# NEW SOUTH WALES

# DEVELOPMENT DESIGN SPECIFICATION

# D8

# **WATERFRONT DEVELOPMENT**

# DEVELOPMENT DESIGN SPECIFICATION D8
# WATERFRONT DEVELOPMENT GENERAL

## D8.01 SCOPE

1. The work to be executed under this Specification consists of the design of waterway facilities and structures for canal type subdivisions to meet the requirements of Council and the Public Works Department.

2. This Specification provides specific requirements related to developments that include water frontages to natural waterways or include the development of artificial waterways. The requirements set out for design in this Specification are to be considered supplementary to the requirements of Council's other design specifications.

## D8.02 OBJECTIVE

1. This Specification aims to provide both guidelines and requirements for Designers of developments that include water frontage. The requirements and guidelines seek to ensure waterfront development that is environmentally sound and avoids major commitments to future maintenance and restoration.

## D8.03 REFERENCE AND SOURCE DOCUMENTS

### (a) Council Specifications

D1 - Geometric Road Design
D3 - Structures and Bridge Design

### (b) Australian Standards

AS 2870.1 - Residential slabs and footings - Construction
AS 3798 - Guidelines on earthworks for commercial and residential developments.

### (c) NSW State Legislation

Rivers and Foreshores Improvement Act No.20, 1948-1965

### (d) State Authorities

PUBLIC WORKS DEPARTMENT, NSW.

- Canal Subdivisions: General Conditions and Guidelines: Reference Document (1989).
- Floodplain Development Manual. Report PWD86010 (1986).
- Design Guidelines for Wharves and Jetties. Report No. 88062 (1990).
- Boat Launching Ramp Guidelines. Report No. PWD78024 (1985).
- Marina Guidelines. Report No. 87054 (1985).

DEPARTMENT OF PLANNING, NSW.

- Canal Estate Development: Planning guidelines Discussion Paper (1989).
- Canal Estate Developments: Design Guidelines (1991).

NSW FISHERIES, NSW
- Guidelines for Canal Estate Developments. Advisory Note 3.84.

SOIL CONVSERVATION SERVICE, NSW
- Urban Erosion and Sediment Control. Technical Handbook No.2 (1978).

NSW GOVERNMENT
- A Greenhouse Strategy for New South Wales: Discussion Paper (1990).

AUSTRALIAN WATER AND COASTAL STUDIES
- Greenhouse Seminar Notes (1990).

## D8.04 CONSULTATION

***Public Authority Approval***

1. Consultation with public authorities is necessarily more comprehensive in the case of waterfront developments. Design proposals shall not be considered by Council until all relevant approvals from public authorities have been obtained. Relevant public authorities include:

- The Department of Public Works and Services, NSW (PWD)
- NSW Fisheries
- Waterways Authority
- National Parks and Wildlife Services (NPWS)
- The Department of Land and Water Conservation.

## D8.05 GENERAL REQUIREMENTS

***Flood Levels***

1. There are general requirements pertinent to waterfront development which are applied by Council or other public authorities. These requirements include:

- No adverse effect to flood levels in the area.
- No adverse effect to erosion or deposition conditions within the existing environment.

***Erosion***

- Revetment walling is to be located with the property boundary.

***Siltation***

- Rivers and Foreshores Improvement Act No. 20 1948-1965.

## D8.06 LAND RECLAMATION

***Fill Bearing Capacity***

1. A detailed foundation investigation shall be carried out by a qualified practising geotechnical engineer to determine the long term bearing capacity of the site. The investigation shall include the bearing capacity of the in-situ and fill components of the foundation. It shall predict the settlement of the finished surface through time (without structural loading). The foundation investigation shall specify any procedures or provisions to ensure that the foundation performance of the site will be suitable for the proposed types of site development in accordance with AS3798.

***Geotechnical Certification for Allotments***

2. Before any allotments can be sold to the public, a certificate shall be issued by a qualified practising geotechnical engineer, attesting that the site has achieved the desired standard of performance and each site is to be classified in accordance with AS 2870.1.

***Foundation Design***

3. The design of structural foundations should be carried out by a qualified practising structural engineer to ensure compatibility with the inherent foundation properties of the proposed site.

## CANALS

### D8.07 PLANNING CONCEPTS

***Appearance***

1. Consideration should be given to design of artificial waterways which are more natural in appearance than conventional rectilinear key type canal developments, exhibit superior mixing and tidal exchange performance and which permit straightforward maintenance. See Figure D8.1 for typical layout.

