. If an rainwater tank airspace "credit" is claimed then answer Q 25(a) to Q 25(b), otherwise move to Q26 25(a) An airspace "credit" has been claimed against the storage volume requirements 25(b) The rainwater tank is shown on the site layout plan 25(c) Part of the rainwater tank is dedicated airspace 25(d) If dedicated airspace is included a correctly sized outlet is included 25(e) If dynamic airspace is claimed then the usage demand on the rainwater tank is consistent with the demands outlined in section 4.2.8 25(f) All overflows from the rainwater tank are directed into the OSD storage(s)				
26. The OSD Calculation Sheet has been completed and signed (refer Appendix B)				
If Yes, see completed sheet in Attachment H				
27. The OSD Calculation Sheet details are consistent with the design plans				

K. Checklists for Work-As-Executed Plans

OSD WAE Survey And Certification Submission

The following checklists have been provided to assist designers/surveyors to confirm that all necessary information has been provided to confirm the as built OSD facility complies with the design. The first WAE checklist is a shorter version of the second. The first list (K.1) is to be completed by the stormwater consultant and submitted to Council together with the plan/s and any necessary attachments.

The second more comprehensive checklist (K.2) may be used as an aid to ensure that all relevant information has been provided. It may also be submitted to Council instead of the shorter form if desired.

K.1 OSD WAE Survey And Certification Submission – Short Form

This form is to be completed and submitted to Council/Principal Certifying Authority (PCA) together with the plan(s), any necessary attachments and a Calculation Sheet completed with WAE details.

PROJECT ADDRESS: _____

WAE PLAN DETAILS:

Company Name:_____

Name of surveyor: _____ **Date of WAE Plan**: _____

Telephone No.: _____ **Fax No**: _____

Items submitted:	**Yes**	**No**	**NA**
• Signed WAE Plans	☐	☐	
• Certificate of Hydraulic Compliance (Appendix L)	☐	☐	
• Certificate of Structural Compliance	☐	☐	☐
• OSD WAE Volume Calculations	☐	☐	
• Signed Calculation Sheet completed with WAE details	☐	☐	

_____

COUNCIL REVIEW DETAILS:

Reviewer's Name: _____**Date**:_____

OSD WAE & CERTIFICATION CHECKLIST	DESIGNER/ SURVEYOR		COUNCIL AGREES	
	Yes	No	Yes	No
1. WAE Plans (Section 4.3.3)				
Are there any major variations from the approved plans?	☐	☐	☐	☐
If so, is a Section 96 (EP&A Act) modification required?	☐	☐	☐	☐
Is the WAE plan superimposed on an approved design plan in red ink?	☐	☐	☐	☐
Has a WAE level boxed in red ink been shown at each design level?	☐	☐	☐	☐
Have WAE dimensions been shown adjacent to design dimensions?	☐	☐	☐	☐
Do the WAE plans show the following information:				
• finished floor levels of dwellings and garages	☐	☐	☐	☐
• levels of overland flow paths	☐	☐	☐	☐
• area and flows from external catchment or reason why its ignored	☐	☐	☐	☐
For the each outlet				
• internal chamber and /or DCP dimensions as appropriate	☐	☐	☐	☐
• diameter and centre line of orifice	☐	☐	☐	☐
• location, dimensions, distance from orifice for fitted screen	☐	☐	☐	☐
• levels of top and invert of chamber or DCP	☐	☐	☐	☐
• levels of maximum water level	☐	☐	☐	☐
• internal diameter of outlet pipe(s)	☐	☐	☐	☐
For each storage:				
• type of storage (roof, above ground, below ground, etc.)	☐	☐	☐	☐
• sufficient levels and dimensions to verify storage volumes	☐	☐	☐	☐
• calculations of actual volume achieved	☐	☐	☐	☐
• level, dimensions and location of overflow between primary and secondary DCP	☐	☐	☐	☐
For rainwater tanks (if an airspace "credit" is claimed against storage volume)				
• the rainwater tank is shown on the site layout plan	☐	☐	☐	☐
• is part of the rainwater tank is claimed as dedicated airspace	☐	☐	☐	☐
- if yes, the diameter and centre line of orifice shown on the WAE plan	☐	☐	☐	☐
• if dynamic airspace is claimed then the usage demand on the rainwater tank is consistent with the demands outlined in section 4.2.8	☐	☐	☐	☐
• all overflows from the rainwater tank are directed into the OSD storage(s)	☐	☐	☐	☐

2.	**Certification**: (Section 4.3.4 and 4.3.5)			
	Has the Calculation Sheet been completed based on WAE been submitted?	☐	☐	☐ ☐
	Have upstream flows been ignored, and if so Why? ……..	☐	☐	☐ ☐
	Are WAE calculations sufficient to show storage(s) & SRDs are satisfactory?	☐	☐	☐ ☐
	Does the WAE volume agree with the design volume for each storage?	☐	☐	☐ ☐
	Does OSD system function correctly?	☐	☐	☐ ☐
	Have structural certificates been submitted?	☐	☐	☐ ☐

K.2 OSD WAE Survey and Certification Submission – Comprehensive

This form may to be completed by the stormwater designer and submitted to Council/Principal Certifying Authority (PCA) if Form K.1 is not used.

PROJECT ADDRESS: _____

DEVELOPER:_____

OSD DESIGNER DETAILS:

Company Name:_____

Address:

_____

Telephone No.: _____**Fax No**: _____

Accreditation Organisation: _____

Accreditation Reference: _____

Name and signature of designer: _____
(Print Name)

_____ **Date**: _____
(Signature)

Items submitted: **

- WAE Plan/s Yes / No
- Certificate of Hydraulic Compliance Yes / No
- Certificate of Structural Compliance Yes / No / NA
- WAE Survey and Certification Checklist Yes / No
- Attachment A: OSD Volume Calculations Yes / No
- Attachment B: OSD WAE Dimensions, etc. Yes / No
- Attachment C: Calculation Sheet completed with WAE details Yes / No

---

COUNCIL REVIEW DETAILS:

Council Review Officer's Name: _____

Review officer's comments: _____

_____

_____

_____

_____

_____

_____

Signature of Review Officer: _____ **Date**:_____

** The above items are to be submitted in a single bound form — a 'loose leaf' format is unacceptable.

OSD WAE & CERTIFICATION CHECKLIST

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
1. The WAE plan/s has/have been prepared If Yes, see Plan No/Nos ..... prepared by .....…… and dated				
1(a) The WAE plan or Attachment B provides the following information about each discharge control pit, DCP (refer Section 4.3.3)				
- internal pit dimensions				
- diameter of fitted orifice plate				
- location, dimensions, distance from orifice for fitted screen				
- levels of top and invert of pit				
- Internal diameter of outlet pipe				
1(b) The WAE survey provides the following information about each storage (ref Section 4.3.3)				
- type of storage (roof, above ground, below ground, etc.)				
- sufficient levels and dimensions to verify storage volumes				
- calculations of actual volume achieved, see Attachment A				
- level, dimensions and location of overflow structure between storage and secondary DCP				
1(c) The WAE plans provide the following information on internal drainage (refer Section 4.3.3)				
- pit lid types and surface levels				
- invert levels and diameters of pipes				
- location, dimensions and levels of any floodways and/or overland flowpaths				
- sufficient spot levels to show site gradings and extent of areas draining and not draining to the storage(s)				
1(d) The WAE plan provides finished floor levels of dwellings and garages (refer Section 4.3.3)				
1(e) The WAE plans provide the following information on rainwater tank(s) if an airspace "credit" has been claimed against storage volume requirements				
- the rainwater tank is shown on the site layout plan				
- is part of the rainwater tank is claimed as dedicated airspace				
- if yes, the diameter and centre line of orifice shown on the WAE plan				
- all overflows are directed to the OSD storage(s)				
The following drainage-related structural elements have been constructed in accordance with the design (refer Section 4.3.5)				
2(a) Free standing walls (see certificate of structural compliance)				
2(b) Retaining walls (see certificate of structural compliance)				
2(c) Underground storages (see certificate of structural compliance)				

