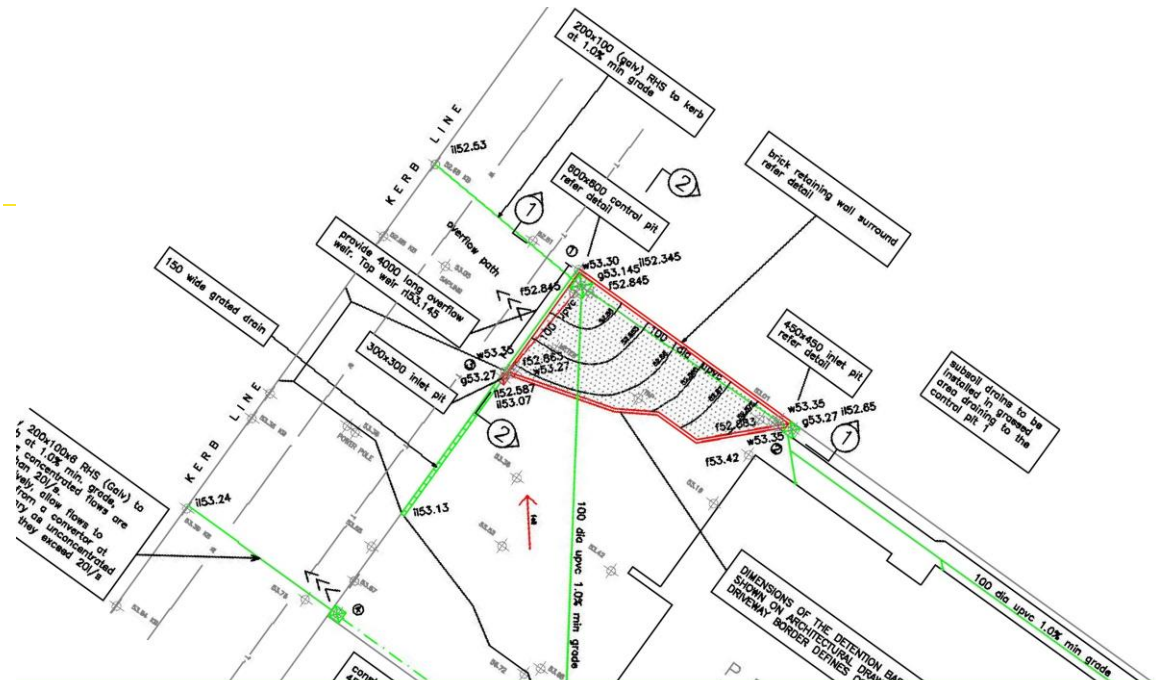
WARRINGAH COUNCIL

On-site Stormwater Detention Technical Specification



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1 General

This Specification supports and compliments the requirements of the Warringah Development Control Plan and Water Management Policy.

Variations to the requirements of this Specification will only be considered on merit following submission of documentation to allow adequate assessment.

Sites which cannot drain directly to a public stormwater drainage system shall require disposal of collected stormwater in such a manner which will not adversely affect downstream land (Refer to Section 2.4 for further details).

If the site is part of a new subdivision and drains into a community detention basin which was constructed as part of that subdivision, On-site Stormwater Detention (OSD) may still be required for developments on the individual allotments, where the design parameters of the community system do not fully compensate for the development. Council staff should be consulted in these cases.

This Specification is intended to apply to Development Applications (DA's) and Construction Certificates (CC's) as from the 1st July 1998, under the provisions of the *Environmental Planning and Assessment Amendment* Act (EP&AA Act 1997).

For stormwater drainage and engineering related matters other than for OSD design, reference is to be made to Council's AUSPEC1 Construction Specification Document and Development Engineering Minor Works Specification.

2 Planning and Design

2.1 Applications

Generally OSD is required for all developments in Warringah where the total existing and proposed impervious areas exceed 40% of the total site area.

The above criterion does not apply to residential flat buildings (RFB's), commercial and industrial developments and subdivisions resulting in the creation of three (3) lots or more, as these will require OSD in all cases.

Where subdivisions result in the creation of two (2) lots, OSD will be required where the total post developed impervious area of the new lots exceed 40% of the total site area. This requirement also applies to newly created lots with existing dwellings to be retained.

All development applications for single residential dwellings where the total site area is 450m^2 or less will not require OSD.

All development applications for alterations and additions for single residential dwellings will not require OSD.

To assist Council in determining whether OSD will be required, an *OSD Checklist,* which can be obtained from the Planning and Assessment Services Counter, is to be filled out and submitted with the Development Application (DA). A copy of this form is attached in APPENDIX 8 of this Specification or Council's internet site http://www.warringah.nsw.gov.au/sites/default/files/documents/pdf-forms/onsite-stormwater-detention-checklist/4osdchecklist000.pdf

Refer to Section 4 for design guidelines.

2.2 Pre-Lodgement Meeting

Council offers a pre-lodgement meeting service which is strongly encouraged for large-scale, complex or controversial development applications, however is available for all development types. A fee is payable for this service with further details provided on the website link below.

Following the meeting, you will receive written advice that lists the information required for the application to be processed. It also indicates whether or not the application is likely to be accepted.

Further information can be found at http://www.warringah.nsw.gov.au/planning-and-development/application-process/submit-your-application

2.3 Rainwater Re-use for Single Residential Development

Council may permit the volume of rainwater reuse to be credited against the calculated OSD storage volume as determined by this Specification for single residential dwellings only.

Please note the rainwater reuse system shall be designed in accordance with the AS/NZS 3500 Plumbing and Drainage Part 3 Stormwater.
The maximum storage volume as determined by the BASIX tool will be credited against the calculated OSD volume. Additional storage beyond the determined BASIX volume will not be credited.

The following calculation may be used to determine the revised OSD volume:

****REVISED OSD VOLUME = Determined OSD volume (Council Specification) – BASIX certificate storage volume.**

**** Revised OSD Volume to a be a minimum of 50% of determined OSD volume (Council OSD Specification)**

To achieve a full credit against the determined OSD volume rainwater reuse must be used for flushing of toilets as a minimum, however rainwater can be used for non-potable usage such as watering of gardens, washing cars, clothes washing etc. Combining OSD and rainwater reuse water in one tank is permitted.

The design must ensure at least 50% of the site is routed through the OSD system.

The calculated Permissible Site Discharge (PSD) is not to be adjusted as determined by Council's On-site Stormwater Detention (OSD) Technical Specification.

2.4 Gravity Drainage and Easements

Stormwater drainage for all properties must be by gravity means. Mechanical methods of stormwater disposal (e.g. pump-out systems), other than for draining sub-surface flows from under-ground areas, such as in a basement carpark in a commercial or residential flat building, will not be permitted. Charged drainage systems (part of the system is below the outlet level and permanently hold water) are not acceptable. All stormwater drainage lines must be free draining.

Diverting flows from one catchment (or sub-catchment) to another catchment (or sub-catchment) will not be permitted. Properties must be drained in their natural direction. Where necessary, drainage easements must be obtained through downstream properties for piping flows to the downstream drainage system at the applicant's

expense. The site's existing discharge point into the public drainage system cannot be altered.

Inability to provide a gravity stormwater drainage system and drainage easement(s) may result in Development Consent not being granted.

Note: Where a stormwater drainage easement(s) is required, evidence in the form of a legal agreement, in regards to obtaining the easement(s), is to be provided to Council with the submission of the Development Application (DA).

The acquisition of a drainage easement(s) must be completed prior to the issue of the Development Consent. Council staff should be consulted for guidelines regarding minimum easement widths and other requirements pertaining to the development.

In exceptional circumstances, where it can be adequately demonstrated that it is not possible to drain to a downstream drainage system due to physical constraints and that there are no existing or reported downstream drainage problems, Council may give some consideration for alternative methods of stormwater disposal. In such cases, the Applicant must submit detailed hydrologic and hydraulic calculations to prove that the alternative method of disposal will not adversely affect downstream land or reduce the capacity of the receiving drainage system or cause nuisance drainage problems.

A geotechnical report must also be submitted where an absorption system is to be used and providing the absorption rate of the soil in litres per square meter per second ($l/m^2/s$). The approval of such a system will be dependent on the soil's ability to absorb water and the availability of land for effective absorption. In some cases, a combination of detention and absorption may be required to satisfy Council's drainage requirements. Refer to Council's Water Management Policy and Stormwater Drainage from Low Level Properties Technical Specification for on-site absorption design guidelines.

Although undesirable, Council may grant approval for a property to be gravity drained to a location outside its natural catchment or natural drainage path. This would be subject to the Applicant demonstrating to Council, beyond any reasonable doubt, that such discharge would, in no way, adversely affect any land, drainage system or receiving watercourse.

Information for determining catchment boundaries and for drainage analysis can be obtained from Council. Copies of scaled 1:2000 maps showing the existing public stormwater drainage system, is available on request.

2.5 Stormwater Drainage Plan (SDP)

A DA must include an SDP demonstrating the feasibility and functionality of the proposed drainage system(s) within the site, and the connection to the public drainage system. Full details must be provided in accordance with Section 3 of this Specification. Details shown on the SDP must be compatible with Council's planning controls (e.g. landscaping requirements and height restrictions). Early coordination between Engineers and Architects is recommended so as to reduce possible conflicts in the final plans.

The SDP is to show:

- the complete stormwater drainage layout for the site including the location and the type of OSD storage to be provided,
- all piped and surface flow paths within the site and through downstream properties, including easements where required,

- all information or computations necessary to support the Application and assist in Council's assessment, and
- that it is compatible with the landscaping drawing(s).

2.6 Visual Impact

All drainage structures are to be designed to be visually unobtrusive and sympathetic with the proposed development and the surrounding environment. This requirement is necessary to integrate drainage structures into the development thereby minimising the likelihood of future occupants removing these facilities for aesthetic or other reasons.

2.7 Flood Prone Land

OSD will not be required where the site of the development is located within a Council established 1 in 100 year ARI flood plain, and that it can be demonstrated that lesser storm events will also flood the site. Otherwise it will be necessary to provide OSD to control the runoff for the minor storm events.

2.8 Hydraulic Grade Line Analysis

If the rate of discharge from the outlet of the OSD system is affected by tailwater conditions from the receiving drainage system, for example, where the invert level of the orifice is lower than the surface level at the point of connection into the existing drainage system, then full hydraulic calculations, will be required. These hydraulic calculations shall include the determination of water surface profiles using hydraulic grade line analysis and/or backwater calculations. The preferred hydrologic model to be used in the analysis, to obtain flowrates, is the ILSAX or DRAINS program. Hydraulic analysis can be performed using hand calculations. However for more complex analysis in the determination of water surface profiles in creeks or rivers, the use of the Hec-Ras computer program is preferred.

Full hydraulic calculations will be required for all public and major piped systems, or where Council believes that it is necessary to determine the feasibility of the proposal. Full hydraulic calculations shall be required in conjunction with a detailed engineering longsection.

Calculations must be in accordance with current design practices and principles outlined in Australian Rainfall and Runoff (1987 or later editions) and Guidelines, and must be prepared by a suitably qualified and experienced civil engineer.

2.9 Legal Requirements

All OSD systems shall require the creation of a Positive Covenant and Restriction on the Use of Land in favour of Warringah Council on the Title, under Section 88E of the *Conveyancing Act 1919* for newly created lots. For existing Titles, a Positive Covenant is to be created by an application to the NSW Department of Lands using Form 13PC. The Restriction on the Use of Land is to be created using Form 13RPA.

The purpose of the Covenant is to ensure that the registered proprietor takes care, control and maintenance obligations for the OSD system. The Restriction on the Use of Land is to ensure that the system is not altered in any manner, shape or form.

The terms of the instrument must be approved by Council. However, standard terms to be included in the Positive Covenant and the Restriction on the Use of Land are given in APPENDIX 3.

All drainage easements are to be acquired prior to the issue of the Development Consent and Positive Covenants and Restriction on the Use of Land are to be finalised prior to the issue of the Occupation Certificate.

3 Information to be Lodged with the Development Application

3.1 Minimum Information required for all Single Residential Dwellings

- An estimate of the volume of OSD Site Storage Required (SSR) in accordance with the Table 1 in Section 4.2.1 - Streamlined Method.
- An estimate of the Permissible Site Discharge of OSD required in accordance with the Table 1 in Section 4.2.1 - Streamlined Method.
- Details of Council's drainage infrastructure burdening the site together with any calculations of the maximum 1 in 100 year ARI flow rate for flowpaths and floodways where applicable; (please refer to Council's Water Management Policy and *Building over or adjacent to constructed Council Systems and Easements* technical specification)
- Details of the OSD facility which must be located clear of any 1 in 100 year ARI flow path where applicable;
- Copies of certificates of title showing the creation of easements to drain water, where applicable
- Details of all paved and roof surface areas which must be collected and discharged into the OSD system
- A Stormwater Concept Plan including the following:
    1. the development/site boundaries and area
    2. contours and spot levels (which reflect the site gradings and extending into adjoining properties)
    3. the extent and area of any upstream catchment for external flows entering the site
    4. the location and extent of detention storages
    5. the location and levels of discharge points for the storages
    6. the layout of the site, including location of all buildings, roadways and landscaped areas
    7. the location and approximate extent of any floodways or flowpaths through the site
    8. the location and area of any portion of landscaped area of the site unable to drain to the detention storages.
    9. Location and levels/invert levels of all surface drainage pits.
    10. Location of stormwater drainage lines detailing sizes and grades.

3.2 Minimum additional information required when lodging a Construction Certificate for single residential dwellings

1. Structural Details of the OSD tank or any proposed retaining wall for above ground systems as designed by a suitably qualified engineer.
2. All other details are to be in accordance with the sample drawings in appendix 9 of this specification.