***Positioning Parks***

2. The location of parks and reserves within the development should be judiciously selected. Location of parks and reserves at the head of canals is desirable.

***Canal Depth***

3. Depths shall be kept as shallow as possible, consistent with navigation and other requirements, in order to maximise tidal flushing and mixing by wind action.

***Moorings***

4. The factors involved in selection of water depth for navigation and mooring areas are as follows:

- draught of boat
- underkeel clearance (UKC)
- allowance for sedimentation.

5. Water quality within canals must be such that the following are not adversely affected:

- occasional swimming and wading
- boating
- passive recreation
- visual aesthetic acceptability
- freedom from excessive plant and algal growth
- the maintenance of a complete aquatic faunal community.

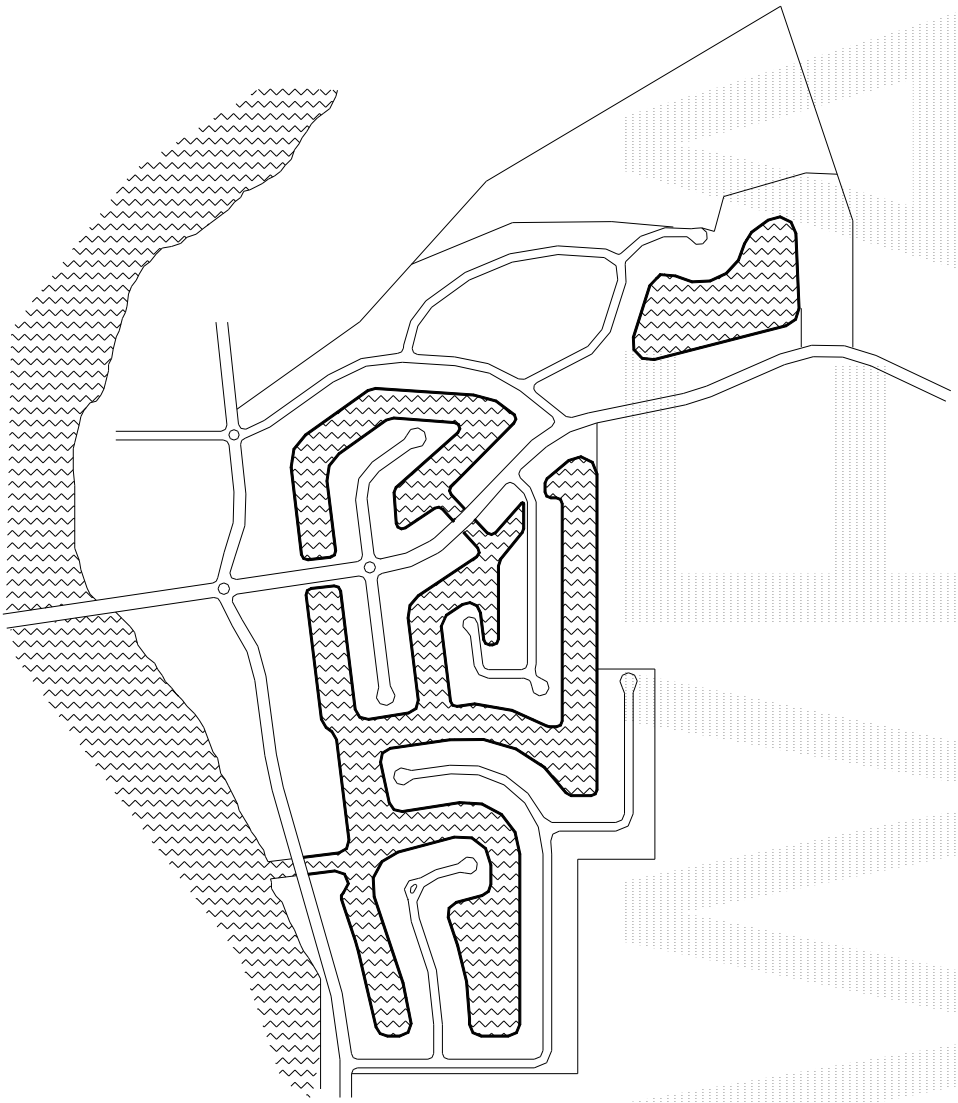


**Figure D8.1 Typical Layout**

Source: Planning Workshop 1994
(Consultants)

## D8.08 PLAN GEOMETRY

1. Wherever possible, the design of the canal development should incorporate the following factors to promote optimal mixing and exchange: ***Waterway Mixing and Exchange***

- provision of bends and meandering canals, and elimination of poorly flushed pockets and coves;
- provision of additional tidal prism at the head of canals by creation of a lake or basin;
- provision of multiple entrances to produce flow-through currents;
- inclusion of artificial islands and roughness elements to enhance local circulation.