Final site inspection details:
By……Date:……

ITEM	DESIGNER		COUNCIL REVIEW	
	YES	NO	YES	NO
3(a) The primary outlet and secondary discharge control pit comply with the following requirements (refer Section 4.3.4). See also Attachment B				
- Outlet / DCP dimensions and levels comply with design parameters				
- material, thickness, diameter and sharp edge of fitted orifice plate				
- the orifice plate is securely fitted				
- the orifice is screened and the screen is properly fixed, located and able to be easily removed				
- outlet pipe is the correct diameter, level and grade (to ensure there is free discharge through the orifice)				
- the levels of the top water surface, storage invert and outlet / DCP are such that the design discharge from the storage is achieved				
3(b) Each storage complies with the following requirements (refer Section 4.3.4), see also Attachment B				
- the actual volume achieved is adequate				
- the actual top water level will not result in either unintended surcharge of the internal drainage system and/or inundation or inadequate freeboard to finished floor levels				
- the base of the storage is well graded and drains to the primary outlet				
- Spillways and overflow paths are constructed to the correct levels and are free from obstructions				
3(c) The internal drainage complies with the following requirements (refer Section 4.3.4)				
- site gradings are in accordance with the design expectation (regarding areas to be commanded by each storage)				
- the internal drainage lines are of a sufficient size, level and grade to convey the flows to the storage				
- the extended detention and flood detention storages cannot be by-passed by overflows from the internal system or by overflows from any surface area designed to drain to the storages				
- floodways and/or overland flowpaths designed to divert flows around the basin have been properly constructed and will function as designed				
- general workmanship is adequate to prevent long-term failure of the system				
3(d) The finished levels of structures (e.g. dwellings, garages) are sufficiently above the as-constructed maximum water surface levels in the storage and flowpaths (refer Section 4.3.4)				
3(e) An emergency spillway or overflow path has been provided so that surcharge will not cause stormwater to enter buildings where significant damage would occur				
3(f) All drainage pits, pipes, storages are in a clean condition and free of building materials,				

ATTACHMENT B: OSD WAE DIMENSIONS, ETC.

DESCRIPTION	APPROVED	WAE	CERTIFIER'S COMMENTS
OUTLET (PRIMARY):			
(a) Orifice diameter (mm)			
(b) Orifice plate material			
(c) Orifice Centre-line RL (m)			
(d) Access grate dimensions			
OUTLET (SECONDARY):			
(a) Orifice diameter (mm)			
(b) Orifice plate material			
(c) Orifice Centre-line RL (m)			
(d) Pit width (m)			
(e) Pit breadth (m)			
(f) Pit crest Reduced Level (m)			
(g) Access grate dimensions			
OVERFLOW WEIR:			
(a) Weir Crest RL (m)			
(b) Width			
(c) Height (mm)			
(d) DCP invert level (m)			
STORAGE:			
(a) Top water level			
(b) Storage volume (m^3)			
(c) Freeboard to F.F.L. (mm)			
(i) Habitable area			
(ii) Garage			
(d) Maximum depth of water (mm)			

CERTIFIER'S NAME: ……

SIGNATURE: ……

DATE: ……

L. Certificate of Hydraulic Compliance

UPPER PARRAMATTA RIVER CATCHMENT TRUST

ON-SITE STORMWATER DETENTION SYSTEM

BAULKHAM HILLS/BLACKTOWN CITY/HOLROYD CITY/PARRAMATTA CITY COUNCIL

(delete not applicable)

JOB NO: _____ **DA NO**: _____ **BA NO**: _____

PROJECT: _____

LOCATION: _____

DESIGNED BY: _____ **CONSTRUCTION CERTIFIED BY**:_____

QUALIFICATIONS: _____ **TELEPHONE**: _____

1.0 WORKS CONSTRUCTED IN ACCORDANCE WITH DESIGN. (Delete if not applicable)

I _____ of _____ (accredited professional being competent to practice in the field of stormwater drainage design) have inspected the above on-site stormwater detention system and certify that the works have been constructed and can be maintained in accordance with the approved design details for the above mentioned project.

Signature: _____ **Date**: _____

2.0 CONSTRUCTION VARIATIONS NOT AFFECTING DESIGN PERFORMANCE. (Delete if not applicable)

I _____ of _____ (accredited professional being competent to practice in the field of stormwater drainage design) have inspected the above on-site stormwater detention system and certify that the works have been constructed and can be maintained in accordance with the approved design details for the above mentioned project, except for the variations listed below which do not affect the performance of the system, subject to satisfactory maintenance.

Variations:

_____

_____

_____

Signature: _____ **Date**: _____

3.0 AUTHORITY TO RELEASE PLANS TO FUTURE OWNERS OF THE PROPERTY

As the copyright owner of the drainage plans, I hereby authorise release of the approved plans/attached sketch plan to future owners of the property to assist in the maintenance of the On-site Stormwater Detention system.

Signature: _____ **Date**: _____

Name: _____(Print)

M. List of Outstanding Works

UPPER PARRAMATTA RIVER CATCHMENT TRUST

ON-SITE STORMWATER DETENTION SYSTEM

BAULKHAM HILLS/BLACKTOWN CITY/HOLROYD CITY/PARRAMATTA CITY COUNCIL
(delete not applicable)

JOB NO: _____ **DA NO**: _____ **BA NO**: _____

PROJECT:
_____

LOCATION:
_____

DESIGNED BY: _____ **CONSTRUCTION CERTIFIED BY**: _____

QUALIFICATIONS: _____ **TELEPHONE**: _____

1.0 CONSTRUCTION VARIATIONS AFFECTING DESIGN PERFORMANCE.

I _____ of _____ (accredited professional being competent to practice in the field of stormwater drainage design) have inspected the above on-site stormwater detention system and the following variations to the approved design. The listed remedial works will be necessary to make the system function and/or be maintained according to the approved design.

Variation	Remedial Work Necessary

Signature: _____**Date**: _____

N. Signs

OSD Warning Sign

Signs are only required for OSD systems where deemed necessary by Council because of the depth and/or location of the storage.

The size of the sign will depend on the individual situation. The following guidelines are suggested:

- 600 mm x 450 mm Open areas or large developments.
- 400 mm x 300 mm Restricted areas.

Confined Space Sign

Signs are required at each entry into confined spaces, such as deep pits or underground storages. Signs may be made of metal or a durable synthetic material.

The size of the sign will depend on the individual situation, but the following sizes are suggested as a guide:

- 300 mm x 450 mm Large entries (such as doors)
- 187.5 mm x 250mm Small entries (such as manholes)

OSD Sign

These signs should be located in or near the OSD facility to alert future owners of their obligations to maintain the facility.