3.3 Minimum Information required for all Developments Except Single Residential Dwelling Developments

At the lodgement of the DA, an SDP showing the general layout of the proposed stormwater drainage system including the location(s) and dimensions of the OSD system(s) must be submitted. The minimum information to be lodged with the DA is to include the following:

- engineering drawings showing all of the existing and proposed stormwater drainage system, including pipe diameters, existing or proposed pits, open drains and points of discharge(s), detention basin(s) (where applicable), control pit(s) and surface flow path(s)
- where a connection is to be made through an easement, a longitudinal section of the pipe through the easement and details at the connection, are to be provided
- dimensions and areas of the site including all existing and proposed roof and paved areas are to be included on the stormwater drainage plan(s)
- copies of certificates of title showing the creation of easements to drain water, where applicable
- dimensions (mm) and volume(s) (m^3) of the proposed OSD system(s) or retention system(s) (where applicable)
- size (mm) and shape of the orifice and outlet device at the control pit
- finished floor levels of all existing and proposed structures, and existing surface levels, to Australian Height Datum (AHD), are to be shown on the drainage plan(s)
- plans, elevations and sections of the OSD system(s) in relation to all existing and proposed buildings and site conditions, finished surface levels and invert levels of all stormwater drainage pipes and structures, centre line level of the outlet pipe and orifice, the maximum design water level in the OSD system, and flood levels (where applicable) of the receiving water
- longitudinal section of all pipe(s) from the OSD basin to the discharge point showing calculated flows, velocities, pipe sizes, type and class, grades, and invert levels of all pipes, all utility services crossings and a hydraulic grade line (where required)

  <u>Note</u>: It is the responsibility of the Applicant to provide full details of all relevant services that may conflict with the proposed OSD system(s) and stormwater lines. The exact locations of any crossings or connections are to be shown.

- the depth of ponding for the 3month, 1yr, 5yr, 20yr and 100yr ARI storm events, for all above ground storage systems, are to be shown on the drawing(s)
- details of surcharge facilities and overland flow paths are to be shown on the drawing(s)
- details of Council's drainage infrastructure burdening the site together with any calculations of the maximum 1 in 100 year ARI flow rate for flowpaths and floodways where applicable;
- details of the OSD facility which must be located clear of any 1 in 100 year ARI flow path where applicable;
- details of access and maintenance facilities
- structural details of all tanks and pits, and manufacturers' specifications for proprietary items, and for above ground OSD systems, the type of surface finish to be used, are to be referenced or shown on the drawing(s)
- all supporting hydrologic and hydraulic computations are to be submitted
- calculations of the times of concentration (T_c minutes) of the existing and developed site are to be submitted
- calculations showing how the 5, 20 and 100 year ARI runoff (in litres per second) were determined for the existing and developed (with and without OSD) site, and the storm duration(s) that corresponds to these values

- all designs and calculations submitted to Council for approval must include a copy of all input and output files on CD-ROM. Please note that $3^1/2$“ and $5^1/4$“ computer discs will not be accepted
- summary information regarding the design of the OSD and associated stormwater drainage system in similar format as shown on drawing no. A1 9070 – 1, as given in Appendix 9, is to be shown on the drawing

3.4 Drawings

Stormwater drainage drawings are to be submitted at the lodgement of the DA. These drawings are to show all relevant details of the OSD system and associated works as outlined above in Section 3 and are to be signed and certified by a suitably qualified and experienced Civil Engineer, who has membership to the Institution of Engineers Australia and National Professional Engineers Register (NPER).

Where an underground tank is to be used, the standard drawing detail as given in Appendix 9 of this Specification can be used.

Where an above ground OSD system is to be used, dimensions and levels of the basin must be provided. Sample drawings are given in Appendix 9 of this Specification.

4 Detailed Design

4.1 General

An experienced and competent designer would need to be engaged to ensure compliance with all of the requirements of this Specification. The general requirement of Council’s OSD Specification is to ensure that the site’s stormwater runoff after any development does not exceed the runoff prior to the development (refer to Section 4.3).

Where possible, the OSD system must be designed to capture stormwater runoff from the entire existing and proposed roof and paved areas of the site and any other areas which can be physically directed to the system. Where this is not possible, then the majority of hardstand surfaces of the site must be directed to the OSD system. In this regard, only 20% of the hardstand area will be allowed to bypass the OSD system, that is, a minimum of 80% of the total hardstand must be directed through the OSD system. If there are more than one OSD system(s), then a minimum of 80% of that proportion of the hardstand area must be directed through each OSD system.

Where partial or staged development of a large site is likely, consideration should be given in locating the OSD system in an area where the entire development can drain to it. The system could be modified as additional development occurs and may be more practical than having numerous smaller systems scattered throughout the site.

4.2 Design Methods

Design of the OSD system shall be undertaken in accordance with one of the following methods:

1. “Streamlined Method” for Single Residential Dwellings as set out in Section 4.2.1
2. "Simplified Method" for All Development Except Single Residential Development as set out in Section 4.2.2
3. "Full Computation Method" for All Development Except Single Residential Development as set out in Section 4.2.3

4.2.1 Streamlined Method

The Streamlined Method involves the use of a table to size the OSD system and determine the Permissible Site Discharge. This method is to be used for all single residential dwelling developments.

Table 1: Minimum Site Storage Required and Maximum Permissible Site Discharge

Types of stormwater disposal	Minimum Site Storage Required (SSR)	Maximum Permissible Site Discharge (PSD) for all storms up to and including 1 in 100 year ARI design storm
All gravity fed drainage systems connected to Council's drainage system	200 m^3 per Ha	400 L/s per Ha
All drainage systems that require a level spreader	In accordance with Council's "Stormwater Drainage from Low Level Properties" policy	In accordance with Council's "Stormwater Drainage from Low Level Properties" policy

Note: All single residential dwellings will be assessed on the above SSR and PSD requirements.

4.2.2 Simplified Method

The Simplified Method as given in APPENDIX 1 – Simplified Method involves the use of tables to size the OSD system. The whole of the site area must be considered in the calculation of the Site Storage Requirement (SSR) and the Permissible Site Discharge (PSD), as predetermined by Council.

It is recommended that the Simplified Method be used only where the site conditions have similar parameters to those given in APPENDIX 1 – Simplified Method, in the derivation of the tables.

The Simplified Method can only be used for developments other than single residential developments when the whole of the site can be collected by the OSD system. That is, all runoff from the site is routed through the OSD system prior to discharging to the receiving external drainage system. A maximum of 30 m^2 of the site area, which cannot be physically drained to the OSD system, is permitted to bypass. However, where more than 30 m^2 of the site cannot be collected by the OSD system, then the Full Computation Method must be used.

Where there is more than one OSD system on the site, it is possible to calculate the required volume and discharge rate from each OSD system by determining the percentage of the site area draining to each OSD unit and then distributing the total calculated SSR and PSD (calculated from the total site area) to each OSD system.

The Simplified Method cannot be used for sites where its area exceeds 1200 m^2 in size. The derived tables were not intended for extrapolation.

4.2.3 Full Computation Method

Where the site conditions vary from those given in the Simplified Method (see also APPENDIX 1 – Simplified Method) and/or more than 30m^2 of the site cannot physically drain to the OSD system then the Full Computation Method must be used.

The Full Computation Method can only be used for developments other than single residential developments as set out in Appendix 2. An experienced and competent designer would need to be engaged to ensure compliance with all of the requirements of this Specification. In many cases, this method of analysis may produce the most economical design. The Full Computation Method involves the use of computer models

to simulate rainfall and runoff from the site. Refer to Section 4.4 for the types of models that can be used.

4.3 Pre and Post Development Runoff for Full Computation Method

The total site runoff for the 5 year ARI and the 100 year ARI storm event under existing site conditions (pre-development) must be determined. For the Simplified Method, these values are read from Tables 2a or 2b given in Appendix 6. In the Full Computation Method, these values are calculated. A check of the 20 year ARI storm event must also be made when using the Full Computation Method.

The direction of runoff from the site, which has to fall in the same direction of the catchment, must be maintained.

The pre-development stormwater runoff or Permissible Site Discharge (PSD), both piped and overland from the total site, must be calculated in the Full Computation Method. For all developments, the runoff from the site after development is not to exceed the runoff from the total site prior to the development, for all storm durations for the 5 year, 20 year and the 100 year ARI storm event.

For all developments except single residential dwelling developments the PSD is to be calculated on the maximum allowable impervious fraction of 0%. That is, discharge off the site is to be restricted to the “state of nature” condition.

Where alterations and additions are proposed, the PSD is to be calculated on the maximum allowable impervious fraction of 0% for the areas considered for the proposed alterations and additions only. Stormwater detention will be required for the extent of the proposed alterations and additions only.

For all subdivision developments that result in the creation of three (3) lots or more, the OSD system is to be designed for a minimum impervious fraction of 60% for each newly created lot.

The overland flow from the site is not to be concentrated at any single point, where necessary, flows are to be spread evenly across the entire site as unconcentrated overland flow.

The post-development runoff is to be determined based on the post-development impervious area for all storm durations for the 5 year, 20 year, and 100 year ARI storm events. The OSD system(s) must be designed to restrict these flows to the calculated pre-development discharge rates. Hence the 5 year ARI post-development runoff must not exceed the 5 year ARI pre-development discharge, the 20 year ARI post-development runoff must not exceed the 20 year ARI pre-development discharge, and the 100 year ARI post-development runoff must not exceed the 100 year ARI pre-development discharge.

The total piped flow from the site must not exceed the maximum 5 year ARI pre-development runoff. The total piped and overland flows from the site must not exceed the 100 year ARI pre-development discharge. Where surcharging out of the OSD system(s) is not permitted or possible, for example where the overflows would pass through a downstream property via an easement and where there is no safe overland flowpath available, the OSD system(s) must be designed not to overflow. In this circumstance, the outlet pipe is to be designed for the 100 year ARI storm event even though the OSD outflow is to be restricted to the 5 year ARI storm event. This is to account for any blockages in the pipe which may cause runoff to overflow out of the OSD system.

4.4 Computer Modelling

4.4.1 General

The Full Computation Method requires computer modelling to determine the volume or Site Storage Requirement (SSR) and the PSD.

The preferred model for analysis is ILSAX or DRAINS. Council has chosen the ILSAX model because it is public domain and requires minimal data entry, and is consistent with Council's drainage database.

Note: Computation methods based on the approximate triangular method or the rational method is not acceptable.

4.4.2 Design Parameters to be used in the Model

Where the Full Computation Method is to be applied, and the ILSAX or DRAINS model is used in the design, the following design parameters are to be adopted:

- soil type = 2.5
- antecedent moisture content, AMC = 3
- infiltration rates:

  initial paved = 1 mm, grassed = 5 mm

- storms, as per Australian Rainfall and Runoff (AR&R 1987). All design storm duration for the 5, 20 and 100 year ARI, must be checked. Stacked rainfall patterns to be used in the ILSAX program are given in Figures 1 to 3 in Appendix 7
- the time of concentration (T_c) can be calculated using the kinematic wave formula from AR&R (1987) p 300, or read from Tables 4 and 5 in Appendix 6

  Where:

  1. The flow path length, L is the distance from the furthest point of the site to the exit to Council's stormwater drainage system. This length may be modified by the development either by piping, paving or redirecting
  2. The surface roughness coefficient, n* is per AR&R (1987) p 300. For non-paved areas the minimum value of n* to be used is 0.33
  3. The area to be considered in the calculations is the total area of the catchment affected and not just the development site

- stored bypass or surcharge is not to be used. That is, type "0" inlets are not to be used
- supplementary areas are not to be used
- orifice size can be estimated using Table 3 in Appendix 1, or calculated from the formula: $Q = CA\sqrt{2gh}$

  Note: The tables are based on a 'C' value of 0.6 for a circular shaped, square edge cut in a flat plate

- all areas likely to be paved after completion of the development (e.g. driveways, and courtyards), will be considered as part of the impervious area and included as such in the calculations

- the determination of the SSR is to be undertaken by trial and error, using the above constraints.

4.5 Surface Flow Paths

Runoff from the developed site must not cause a detrimental effect on any property. This may require the retention of existing surface flow paths and maintaining the same or reduced quantity and water depths in these flow paths.

Surface flow paths may include the provision of an emergency overflow weir or spillway for unexpected blockages which may occur to the system, or for flows in excess of the 100 year ARI storm event. The flow route must be capable of carrying stormwater up to and including the 100 year ARI storm event to account for 100% blockage to the piped system. A minimum freeboard of 300 mm must also be provided between habitable floor levels and the maximum water level on the developed site and any other adjoining properties so affected.

Any uncontrolled flows or overflows that are directed to the street will require calculations to show velocity-depth characteristics for sheet flows to the kerb as per scouring and safety criteria stated in the Australian Rainfall & Runoff manual. The maximum allowable depth of sheet flow is 200mm and the maximum velocity x depth product of 0.4 m^2/s is permitted.

4.6 Stormwater Runoff from Upstream Catchment(s)

Stormwater from upstream catchment(s) must not enter into the OSD system(s). The design of suitable channels, open drains, pits and pipes, mounding, landscaping or walls may be necessary to divert stormwater from adjacent properties away from the system(s). However, care must be exercised to ensure that the provision of such diversions within the site does not result in the concentration of stormwater onto adjoining properties. If this cannot be achieved, then the OSD system(s) must be designed to cater for the additional stormwater inflow.

4.7 Floor and Ground Levels

All office, storage and habitable floor levels are to be set at a minimum of 300 mm above the maximum design storage water surface or surcharge flow path level, whichever is higher. All factory warehouse and garage floor levels are to be set at a minimum of 150 mm above the maximum design storage water surface and surcharge flow path levels.

Council will not approve detention systems directly under habitable floors. In special circumstances, where approval is granted for enclosed systems, the control/inspection pit must be able to be accessed externally to the building.

The definition of *habitable floors* includes all living areas, commercial office space, store rooms and show rooms where there is likely damage by water inundation (or condensation) to stored goods and materials.

Enclosed detention storage systems may be permitted under a basement or ground floor carparking area, garage or patio. Under these circumstances, unobstructed external access to the OSD system(s) must be provided at all times. A safe overflow route from the OSD system must also be provided. Access to the OSD system(s) via enclosed structures will not be acceptable.