## D8.09 WATERWAY DEPTHS

1. Canal centre depths shall not exceed the depth available in the host waterbody at the canal entrance(s). ***Entrance Depth***

2. Canal centre depths throughout the canal system shall be uniform or graded towards the canal entrance(s).

3. Depths should be sufficient for safe navigation by craft likely to use the waterway, except in non navigable areas which may be set aside for creation of wetland habitats. ***Navigable Depths***

4. A maximum canal depth of 2 metres is preferred. Depths in excess of 3 metres below Indian Spring Low Water will not be accepted unless detailed studies are undertaken to satisfy PWD that water quality problems will not arise. ***Preferred Maximum Depth***

5. Suitable allowance shall be made for sedimentation and bank stability in establishing the design canal depth. ***Allowance***

## D8.10 WATERWAY (CANAL) WIDTHS

1. Two measurements for canal width can be distinguished: ***Width Definition***

- navigation width: width of canal at the navigation depth
- overall canal width: width of canal between the top of the revetment walls.

These two canal widths are shown in Figure D8-2 for a typical "Dry Beach" canal cross-section.

2. The navigation widths for Main Canals and Side Canals shall be sufficient for safe navigation by two-way and one-way boat traffic respectively, taking into account the size of craft likely to use the waterway. Minimum navigation widths shall be as follows: ***Navigable Widths***

Main Canal $5 \times B_{max}$ or 20m whichever is the greater

Side Canal $3 \times B_{max}$ or 15m whichever is the greater

Where $B_{max}$ is the maximum beam of the craft likely to use the waterway.

Where any structures or moored craft encroach into the navigation width, a clear distance of $5 \times B_{max}$ and $3 \times B_{max}$ shall be provided in Main Canals and Side Canals respectively, measured between structures or craft moored on opposite sides of the canals.

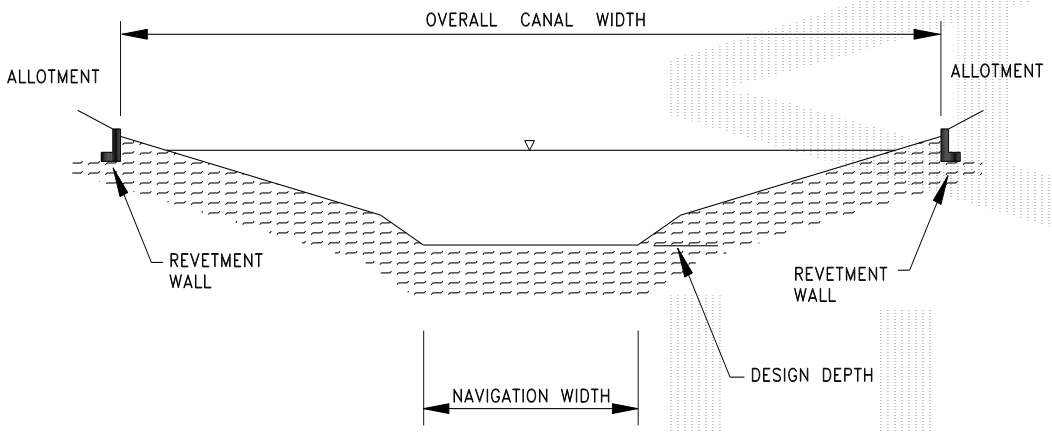



**Figure D8.2 Typical Beach Cross Section**

3. The navigation width of the entrance channel shall be sufficient for safe navigation by craft likely to use the waterway taking into account the degree of exposure of the entrance, but shall not be less than 25m.

4. The overall width of any canal shall not be less than 50m. ***Minimum Overall Width***

5. The Department may require that the overall width of canals be increased above the minimum value where it is considered that such widening is necessary to improve mixing and flushing characteristics.

6. Determination of the navigation and overall canal widths shall take into account bank and bed stability considerations.