Figure N.1 OSD Warning Sign

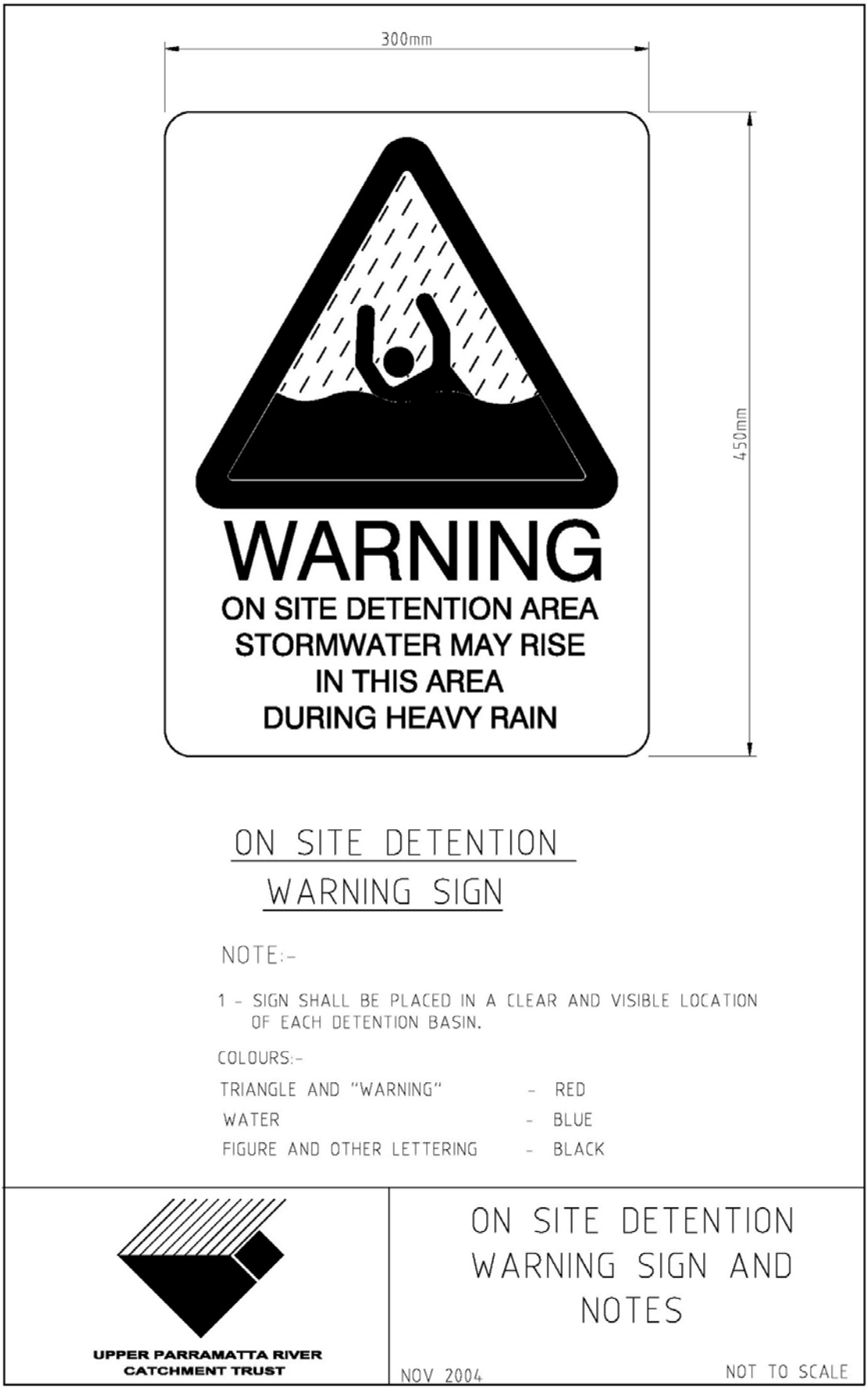
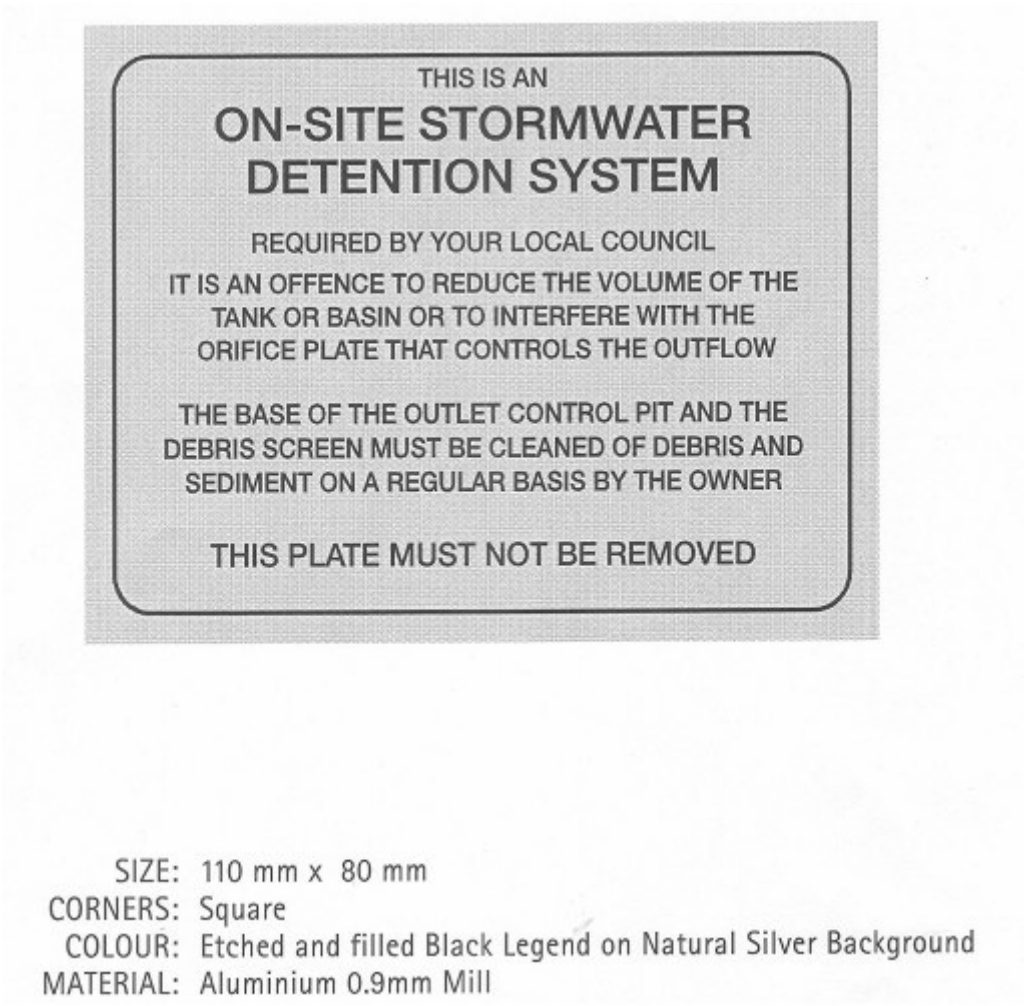


Figure N.2 Confined Space Warning Sign

Figure N.3 OSD Sign



O. Structural walls for surface storage

Typical structural details for storages

Free standing

Figure O.1 Brick Wall - 500 mm

Figure O.2 Brick Wall - 588 – 1000 mm

Figure O.3 Block Wall 1100 mm

Earth retaining

Figure O.4 Brick Wall

Figure O.5 Block Wall

Structural Walls for Surface Storage Systems

A set of typical structural details have been included to demonstrate the need to consider loadings from both soil and water pressures in the design of an OSD system. These designs have been prepared on the basis of a site with homogenous soil condition, and the following characteristics:

- a clay soil with a density of 19kN\m^3 and friction angle of 20 degrees
- saturated soil conditions behind the retaining walls
- footings are generally designed to be adjacent to property boundaries
- free standing walls are designed for water pressure loadings and
- retaining walls have been designed for both soil and water pressure loadings.

The designer will need to take these factors into account when determining whether these details are applicable to their particular site.