4.8 Site Discharge and Connection to Public Drainage System

Where possible, the PSD is to be piped to the nearest downstream formed or natural public drainage system. Piped discharge from the total site may be connected to the kerb and gutter, provided that the PSD does not exceed 20 litres per second per outlet per 15m run of kerb and gutter for storms up to and including the 100 year ARI.

The outlet pipe leaving the site, must exit at an acute angle of less than 45 degrees from the boundary.

Council will require that all concentrated stormwater runoff to be piped to the nearest public drain, or natural watercourse, with a minimum 375 mm diameter pipe, and to Council's specifications, if:

(i) concentrated discharge from the site to the street gutter cannot be restricted to 20 l/s at 15 m apart, and

(ii) a direct connection to the public drainage system outside the subject property is not available.

Pipe junctions are to be orientated to minimise hydraulic losses. Pits are to be located at changes of direction, at property boundaries, and connection to the public drainage system. Where pits cannot be used, suitable transition structures may be accepted at Council's discretion.

Where an outlet pipe is to be connected through a standard 150 mm high kerb and gutter, and is greater than 100 mm in diameter (or there is less than 50 mm cover over the pipe), the following structures will be required:

(i) minimum 450 x 450 grated converter pit to be constructed inside the boundary of the property, and

(ii) between the converter pit and the kerb and gutter, laying galvanised steel rolled hollow rectangular sections to the following equivalent dimensions:

- 100 dia outlet pipe - use 1 x 100 mm x 100 mm x 6 mm thick RHS
- 150 dia outlet pipe - use 1 x 200 mm x 100 mm x 6 mm thick RHS
- 225 dia outlet pipe - use 2 x 200 mm x 100 mm x 6 mm thick RHS.

Note: No other allowance will be considered, especially for twin 150 mm pipes into a 200 mm high kerb and gutter, or multiple outlets of more than three pipes.

The absolute minimum pipe grade on all outlets is to be:

- 1.5 % for pipes less than 225 mm diameter, or
- 1.0 % for pipes greater than 225 mm.

Note: Minimum pipe grades and design requirements for public drainage systems are given in Council's Standard Specification for engineering works.

4.9 Discharge Control Devices

4.9.1 General

The type of control device which is acceptable to Council is a flat plate with a square edge cut to form the orifice hole. This device is to be mounted in front of an oversized outlet pipe. Other forms of control devices may be acceptable to Council provided

adequate supporting calculations can be submitted to demonstrate that it will perform as intended to the requirements of this Specification.

All hydraulic control devices are to be non-removable.

High early discharge or normal discharge control devices can be used.

It is desirable that these control devices operate under *inlet control*, that is, a “free outlet” condition exists. However, in exceptional cases where inlet control cannot be achieved, Council, at its discretion, may allow the system to operate under *outlet control*. Systems which are to operate under outlet control or downstream control will require supporting calculations for determining flows and water levels in the external drainage system for which the OSD system will be connected to. A full range of storm recurrence intervals will need to be considered.

Note: All discharge control devices and pits are to be located externally to all structures and buildings so that 24 hour access to the OSD system is possible and that overflows from the system can be safely directed away.

4.9.2 Orifice Plates

Orifice plates are to be made of a flat sheet of stainless steel plate with minimum dimensions of 200 mm x 200 mm x 3 mm thick. Galvanised steel plates will not be acceptable. The orifice hole is to be cut to the exact dimension as calculated and to be of a uniform circular shape with sharp (not rounded) edges. The centre of the plate is to be cast into the wall or epoxied and securely fixed over the centre of the outlet pipe by the use of at least 4 "Dyna" bolts or similar, one at each corner.

Generally, to minimise blockages, orifice diameters smaller than 50 mm will not be accepted.

The invert of the orifice must be at least 50 mm lower than the base of the main tank. Ideally, the level at the base of the tank should match the level of the centre of the orifice. This is to ensure that the tank will not hold water during dry weather.

4.10 Trash Screens

A stainless steel or galvanised mesh screen (Maxi-mesh RH3030 or equivalent) with a minimum of 50 times the orifice area shall be provided between the orifice and all inlets. This screen is to protect the orifice from blockages.

For orifices greater than 150 mm in diameter, the area of the screen can be reduced to 20 times the orifice area, if a grid mesh is installed. The screen is to be located at a distance of 1.5 x the diameter of the orifice or 200 mm away from the orifice, whichever is the greater. Where possible, the incoming line is to flow across the face of the mesh.

The screen is to be placed diagonally against the face of the tank wall with a dividing wall on the inside of the tank to shield the end of the screen. Preferably, the screen should completely protect the orifice without the need for a dividing wall by having side panels on both ends of the screen. This could be achieved by welding triangular mesh side panels to the screen.

A lifting handle welded to the top of the mesh would also be required to allow for easy removal of the screen for cleaning purposes. The screen must not be bolted securely to the wall but should also not be easily removed.

4.11 Underground Storage Systems

Underground storage systems are accepted as OSD. However they should not be used where surface storage can be provided. Underground systems should be located in areas where they can be readily accessed for inspections and maintenance.

These systems can be constructed from reinforced concrete, prefabricated units or proprietary systems provided they can operate to the requirements of this Specification, can be readily cleaned, and must perform hydraulically as required. The structural adequacy of the system must be checked and certified by a suitably qualified Engineer.

These systems must be watertight if there is the potential for water seepage which may cause damage to adjacent properties or structures.

For safety, all maintenance access to underground storage systems must conform to the current Work Health and Safety Bill 2011, Work Health and Safety Regulations 2011 and Australian Standard AS 2865-2009 “Confined spaces”.

Venting must be provided where gas build up is likely. A hydrostatic valve must be provided where necessary.

Step irons are to be installed where the depth of the tank is greater than 1200 mm.

A high level outlet or grate shall be provided at the discharge control pit to cater for surcharge during major storm events. Access to the discharge control pit must be provided for inspections and maintenance of the silt trap and trash screen.

Underground storage tanks should be located externally to all buildings and structures.

The access opening to the pit must be a minimum of 600 mm x 600 mm in dimension and fitted with a removable galvanised steel grate. The grate is to be placed above the outlet and silt trap.

Additional access openings will be required for larger underground storage tanks and high early discharge structures. Underground tanks which exceed 1500mm in length must have a second access point (300 mm x 300 mm minimum dimension) at the extreme corner of the tank to allow regular inspections, flushing of the system and ventilation, where necessary.

Essentially, the system shall be designed to maximise ease of maintenance and ensure safety for the proprietor.

To avoid unpleasant odours and health risks, maintenance of the OSD structure must be carried out on a regular basis. For this reason Council will require a Positive Covenant to be placed on the title of the subject land to emphasise the proprietor's maintenance responsibilities (refer to section 2.9).

4.12 Surface Storage Systems

Surface storage can be provided in either in landscaped and/or driveways and carpark areas. Surface storage areas must be located externally to all buildings and structures.

Where the depth of storage exceeds 300 mm, a Council approved fence must be provided around the perimeter of the storage area.

Surface storage in driveways must not exceed 200 mm. Reference is made to Section 4.12.2.

4.12.1 Storage in Landscaped areas

The ponding depths in landscaped areas for all residential developments must not exceed 300 mm under design conditions. The maximum depth of ponding in all other developments must not exceed 1200 mm. Pool fences must be installed around the landscaped area where the depth of ponding exceeds 300mm. Pool fences must be designed and constructed in accordance with the requirements of the *Swimming Pools Act 1992.*

Storage which is to be provided in landscaped areas shall include an allowance of an additional 20% volume to compensate for loss of volume due to vegetation growth and construction inaccuracies. The 20% additional volume is to be gained by increasing the surface area of the ponded surface. Increasing the depth of the basin to gain the additional storage will not be approved, as this will alter the designed stage-storage-discharge relationship of the model.

The maximum slope of batters in grassed areas is to be 1 in 4.

The minimum surface slope is 1.5%, with the absolute minimum being 1.0%.

Sub-soil drainage must be provided around the outlet to prevent the ground becoming saturated during prolonged wet weather.

Where the storage is to be located in an area where frequent ponding could create maintenance problems or personal inconvenience to property owners, the first 5% of the storage volume must be provided in a pit. The next 15% must be provided in an area able to tolerate frequent inundation, for example, a small underground tank in conjunction with a paved outdoor entertainment area. A check using the ILSAX model to confirm that the 3 month design storm will occupy the first 5% of storage volume and the 1 year ARI design storm will occupy the first 20% of the storage, will be sufficient. Generally all grassed/landscaped areas would require the first 5% of the storage to be contained within the pit and the next 15% storage to be in a tolerable, frequently wettable zone. This is to be assessed at the discretion of Council.

The structural adequacy of any retaining walls, including any hydrostatic loads caused by full storage must be checked. The retaining walls are to be constructed as waterproof masonry walls.

4.12.2 Storage in Driveways and Carparks

Carparks and driveways used as storage areas must be located externally to all buildings and structures.

To avoid damage to vehicles, depths of ponding on driveways and carparks are not to exceed 200 mm under design conditions.

Transverse paving slopes within storage areas must not be less than 0.7%.

If the storage is to be provided in a commonly used area where ponding will cause inconvenience (e.g. carparks), this area should not, on average, flood more than once every three months. This will require approximately the first 5% of the storage to be provided in a non-visual area, e.g. an underground pit.

5 Constructed Works

5.1 Compliance

If Council issues the Construction Certificate for the OSD system then, on completion of the Works, the system must be certified by a suitably qualified and experienced Civil Engineer, who has membership to the Institution of Engineers Australia and National Professional Engineers Register (NPER), with Works-as-Executed drawings supplied to Council in respect of:

1. Compliance with the DA.
2. Intended purpose of the storage structure, that is, the structure has been designed to comply with all relevant Australian Standards and Codes.
3. The Works have been constructed in accordance with the approved drawings. Where 'approved drawings' are those that bear Council's approval stamp. The Certification shall read "I have carried out all inspections necessary to declare that the work nominated in drawing No.*******, have been carried out in accordance with the approved plans and specifications, and the conditions of development consent". Such certification shall be signed and dated.
4. The Works-as-Executed drawings are to be prepared by a Registered Surveyor and submitted to Council, to include all relevant levels, reduced to Australian Height Datum and locations including:

    - invert levels,
    - surface or pavement levels,
    - floor levels including adjacent property floor levels, if required,
    - maximum water surface level for 100 year ARI storm,
    - dimensions of basin(s), tank(s), pit(s), etc.,
    - locations of basins and distances from building and boundaries,
    - storage volume(s) provided
    - Size of the Orifice.

If the Applicant chooses to have an Accredited Certifier prepare the Construction Certificate, then certification of the Works must be provided by the Accredited Certifier including the submission of Works-as-Executed drawings in respect of the above points 1 to 4.

A copy of the Works-as-Executed drawings must be lodged for Council's records.

5.2 Plaque

At Council's discretion, identification of the OSD system(s) may be required. Identification in the form of a plaque attached near the system and clearly displayed, will be required. This would generally be necessary for large basins.

If required, a plaque measuring no less than 400 mm x 200 mm shall be attached permanently and prominently displayed within the vicinity of the OSD system(s). This plaque shall advise the occupants of the property of the existence of the OSD system(s) and that the controlling device must not be tampered with, changed or modified in any manner without prior written consent from Council.

APPENDIX 1 – Simplified Method

The Simplified Method uses Tables 2a or 2b (Appendix 6) for the design of the OSD system.

Table 2a should be used if the following site conditions apply:

1. The entire site drains to the front or to the rear of the property and the whole of the site was considered in all of the computations.
2. The average slope of the site does not exceed 5%.
3. The width of the site does not exceed 18m.
4. The existing site impervious area is to be 0% of the total site area.
5. The post-development impervious area is assumed to be equal to or less than 60% of the site area.
6. The estimation of the time of concentration for the pre-developed site is to be assumed as grassed for the entire site - refer to Tables 4 & 5.
7. Discharge from the OSD system must not be affected by any downstream tailwater levels from the receiving drainage system. That is, it must have a 'free outlet'.
8. The volume of the tank was designed so that:
    - The maximum discharge through the orifice is equal to the 5 year ARI (or 20 litres per second where concentrated discharge is to the kerb), and
    - The basin surcharged at a rate equal to the difference between the 100 year and the 5 year ARI (or 20 litres per second where concentrated discharge is to the kerb).
9. Stormwater runoff for the total site prior to the development during the 100 year ARI design stacked storm pattern is equal to the estimated flow after the development.
10. The two design stacked rainfall patterns were used to determine the 5 year and 100 year ARI flows. These rainfall patterns are shown in Figure 1.

Note: Where the site constraints vary from the above parameters, it is recommended that the Full Computation Method be used.

Table 2b should be used if the following site conditions apply:

1. The entire site drains to the front or to the rear of the property and the whole of the site was considered in all of the computations.
2. The average slope of the site does not exceed 5%.
3. The width of the site does not exceed 18m.
4. The existing site impervious area is to be 0% of the total site area.
5. The post-development impervious area is assumed to be between 60% and 100%.
6. The estimation of the time of concentration for the pre-developed site is to be assumed as grassed for the entire site - refer to Tables 4 & 5.
7. Discharge from the OSD system must not be affected by any downstream tailwater levels from the receiving drainage system. That is, it must have a 'free outlet'.
8. The volume of the tank was designed so that:
    - The maximum discharge through the orifice is equal to the 5 year ARI (or 20 litres per second where concentrated discharge is to the kerb), and
    - The basin surcharged at a rate equal to the difference between the 100 year and the 5 year ARI (or 20 litres per second where concentrated discharge is to the kerb).
9. Stormwater runoff for the total site prior to the development during the 100 year ARI design stacked storm pattern is equal to the estimated flow after the development.
10. The two design stacked rainfall patterns were used to determine the 5 year and 100 year ARI flows. These rainfall patterns are shown in Figure 1.