## D8.11 WATERWAY LENGTH

1. Determination of the design canal length(s) shall take into account the following main factors:

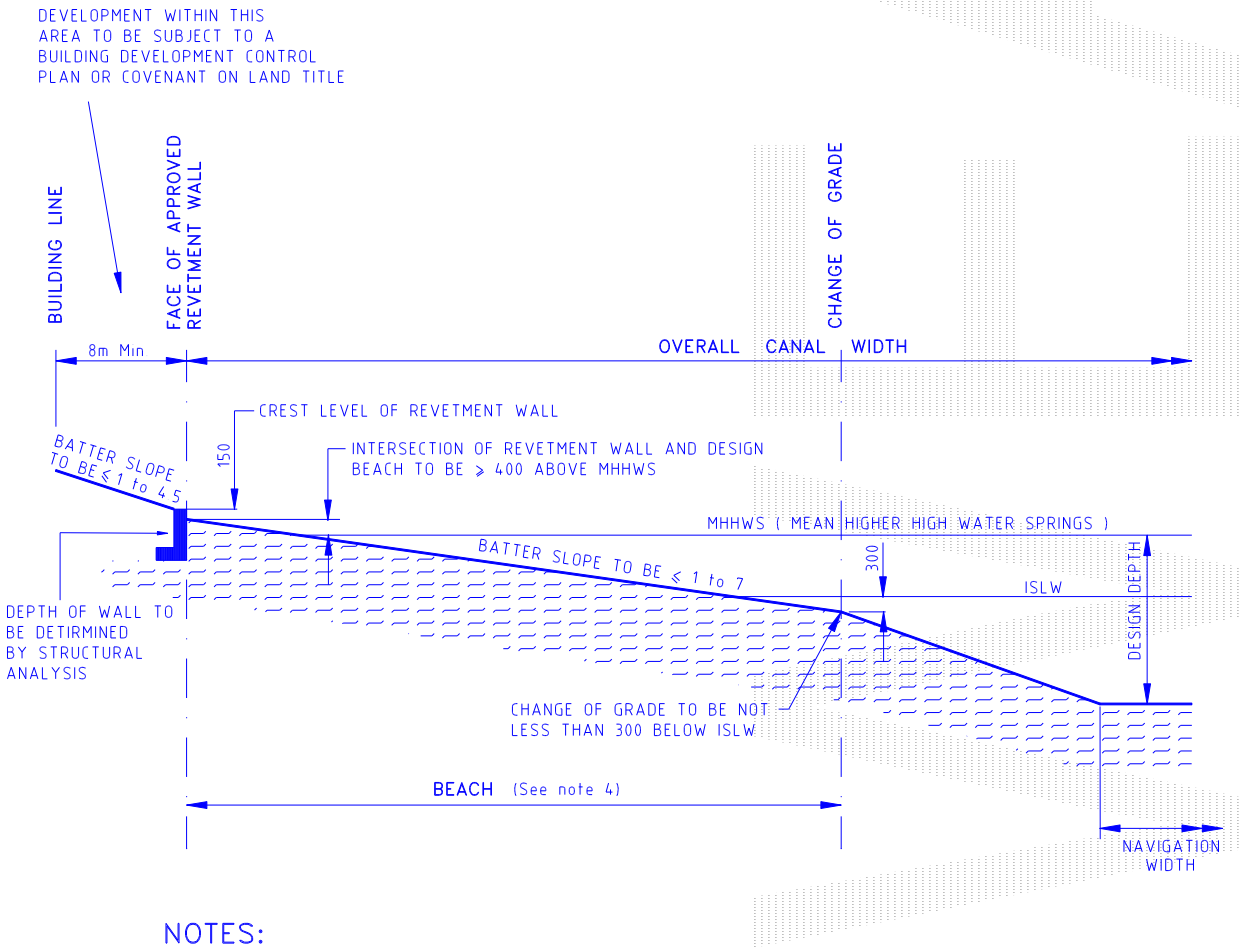
- flushing and water quality considerations
- bank and bed stability
- boat travel times.

2. The maximum distance from the host waterbody to the end of the canal(s) shall not exceed 1 kilometre unless studies are undertaken which establish that water quality will be satisfactory. ***Maximum Canal Length***

## D8.12 WATERWAY CROSS SECTIONS

1. The canal cross-section and edge treatment shall be designed in accordance with sound engineering practice by a qualified civil engineer, taking into account the type of soil conditions, the likely range of water levels including long term variations, and the applied forces. Engineering studies demonstrating the adequacy of the canal cross-sections and edge treatment shall be made available to the PWD. ***Engineering Studies***

2. The canal cross-section design should conform in principle with the design cross-sections shown in Figure D8.3 however, alternative designs will be considered. ***Alternatives***




NOTES:

1 Revetment wall to incorporate kerb and gutter detail to prevent runoff over wall onto beach
2 Design of revetment wall to allow for a minimum of 300 erosion in front of wall
3 Revetment wall shown schematically only
4 Beach to comprise a minimum 600 thickness of clean sand approved grain size and to a minimum width of 7.5m
5 All underwater batter slopes subject to engineering investigation
6 Building line to be specified by Council
7 Diagram not to scale

**Figure D8.3**
**No Beach Submerged Cross Section**

Source: Public Works Department 1992

## D8.13 UNDERWATER BATTERS AT CANALS AND SHORELINES

1. The typical ranges of stable underwater batters for different types of material are designated in Table D8-1.

**Table D8-1**
**Effect Of Material Type On Underwater Batter**

| MATERIAL | STABLE UNDERWATER BATTER | | |
|---|---|---|---|
| Stiff Clay | | 1 : 1.5 | |
| Firm Clay | 1 : 2 | to | 1 : 4.5 |
| Sandy Clay | 1 : 4 | to | 1 : 7 |
| Coarse Sand | 1 : 3 | to | 1 : 6 |
| Fine Sand | 1 : 5 | to | 1 : 10 |
| Mud | 1 : 8 | to | 1 : 50 |

2. Stormwater outlets into beach type canals are to be submerged in the canal waters. ***Stormwater Outlets***

3. Use of coarse granular materials for beach formation, eg. gravels and cobbles, may cause problems in the form of oyster and barnacle growth. ***Beach Material***

## D8.14 ENTRANCES

1. The PWD requires that the proponent adequately demonstrate, by engineering studies, the impact of the physical processes within the host waterbody on the entrance design, and conversely the impact of the entrance design on these processes. These impacts should be considered in the context of establishing: ***Engineering Studies***

- entrance location
- number of entrances proposed
- entrance alignment
- entrance dimensions
- the need for flow control structures (eg, weirs or one-way flow devices) if there is more than one entrance.

2. For navigable entrances, the width and depth of the entrance shall be sufficient for safe navigation by craft likely to use the waterway. ***Navigation***

3. The entrance navigation width shall not be less than 25m. ***Width***

4. The entrance depth shall not exceed the depth available in the host waterbody. ***Depth***

5. Determination of entrance dimensions shall take into account bank and bed stability considerations. ***Bed Stability***

6. The entrance dimensions shall be kept to the minimum practical, consistent with navigation and other requirements, in order to maximise tidal flushing performance and potential for ebb tide scour of any sediments deposited at the entrance. ***Tidal Flushing***

7. In selecting the entrance location(s) for the canal system, the following factors should be taken into account: ***Entrance Locations***

- areas of naturally occurring sedimentation should be avoided;
- areas which would require construction of long access channels, subject to infilling, should be avoided, except where infilling rates can be accurately quantified and be shown to be manageable. Such channels can also act as a sediment "sink" in terms of the sediment budget of the host waterbody and lead to erosion problems;
- the entrance should be sheltered from excessive wave action and strong currents.

8. Significant flushing and water quality benefits can be derived from construction of more than one entrance to a canal development. The additional entrance may be navigable or non-navigable. ***Second Entrance***

9. The alignment of the entrance influences the trajectory of the flood tide currents entering the development, which in turn affects the extent of flood tide penetration and pattern of internal circulations. These factors are important in establishing the degree of flushing under tidal action and hence water quality.

10. Consideration of the alignment of the entrance relative to the host waterbody is also important for several reasons: ***Alignment***

- possibility of flow diversion
- safe navigability
- introduction of debris into the canal development.

11. The factors involved in selection of water depth for the entrance channel are as follows: ***Depth Selection***

- draft of boat
- underkeel clearance (UKC)
- allowance for sedimentation.

## HYDRAULICS

### D8.15 STORMWATER MANAGEMENT

1. The PWD requires that the proponent adequately demonstrate that the proposed method of stormwater management will not adversely affect water quality within the canal development and host waterbody, or lead to problems associated with siltation and erosion. Figure D8.4 is a typical solution for stormwater management. ***Water Quality***

2. The canal allotment shall be graded to ensure as much runoff as possible is directed to the street where it may be collected and then directed into the canals through properly designed stormwater outlets. The preferred system of stormwater discharge is by means of a "drowned outlet" constructed below beach level, incorporating suitable scour protection.