Figure O.1 Brick wall up to 500mm high

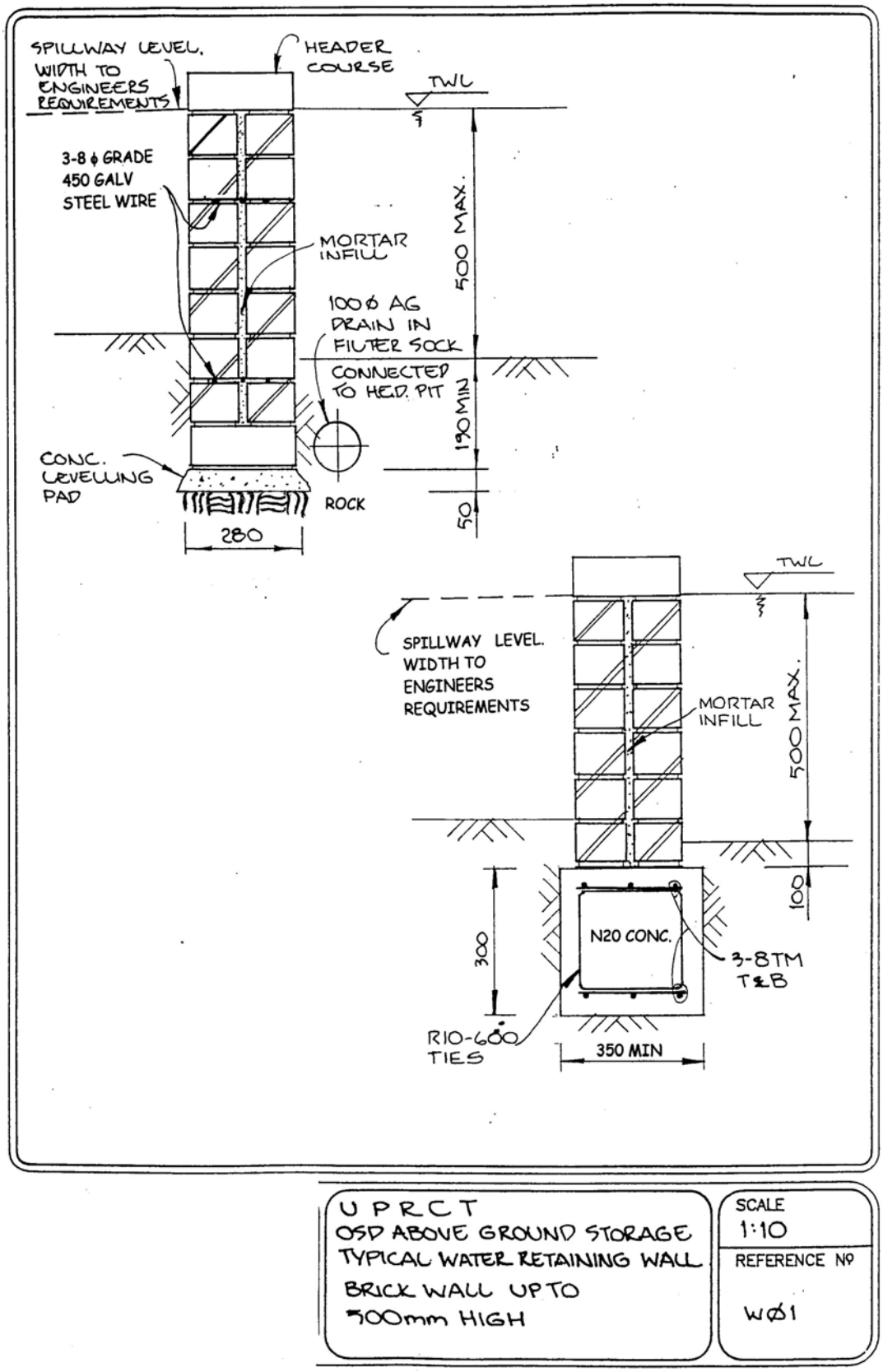


Figure O.2 Brickwall 588 – 1000mm high

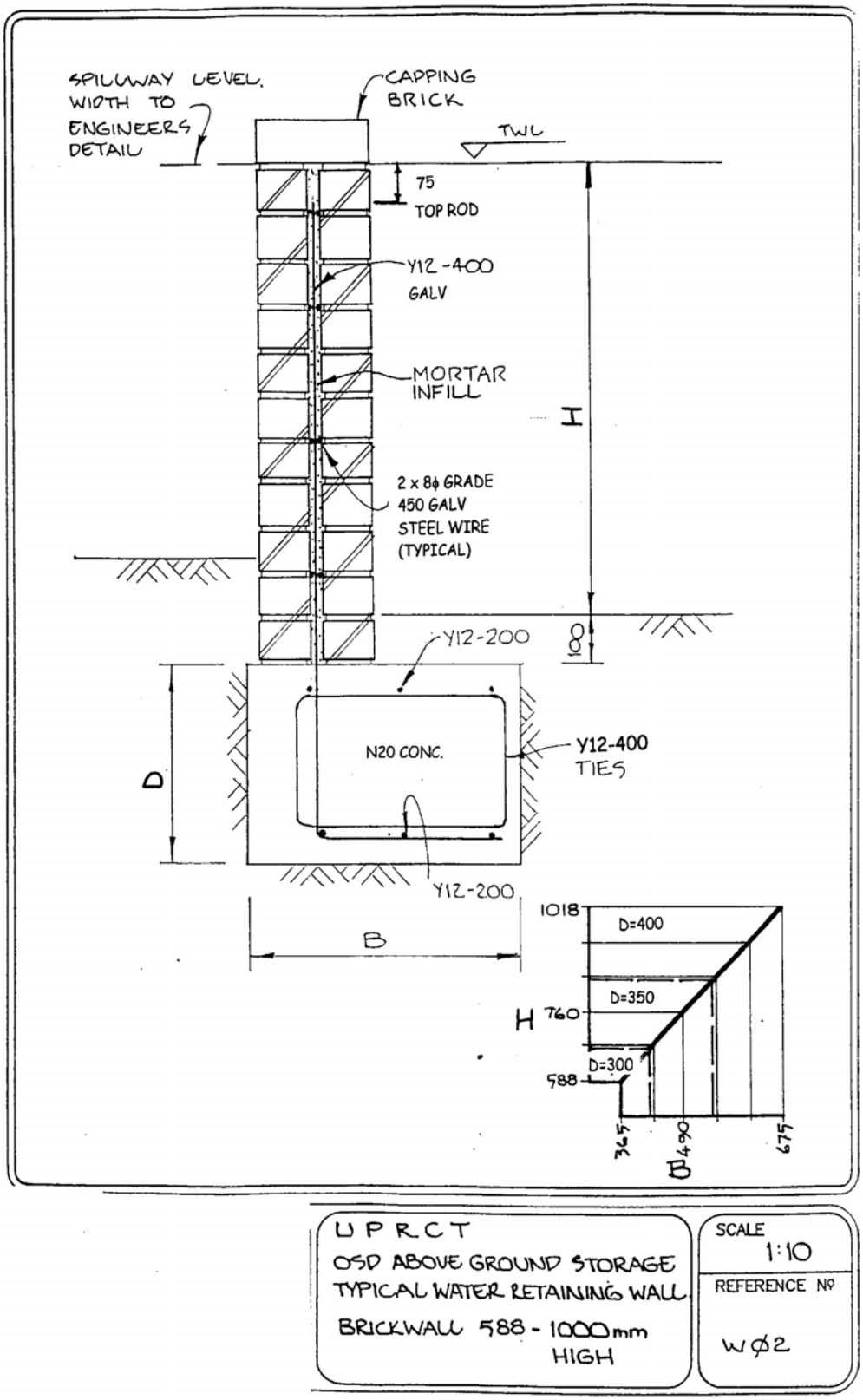


Figure O.3 Block wall up to 1100mm high

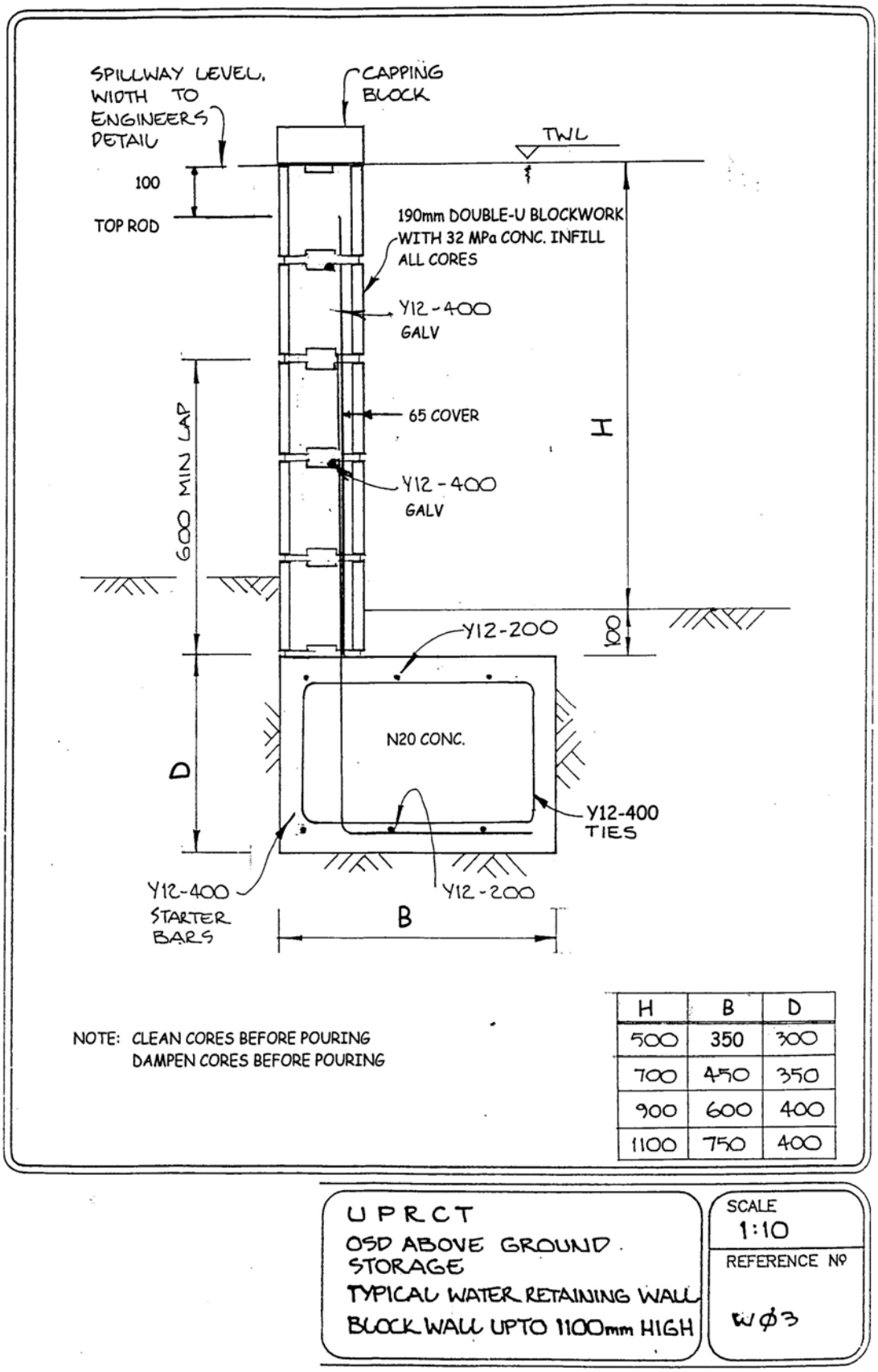


Figure O.4 Brick retaining wall up to 1000 high

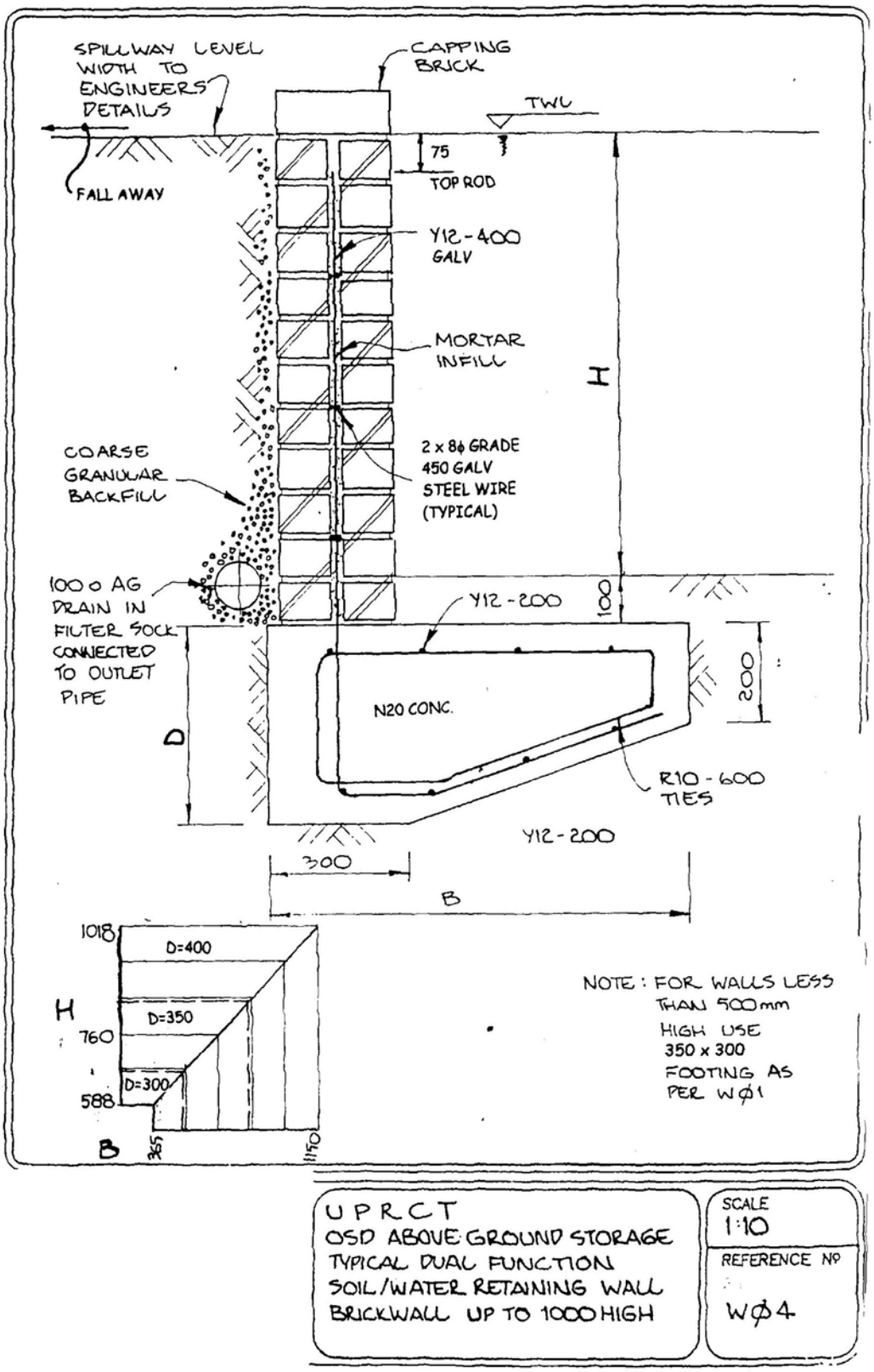
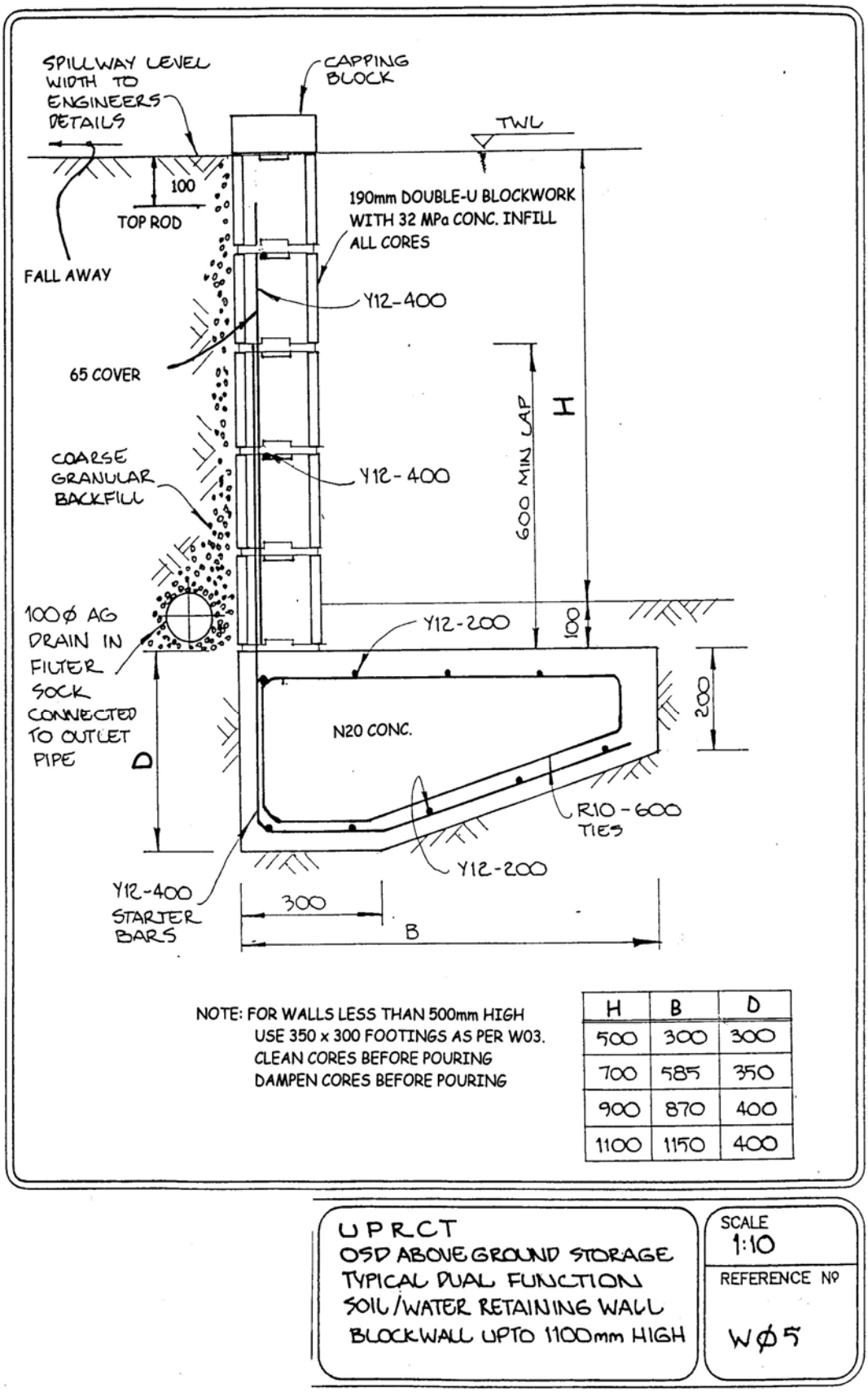


Figure O.5 Block retaining wall up to 1100mm high



H	B	D
500	300	300
700	585	350
900	870	400
1100	1150	400

P. Lists of Manufacturers of Proprietary and Other OSD Products and Maintenance Contractors

Manufacturer	Address	Products
ACO-Polycrete Australia	185 Briens Road NORTHMEAD 2152 Tel: (02) 9630 2788	Pre-cast discharge pits.
Barrys Signs	180 Targo Rd GIRRAWEEN NSW 2145 Tel: (02) 9631 1351	Warning signs
BCP Precast Pty Ltd	Pacific Highway CHARMHAVEN 2263 Tel: (0243) 923 300	Reinforced concrete storage and precast discharge control pits.