Note: Where the site constraints vary from the above parameters, it is recommended that the Full Computation Method be used.

The Simplified Method approach is set out below:

1. The minimum Site Storage Requirement (SSR) and the maximum Permissible Site Discharge (PSD) values are read from Tables 2a or 2b.

   Example: Site area = 600 m^2 and the total post-development impervious percentage is 80%, therefore from Table 2b gives PSD = 18 litres per second and SSR = 19.0 m^3.

2. The size of the outlet and orifice is read from Table 3.

   The top line of the table refers to the maximum depth that the water will pond above the centre of the orifice. Knowing the PSD and depth of ponding, the size of the orifice and the size of the minimum outlet pipe can be obtained.

   Example: PSD = 18 litres per second and the design maximum depth of ponding is 0.5 m, gives orifice size of 110 mm diameter with a 225 mm diameter outlet pipe. Outlet pipe size based on the greater of the minimum grade of 1% or 3 times the orifice outlet.

3. Detention storage volume will be achieved by the use of a properly designed and constructed above ground storage or below ground tank.

   The dimensions of an underground tank will be dependent upon the maximum depth of ponding that the site will allow.

   The dimensions of the tank, depth (D) x width (W) x length (L) should be equal to the minimum SSR determined.

   Example: SSR = 19.0 m^3 and depth = 0.5 m,

   Therefore W x L x 0.5 = 19.0 m^3 or W x L = 38.0 m^2

   Values of W and L are independent. However, as the width approaches 3 m or more, the covering slab may become expensive to construct on site and pre-cast commercial tanks may be more economical. A suitably qualified professional Engineer will be required to design the covering slab.

4. The minimum information required, as set out in Section 3, is to be supplied with the Application to Council.

5. Table 2a and 2b applies only to the total area of the site. Dividing the original site area into smaller allotments and then using the above Tables, is not acceptable. PSD and SSR values shall be determined on the original lot size, which can be proportioned down to the new allotment size.

APPENDIX 2 – Full Computation Method

The Full Computation Method shall be used when the Simplified Method is not appropriate. The analysis shall be undertaken by a suitably qualified professional Civil Engineer to determine the PSD and SSR in accordance with the following:

1. Computations shall be carried out using the "ILSAX" or “DRAINS” program. The estimation of the time of concentration for the pre-developed site is to be assumed as grassed for the entire site - refer to Tables 4 & 5.
2. Where the outlet from the basin cannot be classed as a "free outlet" full hydraulic calculations will be required.

   For simple external Catchment analysis, assume that the HGL level of the next downstream pit is at top of kerb level at street pits or ground level for other pits.
3. Refer to 4 - Detailed Design for Storage and Discharge Requirements.
4. The maximum allowable pre-development impervious fraction, to be used in the determination of the PSD, for all commercial or industrial developments, residential flat buildings and subdivisions resulting in the creation of three (3) lots or more is to be 0% of the total site area.
5. Generally stormwater runoff (both piped and overland) from the total site after development, is not to exceed the runoff from the total site prior to the development. These values must include all storm intensities up to and including the 100 year ARI event.
6. The stacked rainfall patterns used to determine the maximum discharge from the existing site for the 5 year ARI storm event is given in Figure 1 (Appendix 7). The maximum value obtained from the output files will be the (piped) PSD.

   The peak discharge from the total developed site during a 5 year ARI storm, is not to exceed the existing 5 year ARI runoff, or 20 litres per second if discharging to the kerb, whichever is the lower value.
7. The stacked rainfall patterns used to determine the maximum discharge from the site for the 100 year ARI storm event, is given in Figure 1. The maximum 100 year ARI runoff obtained from the output file is the total maximum allowable runoff (both piped and overland) from the total site during the 100 year ARI event. That is, the total non-concentrated discharge (including overflow from the basin) from the site is not to exceed the difference between the 100 year and 5 year ARI stormwater runoff.

   Maximum concentrated discharge to the kerb during a 100 year ARI storm is not to exceed 20 litres per second per 15m run of kerb and gutter.
8. The calculation of the OSD storage volume (SSR) is to be undertaken by trial and error, using the above constraints.

   For the purpose of these computations:

   - The site is to be examined for all typical duration from 10 minutes to 3 hours during the 5, and 100 year ARI storm events, to check the performance of the proposed OSD system. Refer to Figure 1 for stacked rainfalls
   - The total impervious area of the proposed development will be used as the impervious area for the post development site. This will include all existing and proposed roof and other paved areas.
   - All new and existing impervious areas of the site must be directed through the detention storage system(s). Only a minimum of 50% of the total site area can be allowed to bypass the OSD system(s). Where practical, this minimum area is to consist of all the paved and impervious surfaces, plus grassed areas to make up the 50% requirement.

9. The minimum information, as set out in Section 3, is to be supplied with the Application to Council.
10. A check must be made to ensure that the 20 year ARI discharge from the developed site is no greater than the 20 year ARI from the same site prior to development. Refer Figure 3 for the 20 year ARI storm patterns.
11. Where above-ground storage is to be provided, the 3 month and 1 year ARI storm events must also be checked to ensure that the 5% and 15% storage volume requirement has been met.

APPENDIX 3 – Terms of Positive Covenant and Restriction on the Use of Land

Where there is no subdivision of land, that is, no Section 88B instrument required, then the following wording for the "Terms of Restriction on the Use of Land" and "Terms of Positive Covenant" shall be attached to the NSW Department of Lands standard forms 13RPA & 13PC respectively.

Terms of Restriction on the Use of Land

The registered proprietors covenant with the Warringah Council (Council) that they will not:

I. Do any act, matter or thing which would prevent the structure and works from operating in an efficient manner.

II. Make any alterations or additions to the structure and works or allow any development within the meaning of the Environmental Planning and Assessment Act 1979 to encroach upon the structure and works without the express written consent of the authority.

III. This covenant shall bind all persons who claim under the registered proprietors as stipulated in section 88E(5) of the Act.

For the purposes of this covenant:

Structure and Works shall mean the on-site stormwater detention system constructed on the land as set out in the plan annexed hereto and marked with the letter "A" (or alternatively as detailed on the plans approved by Council No: {INSERT DA NUMBER}) including all 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 on the land.

The Act means the *Conveyancing Act 1919*.

Terms of Positive Covenant

The registered proprietors covenant with the Warringah Council (Council) that they will maintain and repair the structure and works on the land in accordance with the following terms and conditions:

I. The registered proprietor will:

   i. keep the structure and works clean and free from silt, rubbish and debris

   ii. maintain and repair at the sole expense of the registered proprietors the whole of the structure and works so that it functions in a safe and efficient manner.

II. For the purpose of ensuring observance of the covenant the Council may by its servants or agents at any reasonable time of the day and upon giving to the person against whom the covenant is enforceable not less than two days notice (but at any time without notice in the case of an emergency) enter the land and view the condition of the land and the state of construction maintenance or repair of the structure and works on the land.

III. The registered proprietors shall indemnify the Council and any adjoining land owners against any claims for damages arising from the failure of any component of the OSD, or failure to clean, maintain and repair the OSD.

IV. By written notice the Council may require the registered proprietors to attend to any matter and to carry out such work within such time as the Council may require to ensure the proper and efficient performance of the structure and works and to that extent section 88F(2) (a) of the Act is hereby agreed to be amended accordingly.

V. Pursuant to section 88F(3) of the Act the authority shall have the following additional powers pursuant to this covenant:

   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 equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in III hereof.

   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 own employees engaged in effecting the said work, supervising the said work and administering the said work together with costs, reasonably estimated by the Council, for the use of 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.

VI. This covenant shall bind all persons who claim under the registered proprietors as stipulated in section 88E(5) of the Act.

For the purposes of this covenant:

Structure and Works shall mean the on-site stormwater detention system constructed on the land as set out in the plan annexed hereto and marked with the letter "A" (or alternatively as detailed on the plans approved by Council No: {INSERT DA NUMBER}) including all 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 on the land.

The Act means the *Conveyancing Act 1919*.

Where a subdivision has been lodged and a Section 88B instrument created, then the following wording for the "Terms of Restriction on the Use of Land" and "Terms of Positive Covenant" is to be included:

Terms of Restriction on the Use of Land referred to in the above-mentioned Plan

The registered proprietor covenant with the Warringah Council (Council) in respect to the structure erected on the land described as "on-site stormwater detention system" (which expression includes all ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to temporarily detain stormwater) shown on plans approved by the Council No. {INSERT DA NUMBER} (hereinafter called "the system").

The registered proprietors covenant with the Warringah Council (Council) that they will not:

I. Do any act, matter or thing which would prevent the structure and works from operating in an efficient manner.

II. Make any alterations or additions to the structure and works or allow any development within the meaning of the Environmental Planning and Assessment Act 1979 to encroach upon the structure and works without the express written consent of the authority.

III. This covenant shall bind all persons who claim under the registered proprietors as stipulated in section 88E(5) of the Act.

For the purposes of this covenant:

Structure and Works shall mean the on-site stormwater detention system constructed on the land as set out in the plan annexed hereto and marked with the letter "A" (or alternatively as detailed on the plans approved by Council No: {INSERT DA NUMBER}) including all 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 on the land.

The Act shall mean the *Conveyancing Act 1919.*

Terms of Positive Covenant referred to in the above-mentioned Plan

The registered proprietors covenant with the Warringah Council (Council) that they will maintain and repair the structure and works on the land in accordance with the following terms and conditions:

I. The registered proprietor will:

   i. keep the structure and works clean and free from silt, rubbish and debris

   ii. maintain and repair at the sole expense of the registered proprietors the whole of the structure and works so that it functions in a safe and efficient manner.

II. For the purpose of ensuring observance of the covenant the Council may by its servants or agents at any reasonable time of the day and upon giving to the person against whom the covenant is enforceable not less than two days notice (but at any time without notice in the case of an emergency) enter the land and view the condition of the land and the state of construction maintenance or repair of the structure and works on the land.

III. The registered proprietors shall indemnify the Council and any adjoining land owners against any claims for damages arising from the failure of any component of the OSD, or failure to clean, maintain and repair the OSD.

IV. By written notice the Council may require the registered proprietors to attend to any matter and to carry out such work within such time as the Council may require to ensure the proper and efficient performance of the structure and works and to that extent section 88F(2) (a) of the Act is hereby agreed to be amended accordingly.

V. Pursuant to section 88F(3) of the Act the authority shall have the following additional powers pursuant to this covenant:

   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 equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in I hereof.

   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 own employees engaged in effecting the said work, supervising the said work and administering the said work together with costs, reasonably estimated by the Council, for the use of 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.

VI. This covenant shall bind all persons who claim under the registered proprietors as stipulated in section 88E(5) of the Act.

For the purposes of this covenant:

Structure and Works shall mean the on-site stormwater detention system constructed on the land as set out in the plan annexed hereto and marked with the letter “A” (or alternatively as detailed on the plans approved by Council No: {INSERT DA NUMBER}) including all 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 on the land.

The Act means the *Conveyancing Act 1919.*

APPENDIX 4 – Examples of ILSAX models with various applications

1. Underground tank - Normal Discharge Control

Original lot size = 800m^2, existing slope = 1%, width of block = 18m. For a vacant lot assume that the maximum existing impervious percentage = 0%, (refer to Section 4.3).

Calculate the existing Q5 (piped PSD) and Q100 (max PSD) for the existing site using the ILSAX program or read from Tables 2a or 2b. Assuming that the grassed flowpath length = paved flowpath length, gives the PSD for Q5 = 23 l/s and Q100 = 45 l/s with overflow = Q100 - Q5 = 22 l/s

For the developed site, calculate impervious percentage and grassed percentage. Also, use Tables 4 and 5 to calculate times of concentration.

Assume that the tank is to be 1.0m deep with 150mm topsoil cover and the walls and roof of the tank is to be 150mm thick.

The post-development paved imp = 80%, grassed imp = 20%, T_c paved = 5 minutes and T_c grassed = 8 minutes.

Orifice size (calculated or read from Table 3) would be 98mm at 1.3m deep for the piped PSD = 23 l/s.

Assuming that the tank will capture all the flows from the site with trial volume = 27.60m^3, then the post-development ILSAX model would be:

```
800sqm SITE AT No.1 SAMPLE STREET, WARRINGAH
AAA  001  -1  -1
10  4  1.0  1.00  225  2
AAA  002  0
13
0.000    0.00  0.0000  0.0
0.100    2.75  0.0064  0.0
0.200    5.50  0.0090  0.0
0.300    8.25  0.0110  0.0
0.400  11.00  0.0128  0.0
0.500  13.75  0.0143  0.0
0.600  16.50  0.0156  0.0
0.700  19.25  0.0169  0.0
0.800  22.00  0.0180  0.0
0.900  24.75  0.0191  0.0
1.000  27.50  0.0202  0.0
1.300  27.60  0.0230  0.0
1.400  27.60  0.0230  0.1
0
0.08  80  5  0  20  8  0

AAA  002  -1  -1
0  1  1.0  1.00  225  -1
10  0  0  0  0
0.00  0  0  0  0  0  0

END
```

2. Multi-underground tanks - Normal Discharge Control with some areas not directed to the tank

Same criteria as before, except with two tanks and not all of the flows will be directed to the detention systems. Note that the PSD for the Q5 (piped) is set at 30 l/s when both tanks are full in this example. Tank 1 has a depth of 1.0m and trial volume of 11.0m^3. Tank 2 has a depth of 1.0m and trial volume of 9.60m^3 and 50m^2 of the site is uncontrolled.