3. Wherever practical, stormwater outlets shall be located at points of maximal flushing, or directly within the host waterbody. ***Flushing***

4. Stormwater outlets shall not be located at the heads of dead-end canals. ***Outlets***

5. Runoff towards the canals from the slope behind the revetment wall shall be intercepted prior to flowing over the revetment wall onto the beach, and otherwise directed into the canal waters without causing beach erosion. The preferred method of collection is by means of a kerb and gutter arrangement incorporated into the revetment wall, with flows then directed via pipework into the canal to discharge below anticipated lowest low water level.

***Runoff***

6. Suitable allowance for sedimentation near stormwater outlets shall be made in the design of the canal cross-section and/or access made available for future maintenance dredging.

7. Suitable temporary sediment control devices shall be installed during the construction phase to ensure that sedimentation within the canal system is minimised and sedimentation does not occur within the host waterbody.

***Sediment Control***

## D8.16 FLOOD CONTROL STRUCTURES

1. Flood control structures usually include a system of canals and weirs which are to be approved by the PWD. Usually detailed designs for flood control structures are commenced only after the overall canals and flood structures have been mathematically and physically modelled and approved by the PWD and Council. Preliminary plans are usually prepared as part of a "flood study" which involves modelling procedures.

***Modelling***

***Flood Study***

2. Designs must ensure that the proposed works and any raising of the land will not result in any significant increase in flood levels in the area.

## D8.17 TIDAL INFLUENCES

1. The level of study of tidal hydraulics necessary to adequately demonstrate the impact of the proposed development on tidal hydraulics, and the effects of the tidal hydraulics on the development, is dependent on a number of factors. It is important that the proponent seek early consultation with the PWD.

2. It is likely that detailed studies, involving mathematical and/or physical modelling, will be necessary where it is proposed that the canal subdivision development have more than one entrance, where an understanding of internal tidal circulations is important, or where the development is located within the entrance reach of the host estuary and would involve significant changes to the frictional and shallow water controls on tidal propagation.