De Neefe Signs Pty Ltd	13 James Ruse Drive GRANVILLE NSW 2142 Tel: (02) 9637 0218	Warning signs
Everhard Industries	3 Jumal Place SMITHFIELD 2164 Tel: (02) 9604 5955	Screens, flap valves, orifice plates, concrete and plastic discharge control pits, concrete storages.
Hu-Tech Metal Products	37 Anzac Street GREENACRE 2190 Tel: (02) 9790 0100	Screens, flap valves, orifice plates and tailwater discharge compensators, confined space sign and OSD sign.
Ingal Civil Products	127-141 Bath Road SUTHERLAND 2232 TEL: (02) 9521 2711	Buffa-tank storage systems.
Mascot Engineering Group	45-51 Clapham Road REGENTS PARK 2143 Tel: (02) 9644 1044	Discharge control pits, light weight lids, screens, orifice plates.
Signs Of Safety	74 Fitzwilliam Road TOONGABBIE 2146 Tel: (02) 9636 8813	Warning signs.
Wilmac Pty Ltd	40 Burrabogee Road PENDLE HILL 2145 Tel: (02) 9631 0957	Screens, flap valves, precast pits, orifice plates, confined space sign and OSD sign.
RMS Roadsigns	2 Cawarra Road TAREN POINT NSW 2229 Tel: (02) 9540 4400	Warning Signs
Safetyman Signs Pty Ltd	17 Commercial Road KINGSGROVE NSW 2208 Tel: (02) 9502 2300	Warning Signs

OSD Maintenance Contractors

The Trust sought updated expressions of interest in April 2004 from companies or individuals able to maintain OSD facilities. The following companies responded and have provided details of their maintenance capability. The list is provided to assist owners to maintain OSD facilities on their properties. No attempt has been made to check the credentials of the listed firms, nor are any specifically recommended by the Trust.

The selection of a suitable maintenance contractor and agreement on the works to be undertaken are matters for individual owners. The Trust will not be liable for any losses incurred by either the owner or the contractor.