The designer has the flexibility to adjust the volumes of the tanks to achieve the required discharge.

```
800sqm SITE AT No.1 SAMPLE STREET,
      *WARRINGAH
AAA  001  -1  -1
10  4  1.0  1.00  150  2
AAA  002  0
13
0.000   0.00  0.0000  0.0
0.100   1.09  0.0044  0.0
0.200   2.18  0.0063  0.0
0.300   3.27  0.0077  0.0
0.400   4.36  0.0089  0.0
0.500   5.45  0.0099  0.0
0.600   6.54  0.0108  0.0
0.700   7.63  0.0117  0.0
0.800   8.72  0.0125  0.0
0.900   9.81  0.0133  0.0
1.000  10.90  0.0140  0.0
1.300  11.00  0.0160  0.0
1.400  11.00  0.0166  0.1
0
0.04  80  5  0  20  8  0

AAA  002  -1  -1
0  2  20.0  1.00  150  -1
10  0  0  0  0
AAA  003  1
0.00  0  0  0  0  0  0

AAB  001  -1  -1
10  4  1.0  1.00  150  2
AAB  002  0
13
0.000  0.00  0.0000  0.0
0.100  0.95  0.0038  0.0
0.200  1.90  0.0054  0.0
0.300  2.85  0.0066  0.0
0.400  3.80  0.0076  0.0
0.500  4.75  0.0085  0.0
0.600  5.70  0.0093  0.0
0.700  6.65  0.0100  0.0
0.800  7.60  0.0107  0.0
0.900  8.55  0.0114  0.0
1.000  9.50  0.0120  0.0
1.300  9.60  0.0137  0.0
1.400  9.60  0.0142  0.1
0
0.035  80  5  0  20  8  0

AAB  002  -1  -1
0  2  5.0  1.00  150  -1
10  0  0  0  0
AAA  003  .2
0.00  0  0  0  0  0  0

ADD  AAB  TO  AAA

AAA  003  -1  -1
0  1  1.0  1.00  225  -1
10  0  0  0  0
0.005  80  5  0  20  8  0

END
```

3. Above Ground Storage - Normal Discharge Control

Original lot size = 800m^2, existing slope = 1%, width of block = 18m. For a vacant lot assume that the maximum existing impervious percentage = 0% (refer to Section 4.3).

Calculate the existing Q5 (piped PSD) and Q100 (max PSD) for the existing site using the ILSAX program or read from Tables 2a or 2b. Assuming that the grassed flowpath length = paved flowpath length, gives the PSD for Q5 = 23 l/s and Q100 = 45 l/s with overflow = Q100 - Q5 = 22 l/s.

For the developed site, calculate the impervious percentage and grassed percentage. Also, use Tables 4 and 5 to calculate times of concentration.

For this design assume that the maximum depth of ponding in the basin = 300 mm deep. Tank depth = 0.8m and the storage in courtyard area = 12.5m x 5m with 1% crossfall. Allow minimum of 20% volume in the control pit = 5m x 2.25m, and the walls and roof of the tank is 150 mm thick with access manhole 0.6m x 0.6m.

The post-development paved imp = 80%, grassed imp = 20%, T_c paved = 5 minutes and T_c grassed = 8 minutes.

Orifice size (calculated or read from Table 3) would be 108mm at 0.9m deep for the piped PSD = 23 l/s.

Assuming that the tank will capture all the flows from the site with trial volume = 18.85m^3, then the post-development ILSAX model would be:

```
800sqm SITE AT No.1 SAMPLE
      *STREET, WARRINGAH
AAA  001  -1  -1
10  4  1.0  1.00  225  2
AAA  002  0
19
0.000   0.00  0.0000  0.0
0.100   1.13  0.0081  0.0
0.200   2.25  0.0115  0.0
0.300   3.38  0.0141  0.0
0.400   3.96  0.0163  0.0
0.500   4.00  0.0182  0.0
0.525   4.16  0.0186  0.0
0.550   4.63  0.0191  0.0
0.575   5.41  0.0195  0.0
0.600   6.50  0.0199  0.0
0.625   7.91  0.0203  0.0
0.650   9.47  0.0207  0.0
0.675  11.04  0.0211  0.0
0.700  12.60  0.0215  0.0
0.725  14.16  0.0219  0.0
0.750  15.72  0.0223  0.0
0.775  17.29  0.0226  0.0
0.800  18.85  0.0230  0.0
0.900  18.85  0.0230  0.1
0
0.08  80  5  0  20  8  0

AAA  002  -1  -1
0  1  1.0  1.00  225  -1
10  0  0  0  0
0.00  0  0  0  0  0  0

END
```

4. High Early Discharge Tank

IMPORTANT NOTE: The ILSAX program will not accurately model the total outflow from high early discharge (HED) storage systems. The outflow from the HED storage closely follows the above ground storage until the tank is full, then as the level in the tank recedes, the outflow follows the normal tank discharge.

Original lot size = 800m^2, existing slope = 1%, width of block = 18m.

For a vacant block, the maximum existing impervious percentage = 0%.

Calculate the existing Q5 (piped PSD) and Q100 (max PSD) for the existing site using the ILSAX program or read from Tables 2a or 2b. Assuming that the grassed flowpath length = paved flowpath length, gives the PSD for Q5 = 23 l/s and Q100 = 45 l/s with overflow = Q100 - Q5 = 22 l/s.

For the developed site, calculate the impervious percentage and grassed percentage. Also, use Tables 4 and 5 to calculate times of concentration.

Assume that the tank is to be 1.0m deep with 150mm topsoil cover and the walls and roof of the tank is to be 150mm thick. The post-development paved imp = 80%, grassed imp = 20%, T_c paved = 5 minutes and T_c grassed = 8 minutes.

Orifice size (calculated or read from Table 3) would be 98mm at 1.3m deep for the piped PSD = 23 l/s.

Assuming that the tank will capture all the flows from the site with trial volume = 18.70m^3, then the post-development ILSAX model would be:

```
800sqm SITE AT No.1 SAMPLE STREET, WARRINGAH
AAA  001  -1  -1
10  4  1.0  1.00  225  2
AAA  002  0
14
0.000   0.00  0.0000  0.0
0.100   0.04  0.0064  0.0
0.200   0.07  0.0090  0.0
0.300   0.11  0.0110  0.0
0.400   0.14  0.0128  0.0
0.500   0.18  0.0143  0.0
0.600   0.22  0.0156  0.0
0.700   0.25  0.0169  0.0
0.800   0.29  0.0180  0.0
0.801 15.50  0.0181  0.0
0.900 17.05  0.0191  0.0
1.000 18.60  0.0202  0.0
1.300 18.70  0.0230  0.0
1.400 18.70  0.0230  0.1
0
0.08  80  5  0  20  8  0

AAA  002  -1  -1
0  1  1.0  1.00  225  -1
10  0  0  0  0
0.00  0  0  0  0  0  0
END
```

APPENDIX 5 – ILSAX Model Instabilities

In all cases, the total area of the site in the model must equal the original site area. The model must include all the site area(s):

- directed to one or more OSD system, and
- not directed to any OSD system, in one (1) hydrological model to allow a direct comparison between the pre and post development surface outflows.

If the error message

WARNING - TIME STEP X. seconds IS MORE THAN TWICE THE MINIMUM RATIO OF

STORAGE DIFFERENCE vs OUTFLOW DIFFERENCE IN THE HEIGHT-STORAGE-OUTFLOW TABLE

- Y. seconds.

THIS MAY CAUSE INSTABILITIES IN BASIN CALCULATIONS.

YOU NEED TO CHECK RESULTS, AND POSSIBLY USE A SHORTER TIME STEP,

OR TO MODIFY THE TABLE.

appears in the large output file after the stage-storage-outflow table, modifications may be necessary to the rainfall and/or the ILSAX model file(s).

Additional stage-storage-discharge values will be required in the model. In the previous examples, 100 mm stage increments are shown. To remove this instability, the stage increments could be reduced to 50 or even as low as 10 mm. Also, additional increments for the high level discharge will help. Remember, 30 sets of values is the maximum limit for the ILSAX program.

Alternatively, a reduction in the time computation step may remove this instability. Figure 1 shows the rainfall files. Lines 6, 12, 18, 24, 30, 36, 42, 48, 54 and 60, the fourth number in each line represents the computation time interval. Reducing the value of this number will improve the accuracy of the flood routing through the basin. Also, it will increase the total time to do the analysis and may produce more than 360 rainfall ordinates. Any ordinates greater than 360 will be ignored and lost. This may occur for the longer duration storms greater than 60 minutes.

Extreme care must be taken to ensure that a least the first 70% of any storm passes through the basin. Usually, in small basins, once the basin has been filled, the remaining 30% of the storm will have a minimal effect upon the storage. The rainfall intensities at the end of a storm will be significantly lower than the first part of the storm. The inflow into a basin will be less than the outflow, hence its water level should be receding. It is the maximum volume of storage that is important, not the time to drain the basin.

In some cases, both types of modification will be necessary to produce a satisfactory result.

If the error message cannot be eliminated, especially for the very small basins, and there is no overflow from the structure, then the error message can be ignored. If the “Y” value is 0 or less, nothing can be done to improve the accuracy or remove the instabilities in the basin calculations.

However, if there is surcharge from the basin, fluctuating values will be produced from the overflow hydrograph in the output files. Simply average the immediate high and low values from the overflow hydrographs to obtain the more appropriate surcharge flow. The maximum modified value must then be added to the basin's maximum discharge from the orifice to obtain the total discharge exiting the site. Also, the designer must add the maximum discharge values from any areas not draining through the basin. This total value must be equal to or less than the pre-development discharges for the 5 year and 100 year ARI storm events.

APPENDIX 6 – SSR and PSD Tables

Table 2a: SSR and PSD for various site areas with equal to or less than 60% impervious

total area of site	min. size of basin (SSR)	max. Q5 from existing site (PSD from basin)	max. Q100 from existing site	Max. overflow from basin
m^2	m^3	l/s	l/s	l/s
200	5.0	7	13	6
250	6.1	9	16	7
300	7.4	11	19	8
350	8.5	12	22	10
400	9.8	14	25	11
450	11.6	15	28	13
500	13.5	16	30	14
550	15.2	17	33	15
600	17.0	18	36	18
650	18.9	20	39	19
700	20.9	21	41	20
750	22.8	22	43	21
800	24.7	23	45	22
850	26.1	24	47	23
900	28.6	25	49	24
950	29.1	26	51	25
1000	30.5	27	53	26
1050	32.0	29	56	27
1100	33.5	30	58	28
1150	35.1	32	61	29
1200	36.6	33	63	30

Note: Maximum concentrated discharge to kerb and gutter is 20 l/s

650	18.9	20	39	19
700	22.9	20	41	21
750	25.8	20	43	23
800	28.6	20	45	25
850	31.7	20	47	27
900	34.7	20	49	29
950	37.8	20	51	31
1000	40.8	20	53	33
1050	44.2	20	56	36
1100	47.6	20	58	38
1150	50.9	20	61	41
1200	54.3	20	63	43

Table 2b: SSR and PSD for various site areas with between 60 and 100% impervious

total area of site	min. size of basin (SSR)	max. Q5 from existing site (PSD from basin)	max. Q100 from existing site	Max. overflow from basin
M^2	m^3	l/s	l/s	l/s
200	5.5	7	13	6
250	6.8	9	16	7
300	8.2	11	19	8
350	9.5	12	22	10
400	10.9	14	25	11
450	12.9	15	28	13
500	15.0	16	30	14
550	17.0	17	33	15
600	19.0	18	36	18
650	21.1	20	39	19
700	23.3	21	41	20
750	25.4	22	43	21
800	27.5	23	45	22
850	29.1	24	47	23
900	30.8	25	49	24
950	32.4	26	51	25
1000	34.0	27	53	26
1050	35.7	29	56	27
1100	37.4	30	58	28
1150	39.1	32	61	29
1200	40.8	33	63	30

Note: Maximum concentrated discharge to kerb and gutter is 20 l/s

650	21.1	20	39	19
700	25.1	20	41	21
750	28.0	20	43	23
800	30.8	20	45	25
850	33.9	20	47	27
900	36.9	20	49	29
950	40.0	20	51	31
1000	43.0	20	53	33
1050	46.4	20	56	36
1100	49.8	20	58	38
1150	53.1	20	61	41
1200	56.5	20	63	43