***Modelling***

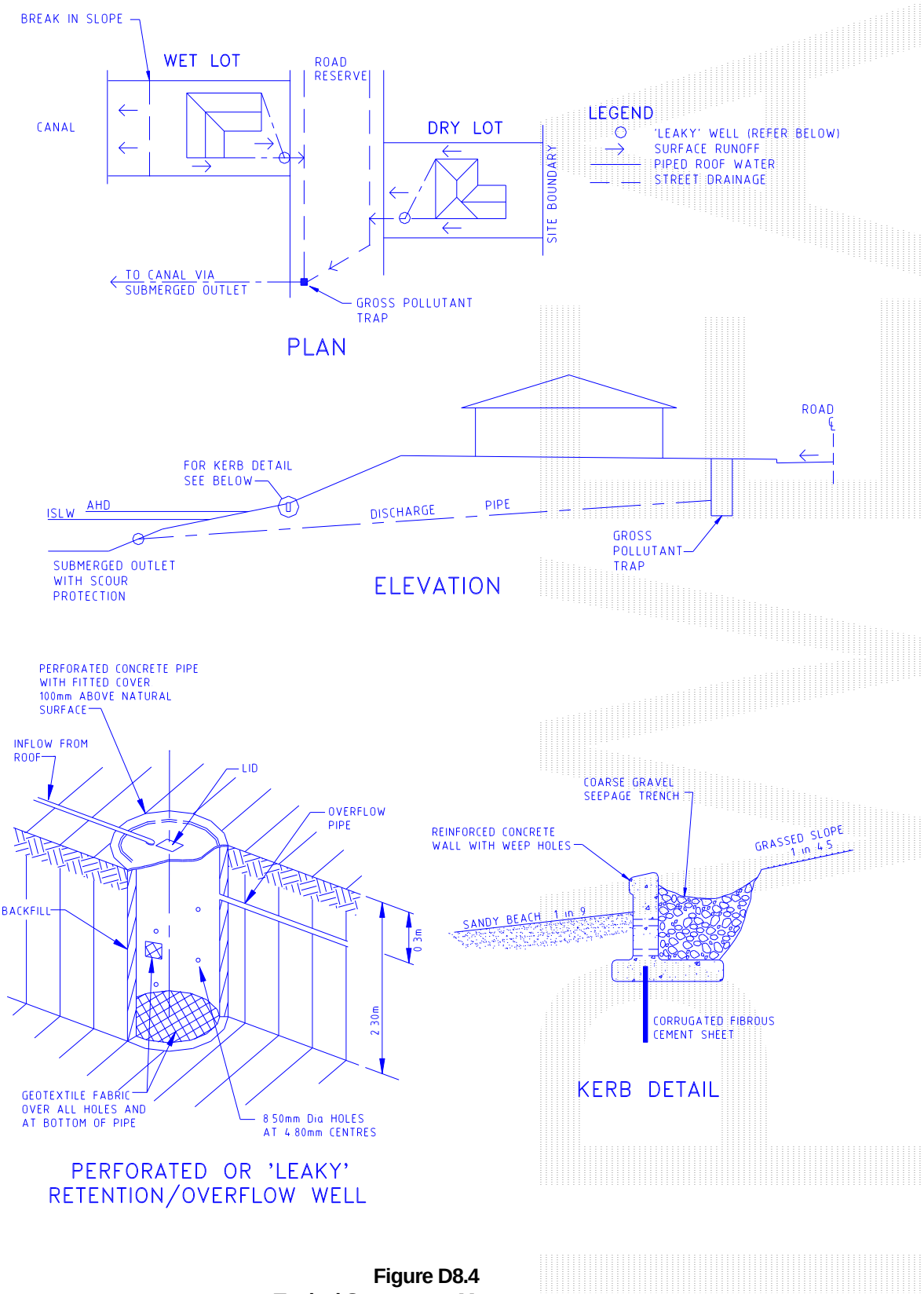



**Figure D8.4**
**Typical Stormwater Management**

Source: Planning Workshop 1994 (Consultants)

3. The proponent shall assess variations in the tidal characteristics of the host estuary at the development site taking into account cyclic and long term changes in: estuary shoaling and scour, entrance stability, hydrologic input, mean sea level, and any engineering works (such as large scale estuary dredging, entrance works, or other canal subdivisions) proposed or approved by the various government authorities. The implications of these changes to the design and functionality of the canal subdivision shall be established and accommodated. ***Tidal Characteristics***

4. The proponent shall establish the tidal levels at the proposed development site. These levels may be based on existing information supplied by the PWD, where available, or measurements undertaken on behalf of the proponent by a suitably qualified surveyor or civil engineer. ***Tidal Levels***

5. There is no minimum acceptable tidal range below which canal developments would not be considered. The degree of tidal flushing will however reduce as tidal range decreases, and this effect must be considered in the water exchange and mixing studies required by the Department and outlined elsewhere in the guidelines. ***Tidal Range***

## D8.18 WATER QUALITY INFLUENCES

1. Consideration should be given, where practical, to enhancement of water circulation and/or exchange by the following additional means: ***Water Circulation***

- provision of an additional entrance(s), not necessarily navigable
- provision of additional tidal prism by creation, for example, of a lake or basin at the head of the canal(s)
- provision of bends, curves and island features
- elimination of poorly flushed dead-end canals, pockets and covers
- alignment of the canals in the direction of prevailing winds
- mechanical assistance.

2. There would appear to be benefit in aligning canals in the direction of prevailing winds if this is possible, providing the canals are not too long, in order to maximise mixing and exchange processes. ***Winds***

3. Fetch lengths in the direction of strong winds should be minimised to mitigate the potential adverse impacts of wind-generated waves. ***Waves***

4. The effectiveness of the wind in developing vertical secondary mixing circulation is increased by increasing the width of the water surface in the canals. It follows that broad canals, and lake-type developments, will exhibit enhanced vertical secondary mixing. ***Vertical Mixing***

## D8.19 EROSION AND SEDIMENTATION INFLUENCES

1. Sandy beaches within canal developments require maintenance (nourishment) at regular intervals. Where recovery of the eroded sand from the bad of the canal is unlikely to be feasible, it is necessary to make allowance for ongoing sedimentation on the canal bed from this source. ***Sand Beach Maintenance***

2. Long canals with sandy shorelines, and aligned with prevailing winds, are likely to experience littoral drift. Generally speaking, the length and alignment of canals should be carefully considered and the potential for littoral drift balanced against the advantages of wind action for promotion of mixing of canal waters.

3. Shoreline structures which extend across the littoral drift zone, eg. some stormwater outlet designs, should be avoided where relatively high littoral drift rates are anticipated, except where special provision has been made to mitigate beach erosion. ***Drift***

4. In assessing the sediment load carried by stormwater outlets from a given catchment area, it is reasonable to adopt the following sediment quantities per hectare of catchment area per year: ***Sediment Load***

- partially developed urban catchment 5.5 tonnes/ha/yr
- fully developed urban catchment 1.5 tonnes/ha/yr
- rural areas 0.3 tonnes/ha/yr

5. Stormwater outlets should be arranged so as not to directly or indirectly cause beach erosion or local scour. Consideration should be given to construction of the stormwater outlets below the beach level.