COMPANY	CONTACT DETAILS	STATED MAINTENANCE CAPABILITY
Australian Wastewater Management Strategies Pty Ltd Suite 1/191 Blues Point Road, NORTH SYDNEY NSW 2060	Mr Armen Mesrobian (02) 9460 2020 (ph) (02) 9460 2121 (fax) AWMS1@bigpond.com (em)	-General repair and maintenance -Envirocell Sewage treatment systems
Beachs Fencing 82 Ulundri Drive CASTLE HILL NSW 2154	Mr Robert Beach (02) 9680 3247 (ph) 0408 470 783 (mob)	-General maintenance
Collex Industrial Services PO Box 4574 MILPERRA DC NSW 1891	Ms Carol Smith (02) 9709 3011 (ph) (02) 9709 3411 (fax)	-Stormwater, Gross Pollution Traps and Sewer maintenance services -Confined space trained staff
D-CO Plumbing and Drainage P/L PO Box 3350 ROUSE HILL NSW 2155	Mr Keenan Di Francesco (02) 9836 5654 (ph) 0419 126 166 (mob) (02) 9636 3120 (fax)	-Plumbing and Draining -General cleaning and maintenance
BR Durham& Son Pty Ltd Lot 103, Curtis Road MULGRAVE NSW 2756	Mr Denis Durham, Mr Charles Durham (02) 4587 7011 (ph) (02) 4587 7069 0418 861 977 (Denis) 0418 202 094 (Charles) sales@durham.com.au	-Suppliers of civil drainage products -Maintenance of drainage systems including Full Vacuum Pump cleanout (for road use)
Ecosol Wastewater Filtration Systems Unit 29/56 O'Riordan Street ALEXANDRIA NSW 2015	Mr Andrew Middleton (02) 9669 6000 (ph) (02) 9669 6100 (fax) 0427 013 355 (mob) info@ecosol.com.au (em)	-Design, supply, installation, cleaning and maintenance of solid pollutant filters.

COMPANY	CONTACT DETAILS	STATED MAINTENANCE CAPABILITY
Envirocivil (NSW) P/L PO Box 158 LANE COVE NSW 1595	Mr Peter Day (02) 9418 9601 (ph) (02) 9418 3498 (fax) 0412 232 859 (mob) peterday@netspace.net.au (em)	-General cleaning and maintenance
James Plumbing Services 7/143 Coreen Avenue PENRITH NSW 2750	Mr Steve James, (02) 4722 9698 (ph) (02) 4722 8481 (fax)	-Plumbing and drainage installation, repair and maintenance
Storm Water Systems PO Box 96 PYRMONT NSW 2009	Mr Anto Pratten (02) 9555 8744 (ph) (02) 9555 8766 (fax) 0419 419 478 (mob) antopratten@stormwater.com.au (eml)	-Supply and install floating booms, end of line traps and pit inserts -Vacuum eductor truck -Cleaning and maintenance of pits and pollution devices
Sydney Wide Pipe Cleaning Pty Ltd PO Box 506 BLACKTOWN NSW 2148	Mr Jeff Field (02) 9627 7133 (ph) (02) 9627 7144 (fax) 0417 924 993 (mob) sydwide@bigpond.com.au (em)	-OSD cleaning & maintenance -High velocity water jetting -CCTV pipeline inspections -Rootcutting -Grease trap cleansing -Liquid waste transport
Transpacific Industrial Solutions Pty Ltd PO Box 20 CARRINGTON NSW 2294	Mr Ian Wellsmore (02) 4967 6600 (ph) (02) 4967 3337 (fax)	-maintenance, cleaning and service of stormwater and waste water infrastructure -facilities maintenance -drain cleaning -CCTV inspections

Q. OSD Parameters outside the Upper Parramatta River Catchment

Baulkham Hills Shire Council (BHSC), Holroyd City Council (HCC) and Parramatta City Council (PCC) have adopted the principles of the Trust policy for other catchments in their local government areas. The parameters previously used for the other catchments are given in the table below. A procedure for estimating interim OSD parameters for catchments outside the upper Parramatta River catchment in accordance with the latest approach is given in Appendix R.

The OSD policy applies to the Hawkesbury River catchment within the Baulkham Hills Shire except in the:

- Rouse Hill Development Area (including Norwest Business Park) defined as the gazetted River Management Area; and
- Bingara Drainage Catchment and Barina Downs North Precinct as defined in Section 94 Contribution Plan No 3 – Crestwood.

For buildings in Rural/Non-urban areas in the Baulkham Hills Shire, contact Council's Subdivision Section to obtain the OSD requirements.

Blacktown City Council (BCC) requires OSD in identified drainage problem areas outside the upper Parramatta River catchment. Contact Council's Drainage Engineers for further information

Local Government Area	Catchment	Site Slope *BHSC only	PSD (l/s/ha)	SSR (m^3/ha)
BHSC	Hawkesbury River	>15%	136	298
BHSC	Hawkesbury River	10% to 15%	115	336
BHSC	Hawkesbury River	6% to 10%	104	362
BHSC	Hawkesbury River	3% to 6%	92	396
BHSC	Hawkesbury River	0% to 3%	87	412
HCC	A'Becketts Creek		140	300
HCC	Duck Creek		140	300
HCC	Prospect Creek		140	300
PCC	A'Becketts and Duck River/Creek		80	470
PCC	Claycliff Creek		235	215
PCC	Devlins Creek		210	250
PCC	Parramatta River – North Side – Charles St to Vineyard Creek		208	235
PCC	Parramatta River – North Side – East of Vineyard Creek		280	190
PCC	Parramatta River –South Side –		80	470
PCC	Ponds/Subiaco Creek		130	330
PCC	Terrys Creek		210	250
PCC	Vineyard Creek		160	285

R. Procedure for Applying Methodology outside the Catchment

This **fourth edition** reflects the outcomes of detailed investigations undertaken in recent years. These studies have used the latest version of the XP-RAFTS software which explicitly models the rainfall runoff process on an individual lot and the adjoining strip of roadway, then combines countless individual single lot models to simulate flood behaviour at the neighbourhood, sub-catchment and catchment scales, based on the Trust's very detailed hydrologic XP-RAFTS model. This approach was used to determine the OSD parameters required to ensure no increase in flood peak flows under a plausible ultimate development scenario.

Clearly, local councils wishing to apply the catchment OSD policy to other areas would find it difficult to duplicate such an exercise. To assist Councils the effect of catchment scale was also investigated by determining the OSD parameters that would apply as the catchment area is progressively reduced. In all cases it was assumed that the primary SRD (SRD_L) and secondary SRD (SRD_U) remained constant at 40 L/s/ha and 150 L/s/ha respectively.

The resulting values for SSR_L and SSR_T are summarised as follows:

Catchment Area (ha)	SRD_L (L/s/ha)	SSR_L (m^3/ha)	SRD_U (L/s/ha)	SSR_T (m^3/ha)
100	40	190	150	334
200	40	230	150	378
400	40	260	150	413
600	40	274	150	428
800	40	283	150	437
1,000	40	288	150	443
1,200	40	292	150	447
1,500	40	295	150	451
2,000	40	299	150	454
> 2,000	40	300	150	455

In all cases it was assumed that all roof runoff is directed to the OSD storage.

It was found that for catchments greater than around 2,000 ha (20 km^2) that there would be a negligible reduction in the extended detention (SSR_L) and overall detention volume (SSR_T) values.

An example of this use of these results is as follows. What would be the OSD parameters for the Subiaco/Ponds Creek catchment that has an area of 840 ha to its confluence with the lower Parramatta River? Linear interpolation between the values for 800 ha and 1,000 ha catchments the OSD parameters for this catchment would give:

SRD_L = 40 L/s/ha SRD_U = 150 L/s/ha
SSR_L = 284 m^3/ha SSR_T = 438 m^3/ha

A list of PSD and SSR values previously adopted for other nearby catchments is given in Appendix Q. Contact your Council to determine appropriate OSD requirements for catchments outside the upper Parramatta River catchment.

S. On-site Stormwater Detention System Costs

In 1996, Bewsher Consulting Pty Ltd was commissioned jointly by the Upper Parramatta River Catchment Trust and the NSW Department of Housing to report on the costs associated with the design, approval, installation of OSD systems. The consultant's report was completed in January 1997 and provided indicative costs of OSD although no data was available for on-going maintenance costs.