Table 3: Orifice sized according to depth of ponding and PSD

PSD	Depth of tank above centreline of orifice																				
l/s	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	
2	55	46	42	39	37	35	34	33	32	31	30	30	29	28	28	28	27	27	26	26	
3	67	57	51	48	45	43	41	40	39	38	37	36	36	35	34	34	33	33	32	32	Min.
4	78	65	59	55	52	50	48	46	45	44	43	42	41	40	40	39	38	38	37	37	100 mm
5	87	73	66	62	58	56	54	52	50	49	48	47	46	45	44	44	43	42	42	41	diameter
6	95	80	72	67	64	61	59	57	55	54	52	51	50	49	48	48	47	46	46	45	outlet
7	103	87	78	73	69	66	63	61	59	58	57	55	54	53	52	51	51	50	49	49	pipe
8	110	93	84	78	74	70	68	65	64	62	60	59	58	57	56	55	54	53	53	52	
9	117	98	89	83	78	75	72	69	67	66	64	63	61	60	59	58	58	57	56	55	
10	123	104	94	87	82	79	76	73	71	69	68	66	65	64	63	62	61	60	59	58	
11	129	109	98	91	86	82	79	77	75	73	71	69	68	67	66	65	64	63	62	61	
12	135	113	102	95	90	86	83	80	78	76	74	72	71	70	69	67	66	65	65	64	
13	140	118	107	99	94	90	86	83	81	79	77	75	74	73	71	70	69	68	67	66	
14	146	122	111	103	97	93	90	87	84	82	80	78	77	75	74	73	72	71	70	69	Min.
15	151	127	115	107	101	96	93	90	87	85	83	81	79	78	77	75	74	73	72	71	150 mm
16	156	131	118	110	104	99	96	93	90	88	85	84	82	80	79	78	77	76	75	74	diameter
17	160	135	122	113	107	103	99	95	93	90	88	86	85	83	82	80	79	78	77	76	outlet
18	165	139	125	117	110	106	102	98	95	93	91	89	87	85	84	83	81	80	79	78	pipe
19	170	143	129	120	113	108	104	101	98	95	93	91	89	88	86	85	84	82	81	80	
20	174	146	132	123	116	111	107	104	100	98	96	94	92	90	88	87	86	85	83	82	
21	178	150	136	126	119	114	110	106	103	100	98	96	94	92	91	89	88	87	85	84	
22	183	154	139	129	122	117	112	109	105	103	100	98	96	94	93	91	90	89	87	86	
23	187	157	142	132	125	119	115	111	108	105	102	100	98	97	95	93	92	91	89	88	
24	191	160	145	135	128	122	117	113	110	107	105	102	100	99	97	95	94	93	91	90	
25	195	164	148	138	130	124	120	116	112	109	107	105	102	101	99	97	96	94	93	92	
26	198	167	151	140	133	127	122	118	115	112	109	107	105	103	101	99	98	96	95	94	
27		170	154	143	135	129	124	120	117	114	111	109	107	105	103	101	100	98	97	96	
28		173	156	146	138	132	127	122	119	116	113	111	108	106	105	103	101	100	99	97	
29		176	159	148	140	134	129	125	121	118	115	113	110	108	107	105	103	102	100	99	
30		179	162	151	143	136	131	127	123	120	117	115	112	110	108	107	105	104	102	101	
31		182	165	153	145	138	133	129	125	122	119	116	114	112	110	108	107	105	104	102	
32		185	167	156	147	141	135	131	127	124	121	118	116	114	112	110	108	107	105	104	
33		188	170	158	150	143	137	133	129	126	123	120	118	116	114	112	110	109	107	106	
34		191	172	160	152	145	140	135	131	128	125	122	120	117	115	113	112	110	109	107	Min.
35		194	175	163	154	147	142	137	133	129	126	124	121	119	117	115	113	112	110	109	225 mm
36		196	177	165	156	149	144	139	135	131	128	125	123	121	119	117	115	113	112	110	diameter
37		199	180	167	158	151	146	141	137	133	130	127	125	122	120	118	117	115	113	112	outlet
38		202	182	170	160	153	148	143	139	135	132	129	126	124	122	120	118	116	115	113	pipe
39		204	185	172	163	155	149	145	140	137	133	131	128	126	124	122	120	118	116	115	
40		207	187	174	165	157	151	146	142	138	135	132	130	127	125	123	121	120	118	116	
41		210	189	176	167	159	153	148	144	140	137	134	131	129	127	125	123	121	119	118	
42		212	192	178	169	161	155	150	146	142	139	136	133	130	128	126	124	122	121	119	
43		215	194	180	171	163	157	152	147	144	140	137	134	132	130	128	126	124	122	121	
44		217	196	183	173	165	159	154	149	145	142	139	136	133	131	129	127	125	124	122	
45		220	198	185	175	167	161	155	151	147	143	140	138	135	133	131	129	127	125	123	
46		222	201	187	177	169	162	157	152	148	145	142	139	136	134	132	130	128	126	125	
47		224	203	189	178	170	164	159	154	150	147	143	141	138	136	133	131	130	128	126	
48		227	205	191	180	172	166	160	156	152	148	145	142	139	137	135	133	131	129	128	
49		229	207	193	182	174	168	162	157	153	150	146	143	141	138	136	134	132	131	129	
50		231	209	195	184	176	169	164	159	155	151	148	145	142	140	138	136	134	132	130	

Min. 375 mm diameter outlet pipe

Min. 300 mm diameter outlet pipe

For orifice diameters less than 50 mm, a 90 mm diameter plastic pipe may be used as the outlet pipe from the basin.
Discharge allowed to kerb is not to exceed 20 l/s

Flow through the orifice is based on the equation

$Q = C A \sqrt{(2 g H)} \times 10^3$

$d = \sqrt{(4 A / \pi)} \times 10^3$

Q = the flowrate in litres per second

Where

C = 0.6 for a circular, square cut edged orifice

H = the depth of ponding from the centreline of the orifice to the upper water surface level in metres

A = the area of the orifice in square metres

g = 9.81 metres per second per second (gravity)

π = 3.1416

d = the diameter of the orifice in millimetres

Table 4: Time of concentration for 5 year ARI design storm

(i) grassed times of flow

n* = 0.33

slope % / length (m)	.5	1	2	3	4	5	6	8	10	12	14	16	18	20	25	30
5	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10	10	8	6	5	5	5	5	5	5	5	5	5	5	5	5	5
15	13	10	8	7	6	6	6	5	5	5	5	5	5	5	5	5
20	16	13	10	9	8	7	7	6	6	5	5	5	5	5	5	5
25	19	15	12	10	9	8	8	7	7	6	6	6	6	5	5	5
30	22	17	13	11	10	10	9	8	7	7	6	6	6	6	5	5
35	25	19	15	13	12	11	10	9	8	8	7	7	7	7	6	6
40	27	21	16	14	13	12	11	10	9	9	8	8	8	7	7	6
45	30	23	18	15	14	13	12	11	10	9	9	8	8	8	7	7
50	32	25	19	17	15	14	13	12	11	10	9	9	9	8	8	7
55	35	27	21	18	16	15	14	12	12	11	10	10	9	9	8	8
60	37	28	22	19	17	16	15	13	12	12	11	10	10	10	9	9
65	39	30	23	20	18	17	16	14	13	12	12	11	11	10	10	9

(ii) Concentrated times of flow over driveways, pathways, through pipes, etc. for the remainder of the site.

n* = 0.012

slope % / length (m)	.5	1	2	3	4	5	6	8	10	12	14	16	18	20	25	30
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
35	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
40	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
45	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
50	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
55	3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1
60	3	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1
65	4	3	2	2	2	2	2	1	1	1	1	1	1	1	1	1

Table 5: Time of concentration for 100 year ARI design storm

(i) grassed times of flow

n* = 0.33

slope % / length (m)	.5	1	2	3	4	5	6	8	10	12	14	16	18	20	25	30
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
10	7	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5
15	10	8	7	6	5	5	5	5	5	5	5	5	5	5	5	5
20	13	10	8	7	6	6	5	5	5	5	5	5	5	5	5	5
25	15	12	9	8	8	7	6	6	5	5	5	5	5	5	5	5
30	17	13	10	9	8	8	7	6	6	5	5	5	5	5	5	5
35	19	15	12	10	9	9	8	7	7	6	6	6	5	5	5	5
40	21	16	13	11	10	9	9	8	7	7	6	6	6	6	5	5
45	23	18	14	12	11	10	9	9	8	7	7	7	6	6	6	5
50	25	19	15	13	12	11	10	9	9	8	8	7	7	7	6	6
55	26	21	16	14	13	11	11	10	9	8	8	7	7	7	6	6
60	28	22	17	15	13	12	12	11	10	9	9	8	8	8	7	7
65	30	23	18	16	14	13	12	11	10	9	9	8	8	8	7	7

(ii) Concentrated times of flow over driveways, pathways, through pipes, etc. for the remainder of the site.

n* = 0.012

slope % / length (m)	.5	1	2	3	4	5	6	8	10	12	14	16	18	20	25	30
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
35	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
40	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
50	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
55	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
60	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
65	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1

APPENDIX 7 – ILSAX Rainfall Files

Figure 1: ILSAX rainfall files for 5 and 100 year ARI storms

```
3  2  10
5 YEAR, 10 MINUTE ARI
1  2  -1  0  -0.3  0  -100  0.3
1  5  2.5  3.0  1  1  0
1
5  10  5  .2  1
1  5  130
0
5 YEAR, 15 MINUTE ARI
-1  0  3.0
1
5  15  5  .2  1
1  5  110
0
5 YEAR, 20 MINUTE ARI
-1  0  3.0
1
5  20  5  .2  1
1  5  97
0
5 YEAR, 25 MINUTE ARI
-1  0  3.0
1
5  25  5  .2  1
1  5  87
0
5 YEAR, 30 MINUTE ARI
-1  0  3.0
1
5  30  5  .2  1
1  5  80
0
5 YEAR, 45 MINUTE ARI
-1  0  3.0
1
5  45  5  .2  1
1  5  65
0
5 YEAR, 1 HOUR ARI
-1  0  3.0
1
5  60  5  .3  1
1  5  55
0
5 YEAR, 1.5 HOUR ARI
-1  0  3.0
1
5  90  5  .3  1
1  5  44.0
0
5 YEAR, 2 HOUR ARI
-1  0  3.0
1
5  120  5  .3  1
1  5  37.0
0
5 YEAR, 3 HOUR ARI
-1  0  3.0
1
5  180  15  .3  1
1  5  29.1
0
```

```
3  2  10
100 YEAR, 10 MINUTE ARI
1  2  -1  0  -0.3  0  -100  0.3
1  5  2.5  3.0  1  1  0
1
5  10  5  .2*  1
1  100  213
0
100 YEAR, 15 MINUTE ARI
-1  0  3.0
1
5  15  5  .2*  1
1  100  184
0
100 YEAR, 20 MINUTE ARI
-1  0  3.0
1
5  20  5  .2*  1
1  100  163
0
100 YEAR, 25 MINUTE ARI
-1  0  3.0
1
5  25  5  .2*  1
1  100  149
0
100 YEAR, 30 MINUTE ARI
-1  0  3.0
1
5  30  5  .2*  1
1  100  135
0
100 YEAR, 45 MINUTE ARI
-1  0  3.0
1
5  45  5  .2*  1
1  100  112
0
100 YEAR, 1 HOUR ARI
-1  0  3.0
1
5  60  5  .3*  1
1  100  96
0
100 YEAR, 1.5 HOUR ARI
-1  0  3.0
1
5  90  5  .3*  1
1  100  77
0
100 YEAR, 2 HOUR ARI
-1  0  3.0
1
5  120  5  .5*  1
1  100  65
0
100 YEAR, 3 HOUR ARI
-1  0  3.0
1
5  180  15  .5*  1
1  100  52
0
```

***Note: For larger site areas use increments of '1' or '2' to avoid program from 'crashing'.**

Figure 2: ILSAX rainfall files for 3 month and 1 year ARI storms

```
3  2  10
3 MONTH, 10 MINUTE ARI
1  2  -1  0  -0.3  0  375  0.3
1  5  2.5  3.0  1  1  0
1
5  10  5  .2  1
1  1  30.5
0
3 MONTH, 15 MINUTE ARI
-1  0  3.0
1
5  15  5  .2  1
1  1  24.0
0
3 MONTH, 20 MINUTE ARI
-1  0  3.0
1
5  20  5  .2  1
1  1  20.0
0
3 MONTH, 25 MINUTE ARI
-1  0  3.0
1
5  25  5  .2  1
1  1  17.4
0
3 MONTH, 30 MINUTE ARI
-1  0  3.0
1
5  30  5  .2  1
1  1  15.3
0
3 MONTH, 45 MINUTE ARI
-1  0  3.0
1
5  45  5  .2  1
1  1  10.8
0
3 MONTH, 1 HOUR ARI
-1  0  3.0
1
5  60  5  .2  1
1  1  7.8
0
3 MONTH, 1.5 HOUR ARI
-1  0  3.0
1
5  90  5  .2  1
1  1  7.0
0
3 MONTH, 2 HOUR ARI
-1  0  3.0
1
5  120  5  .2  1
1  1  5.5
0
3 MONTH, 3 HOUR ARI
-1  0  3.0
1
5  180  15  .2  1
1  1  4.5
0
```

```
3  2  10
1 YEAR, 10 MINUTE ARI
1  2  -1  0  -0.3  0  375  0.3
1  5  2.5  3.0  1  1  0
1
5  10  5  .2  1
1  1  80
0
1 YEAR, 15 MINUTE ARI
-1  0  3.0
1
5  15  5  .2  1
1  1  67
0
1 YEAR, 20 MINUTE ARI
-1  0  3.0
1
5  20  5  1  1
1  1  58
0
1 YEAR, 25 MINUTE ARI
-1  0  3.0
1
5  25  5  1  1
1  1  52
0
1 YEAR, 30 MINUTE ARI
-1  0  3.0
1
5  30  5  1  1
1  1  47.4
0
1 YEAR, 45 MINUTE ARI
-1  0  3.0
1
5  45  5  1  1
1  1  38.0
0
1 YEAR, 1 HOUR ARI
-1  0  3.0
1
5  60  5  1  1
1  1  32.4
0
1 YEAR, 1.5 HOUR ARI
-1  0  3.0
1
5  90  5  2  1
1  1  25.7
0
1 YEAR, 2 HOUR ARI
-1  0  3.0
1
5  120  5  2  1
1  1  21.6
0
1 YEAR, 3 HOUR ARI
-1  0  3.0
1
5  180  15  2  1
1  1  17.0
0
```

Figure 3: ILSAX rainfall files for 20 and 50 year ARI storms

```
3  2  10
20 YEAR, 10 MINUTE ARI
1  2  -1  0  -0.3  0  375  0.3
1  5  2.5  3.0  1  1  0
1
5  10  5  1  1
1  20  166
0
20 YEAR, 15 MINUTE ARI
-1  0  3.0
1
5  15  5  1  1
1  20  142
0
20 YEAR, 20 MINUTE ARI
-1  0  3.0
1
5  20  5  1  1
1  20  125
0
20 YEAR, 25 MINUTE ARI
-1  0  3.0
1
5  25  5  1  1
1  20  112
0
20 YEAR, 30 MINUTE ARI
-1  0  3.0
1
5  30  5  1  1
1  20  104
0
20 YEAR, 45 MINUTE ARI
-1  0  3.0
1
5  45  5  1  1
1  20  85
0
20 YEAR, 1 HOUR ARI
-1  0  3.0
1
5  60  5  1  1
1  20  73
0
20 YEAR, 1.5 HOUR ARI
-1  0  3.0
1
5  90  5  2  1
1  20  58
0
20 YEAR, 2 HOUR ARI
-1  0  3.0
1
5  120  5  2  1
1  20  49.2
0
20 YEAR, 3 HOUR ARI
-1  0  3.0
1
5  180  15  2  1
1  20  38.7
0
```

```
3  2  10
50 YEAR, 10 MINUTE ARI
1  2  -1  0  -0.3  0  375  0.3
1  5  2.5  3.0  1  1  0
1
5  10  5  1  1
1  50  193
0
50 YEAR, 15 MINUTE ARI
-1  0  3.0
1
5  15  5  1  1
1  50  168
0
50 YEAR, 20 MINUTE ARI
-1  0  3.0
1
5  20  5  1  1
1  50  147
0
50 YEAR, 25 MINUTE ARI
-1  0  3.0
1
5  25  5  1  1
1  50  132
0
50 YEAR, 30 MINUTE ARI
-1  0  3.0
1
5  30  5  1  1
1  50  122
0
50 YEAR, 45 MINUTE ARI
-1  0  3.0
1
5  45  5  1  1
1  50  100
0
50 YEAR, 1 HOUR ARI
-1  0  3.0
1
5  60  5  1  1
1  50  86
0
50 YEAR, 1.5 HOUR ARI
-1  0  3.0
1
5  90  5  2  1
1  50  69
0
50 YEAR, 2 HOUR ARI
-1  0  3.0
1
5  120  5  2  1
1  50  58
0
50 YEAR, 3 HOUR ARI
-1  0  3.0
1
5  180  15  2  1
1  50  46.1
0
```

APPENDIX 8 – OSD Checklist

Warringah Council

On-site Stormwater Detention (OSD) Checklist

For Single Dwelling Residential Developments

This form is to be used to determine if OSD will be required for demolition and reconstruction, or construction of new single dwelling residential developments and **must be completed and included with the submission of any development application for these works**. Please read both sides of this form carefully for its applications, guidelines and definitions.