Table 2 of their report provided the following costs associated with the design and approval of OSD systems.

ITEM	INDICATIVE COSTS ($)
Concept design	500-2,000
Detailed design	500-2,000
Council charges	200-400
Certification	350-550

For construction costs, the consultant had a qualified quantity surveyor estimate the additional costs of installing OSD systems from design plans that had been submitted to the four catchment councils for a range of development types. The study found a

> *"consistent trend whereby the fully or majority above ground storage systems are cheaper per cubic metre than the below-ground systems."*

For storage volumes between 20 $m^3$and 100 m^3, a saving of between $100 and $150 per m^3 of storage was identified. Figure S.1 is a copy of Figure 1 of the consultant's report that shows the unit costs of different types of storage.

The report made the following conclusions:

- *"the total costs associated with installation of OSD systems – being the combination of design, Council review, construction and certification costs are very substantial. (To this should be added the long term maintenance costs however at this point in time there is no data available regarding system maintenance.);*

- *for smaller site developments there are definite cost advantages in providing the OSD storage by using above ground systems. Given that advantage it is obviously important that site layouts should make adequate provision for such systems at an early stage of site planning;*

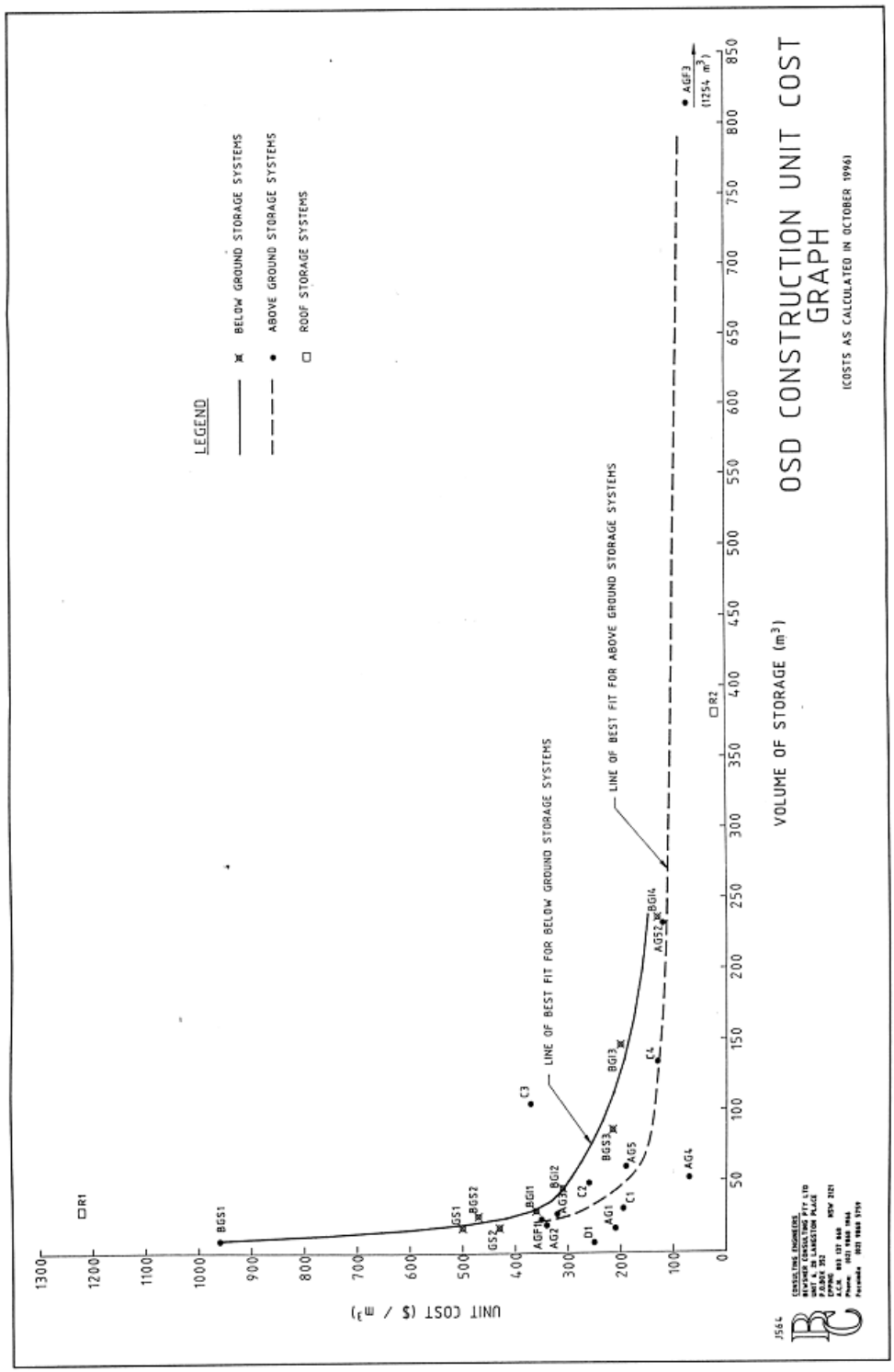
- *for larger site developments there would still appear to be advantages in making allowance within the site for an above ground system. However based on the limited number (6) of large scale (ie. greater than 100m^3) storage systems analysed during this survey the cost advantages for above ground systems compared with below ground (in-situ) tanks are not as clear cut as for smaller sites;*

- *based on an assessment of other costs – such as design, approval and certification – the costs associated with constructing the storages are easily the greatest single cost associated with OSD systems. It therefore follows that it would be prudent to spend additional effort (and cost) at the investigation and design stages so that the overall cost of providing an OSD system is minimised;*

- *given the relatively small sample of sites that were sampled in this survey it is recommended that additional sites be costed so that the initial trends identified in this report can be confirmed. The additional sites should ideally include the following:*

  a) those that have storage volumes larger than 100 m^3; and
  b) those that include innovative solutions for difficult sites (including those that utilise roof top systems to achieve storage)."

Figure S.1 OSD Construction Unit Cost Graph



T. On-site Stormwater Detention Excellence Award Winners

The Trust sponsored the national Stormwater Industry Association (SIA) OSD Excellence Awards in 1999-2001. That sponsorship was refocussed on the SIA's Educational Excellence Award from 2002, and the Award for OSD Excellence for design or construction was incorporated into the Regional Environment Awards sponsored by the Trust and the four catchment Councils. Projects for the Regional Environment Awards must be located within one of the Cities of Blacktown, Holroyd or Parramatta or the Shire of Baulkham Hills.

Year	Winner	Highly Commended
1999	Haddad Khaicy Partners 80 Weston Street, Harris Park NSW Tel: 9687 9222	
2000	D S Agencies Pty Ltd PO Box 7027 Cloisters Square WA 6850 Tel: (08) 9322 3090	Haddad Khaicy Partners 80 Weston Street, Harris Park NSW Tel: 9687 9222 Rammy Associates PO Box 280, Pendle Hill NSW 2145 Tel: 9896 6116
2001	Tweed Shire Council Tumbulgum Road Murwillumbah NSW 2484 Tel: (02) 6670 2400	
2002	*Messrs Steve Arraj and Giorgio Bucci* Dincel & Associates Level 3, 7K Parkes Street, Parramatta NSW 2150	
2003		*Mr Steve Arraj* Haddad Khaicy Mance Arraj Partners 1/142 James Ruse Drive Rosehill NSW 2150
2004	*Messers Steve Arraj and Giorgio Bucci* Haddad Khalil Mance Arraj Partners 1/142 James Ruse Drive Rosehill NSW 2150	

U. Index

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