For assistance and support, please contact Council's Customer Service Centre on (02) 9942 2111.

Address of Proposed Development	
Address of proposed development	Lot ☐ DP (if applicable) ☐ No. ☐ Street ☐ Suburb ☐
PART 1 Exemption for properties that drain naturally away from the street	
Tick one only	Does the site fall naturally away from the street? Yes ☐ No ☐ If yes, stormwater drainage must be in accordance with Council's Policy No. PDS-POL 136 'Stormwater Drainage from Low Level Properties'. If no, proceed to the next part.
PART 2 Is the site area less than 450m^2	
Tick one only	Yes ☐ No ☐ If yes, OSD is not required. If no, proceed to next part.
PART 3 Exemption for Direct Discharge to Ocean	
Tick one only	Does the site of the development drain directly to the ocean without the need to pass through a drainage control structure such as a pipe, bridge, culvert, kerb and gutter or natural drainage system? Yes ☐ No ☐ If yes, OSD is not required. If no, proceed to the next part.

PART 4 Exemption for Flood Affected Areas	
Tick one only	Is the site of the development located within an established Flood Prone Land as referred to in the Warringah Local Environmental Plan? Refer to section 2.6 of Council's OSD Technical Specification. Yes ☐ No ☐ If yes, OSD is not required. If no, proceed to the next part.
PART 5 Determination of OSD Requirements	
3.1 Calculations Please view below examples	(a) Site area _____ m^2 x 0.40 = _____ m^2 (b) Proposed and remaining impervious area _____ m^2 **OSD will not be required when (a) is greater than (b)** Is OSD required for this development (tick one only) Yes ☐ No ☐ If yes, then a design in accordance with the Streamlined Method in Council's OSD Technical Specification is to be provided with the Development Application (refer to Clause 3.1.1) If no, OSD is not required.
3.2 Example	If the proposed combined impervious area is greater than 40% of the site area, then OSD is required. *Example 1*: Site Area = 600m^2 Total proposed & remaining impervious area = 290m^2 600 x 0.4 = 240m^2 (290 > 240) OSD required *Example 2*: Site Area = 800m^2 Total proposed & remaining impervious area = 290m^2 800 x 0.4 = 320m^2 (290 < 320) OSD is **not** required
DEFINITIONS	
Designed to help you fill out this application	**Site area:** This refers to the area of the land bounded by its existing or proposed boundaries. **Impervious areas:** This refers to driveways, pathways, paved areas, hardstand areas, roofed areas, garages and outbuildings that are proposed and to be retained. Where an existing structure is to be demolished to make way for a new dwelling, only the proposed impervious areas and remaining impervious areas are to be used in the calculations. No credit is given for existing impervious areas that are not retained.
NOTES	
Please read before filling out this form	1. Other works, ancillary buildings, commercial, industrial, subdivisions and multiple occupancy developments are to comply with Council's **OSD Technical Specification**. 2. A reduction in the OSD volume required may be permitted. Refer to Council's "OSD Rainwater Re-use Policy for Single Residential Dwellings". If OSD is required, then a design for OSD in accordance with Council's "OSD Technical Specifications" is to be provided with the development application.

APPENDIX 9 – Sample Drawings

Figure 4: Typical OSD Underground Tank Detail

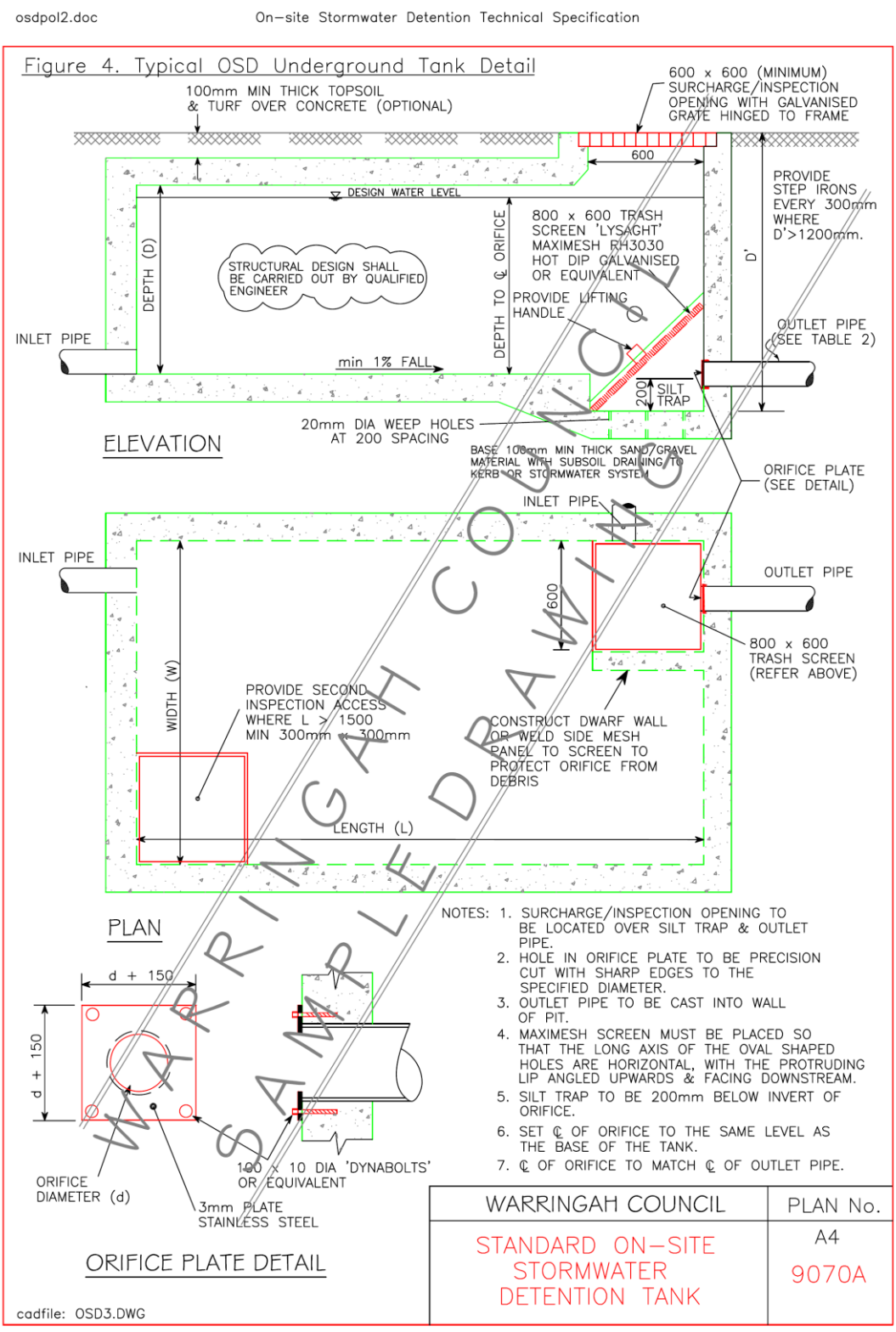


Figure 5: Typical OSD Underground Tank with HED Control Detail

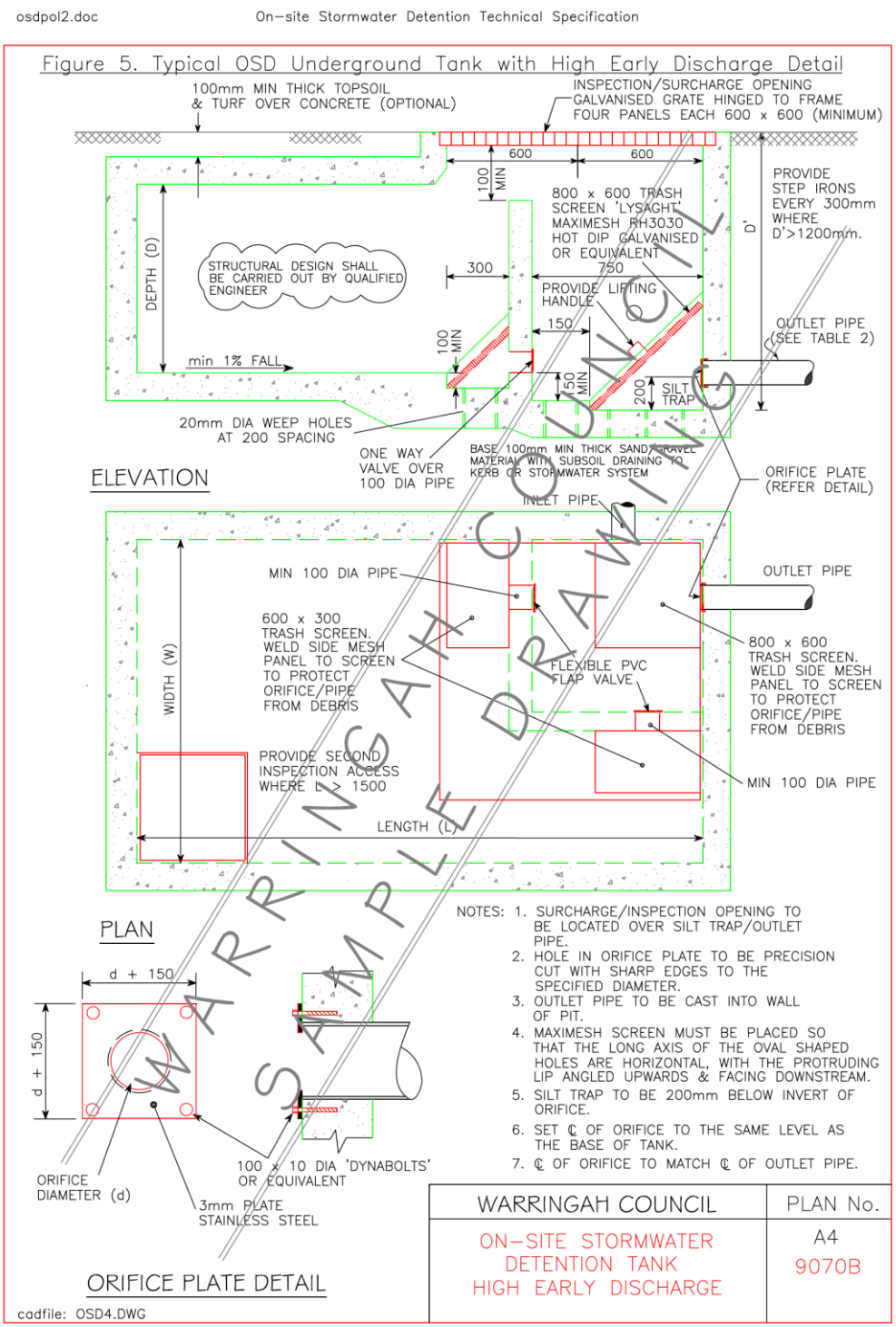


Figure 6: Sample OSD stormwater drainage details underground tank

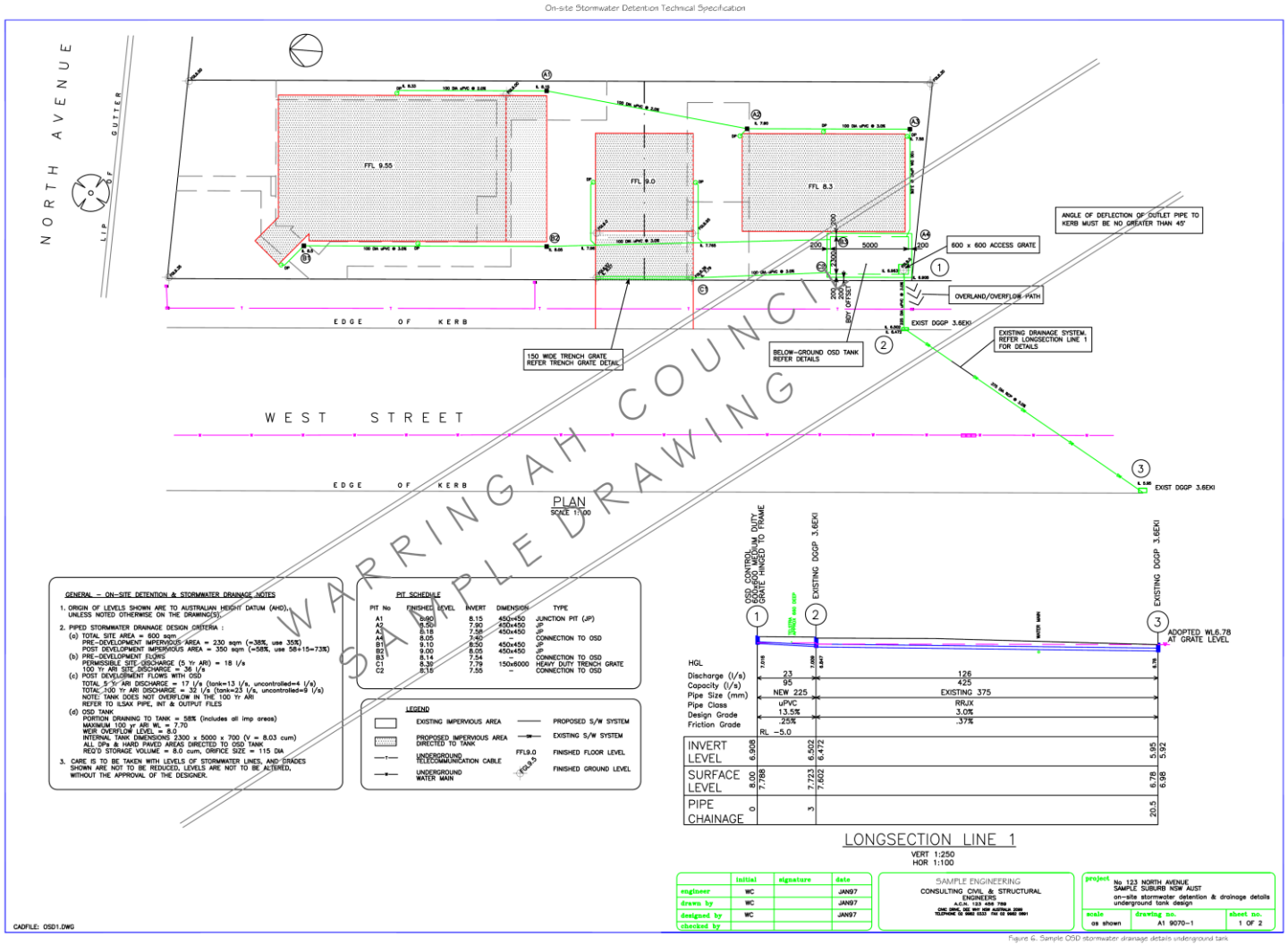


Figure 6: Sample OSD stormwater drainage details underground tank

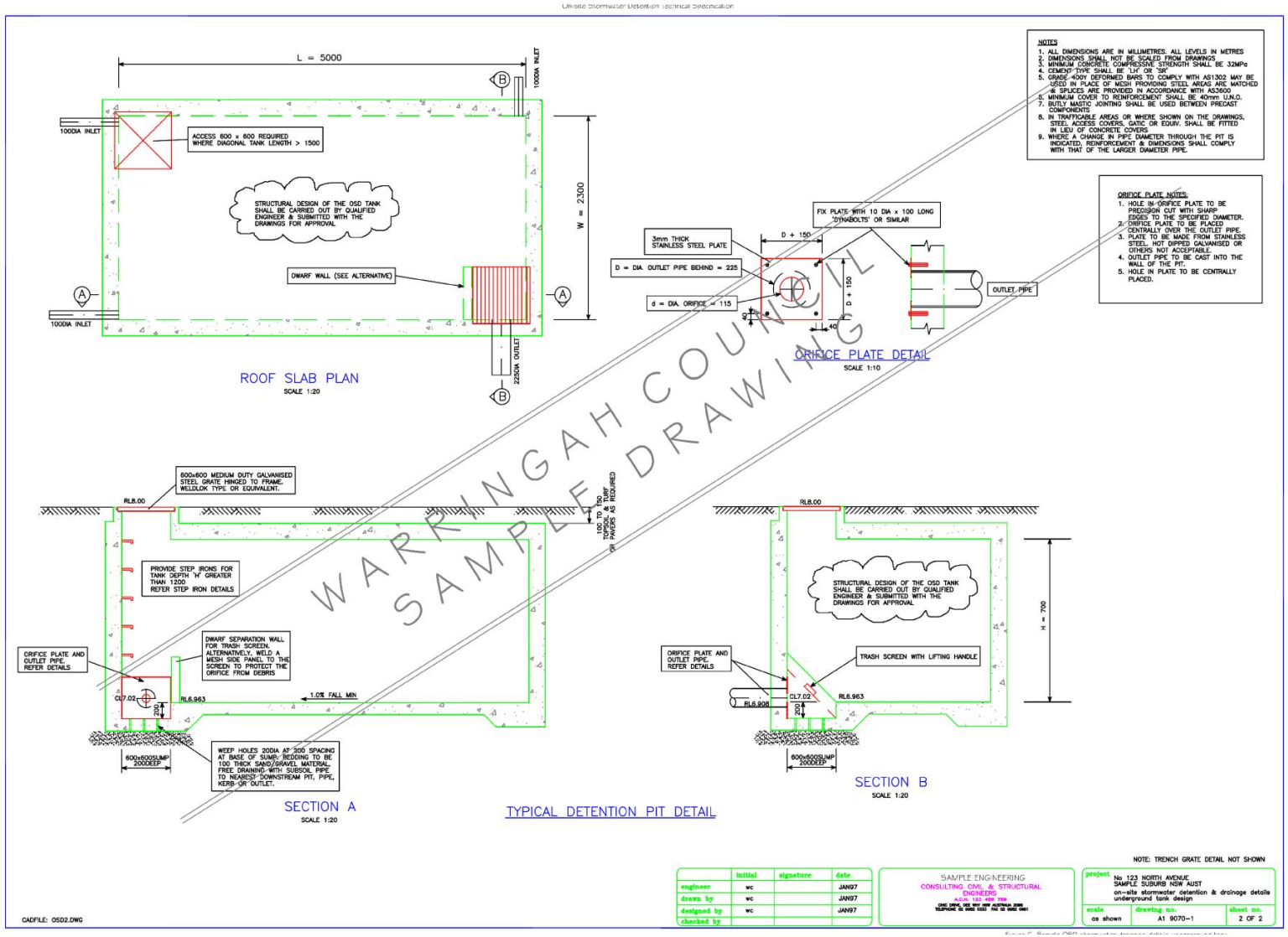
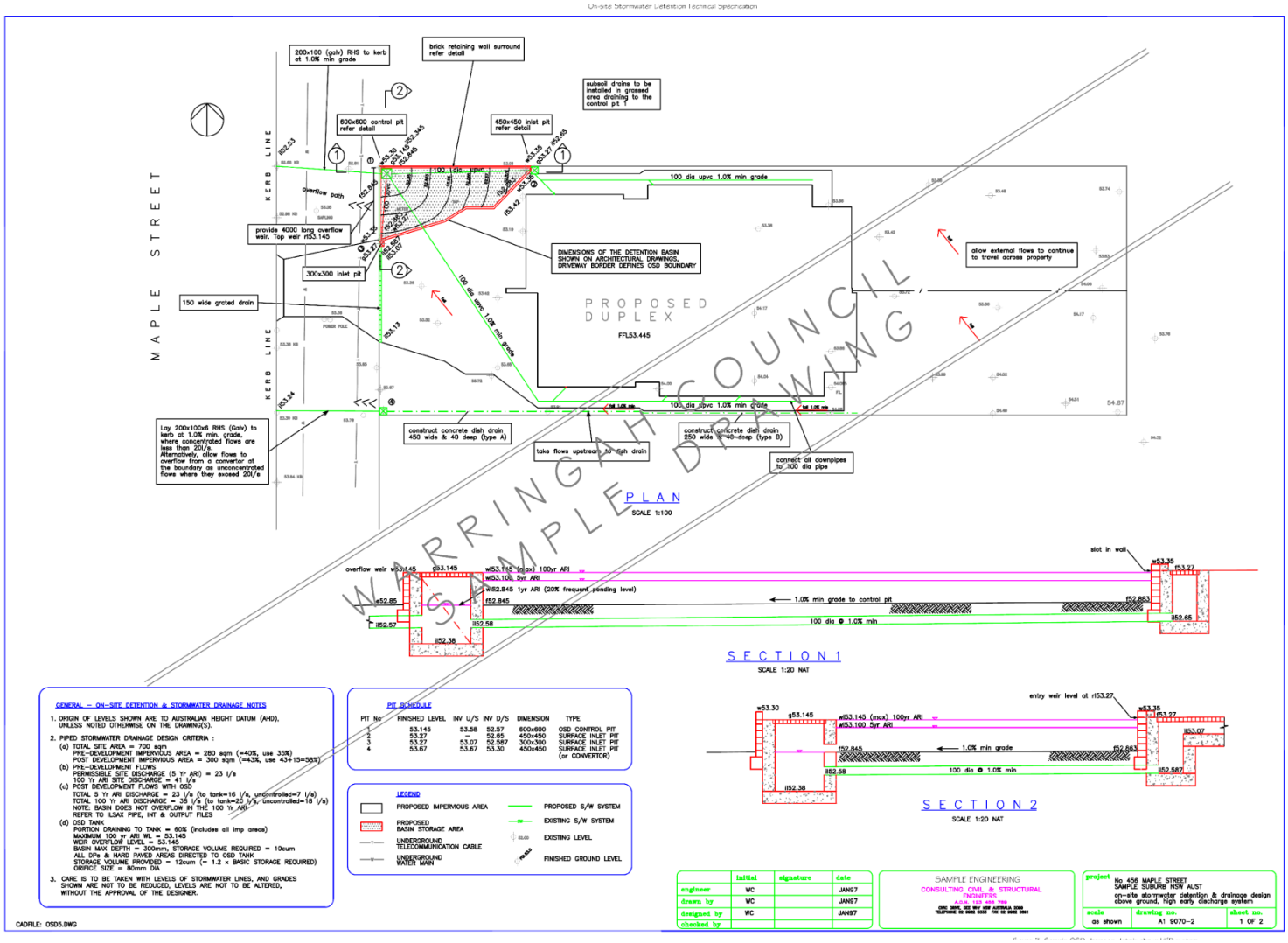


Figure 7: Sample OSD drainage details above ground HED system



On-site Stormwater Detention Technical Specification

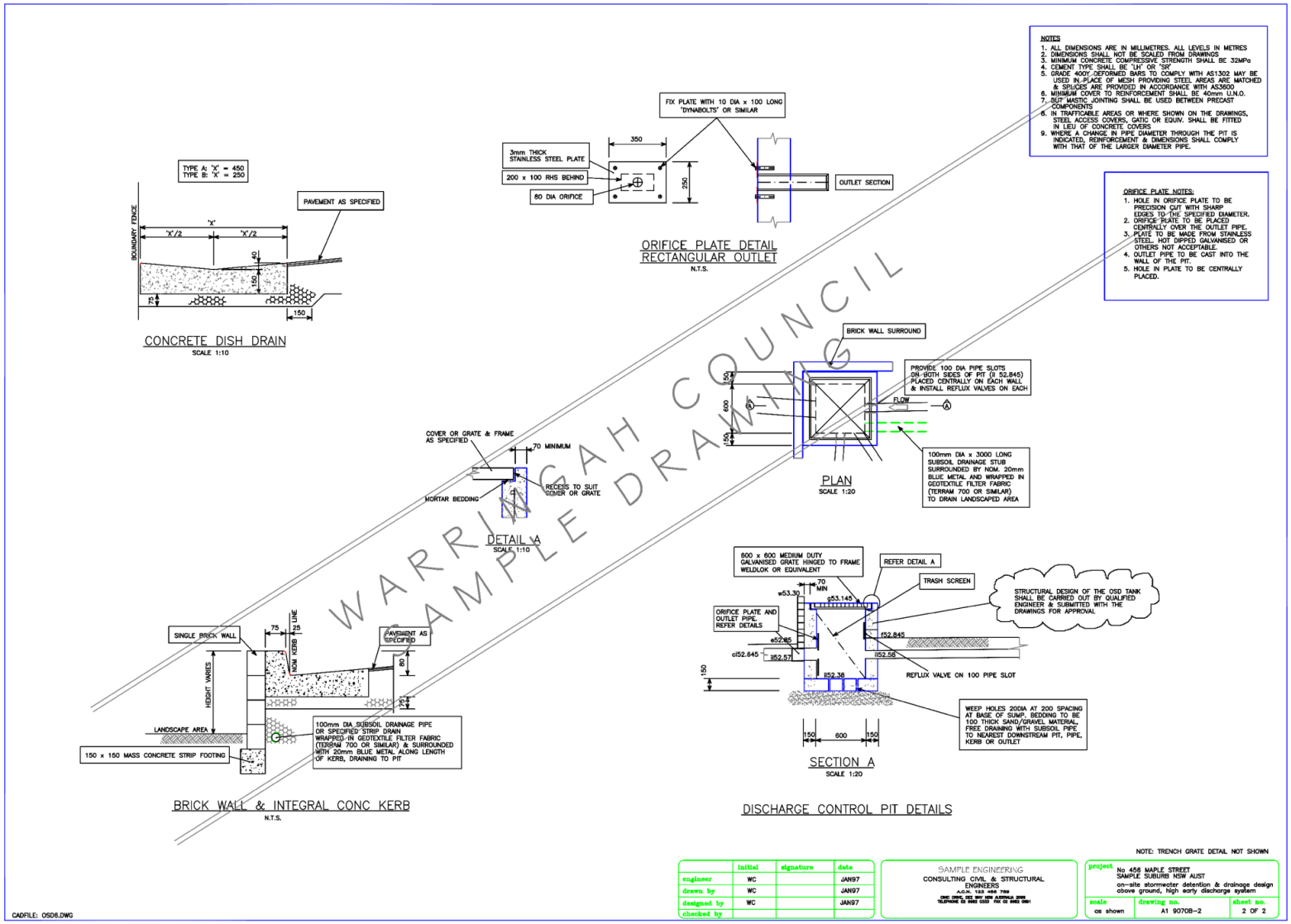


Figure 7. Sample OSD drainage details aboveground MED system