## STRUCTURES

### D8.20 REVETMENT WALLS

1. There will be some locations in the canal development where it will not be possible to "hold" a sandy beach due to the level and type of wave and current exposure, eg. at so called "external corners". In such locations it will be necessary to adopt an alternative canal edge treatment, most probably a rock revetment. ***Wall Requirement***

2. Revetment walls are to be designed as retaining walls certified by a practicing Structural Engineer and submitted to Council for approval.

3. Filling is to be composed of material not injurious to the health of the neighbourhood and shall comply with Council's requirements for filling in subdivisions. ***Filling Behind Walls***

4. The crest of the revetment wall above the design canal profile, for the particular type of canal cross-section adopted, shall conform with the requirements set out in Table D8-2. ***Wall Height***

5. There is no maximum height for revetment walls as such. However, consistent with the requirements in Table D8-2 the crest level of revetment walls should be kept as low as possible to enable easy access from the allotments onto the waterway, to optimise mixing wind action, and to reduce visual impact. ***Maximum Height***

6. Determination of the full construction height, structural adequacy and stability of the wall shall take into account an erosion allowance in front of the wall. In the absence of detailed hydraulic tests the allowances for erosion shall not be less than the values specified in Table D8-3. ***Erosion Allowance***

**Table D8-2**
**Factors For Determining Height Of Revetment Walls**

| CANAL CROSS-SECTION | HEIGHT OF REVETMENT WALL ABOVE DESIGN CANAL PROFILE |
|---|---|
| Dry Beach | Minimum of 150mm |
| Inter-Tidal Beach | Sufficiently high to accommodate MHHWS* plus wind setup, wave runup, long term changes in mean sea level and local tide levels, without overtopping. |
| No Beach - Submerged Slope | Sufficiently high to accommodate MHHWS plus wind setup, wave runup, long term changes in mean sea level and local tide levels, without overtopping. |
| No Beach - Vertical Wall | Sufficiently high to accommodate design water depth, MHHWS, wind setup, wave runup, long term changes in mean sea level and local tide levels, without overtopping. |

(* MHHWS = Mean Higher High Water Springs)

**Table D8-3**
**Minimum Erosion Allowances For Revetment Walls**

| CANAL CROSS-SECTION | MINIMUM EROSION ALLOWANCE IN FRONT OF REVETMENT WALL (MM) |
|---|---|
| Dry Beach | 300 |
| Inter-Tidal Beach | 450 |
| No Beach - Submerged Slope | 300 |
| No Beach - Vertical Wall | 300 |

7. To mitigate against beach erosion, runoff from the slope behind the revetment wall should be interrupted prior to flowing over the revetment wall onto the beach. The preferred method for collection and discharge of the runoff is by means of a kerb and gutter arrangement incorporated into the revetment wall, with flows then directed via pipework into the canal to discharge below ISLW. ***Beach Erosion***

## D8.21 JETTIES, PONTOONS AND BOAT RAMPS

1. Where jetties and pontoons are proposed for canals which serve as floodways, the effect of these structures on the hydraulic performance of the canals shall be taken into account in the hydraulic design of the canals. ***Pontoons Jetties***

2. Jetties, pontoons and boat ramps shall be designed in accordance with sound engineering practice by a qualified Civil Engineer to satisfactorily resist all dead loads and applied live loads. Particular consideration shall be given to the effect of flood currents and debris loading on structures proposed to be located within canals which will serve as floodways.

3. Special design requirements due to the height of water levels during flooding shall also be considered, eg. electrical connections and cut-off levels for mooring piles. ***Electrical Connections***

4. Account shall be taken of jetty pontoon, ramp, etc design in assessing the required width of the canals.

5. Where a hinged access ramp leads to a pontoon the slope of the hinged access ***Ramp***

***Geometry***

ramp should not exceed 1 in 6 at the lowest anticipated water level. Where pontoons are to be provided, fixed-jetties can be used to reduce the length of hinged access ramps but should not extend past the revetment wall by a distance greater than 7m. The level of the jetty deck should be not greater than 300mm above the top of the revetment wall, and the deck should not rest on the wall. The overall length from the revetment wall to the outer edge of the mooring structure should not exceed 17m and must not extend into the navigation channel.

***Boat Ramps***

6. Boat ramps for individual allotments are acceptable only in the Dry Beach and Inter-Tidal Beach cross-sections. They should be constructed of concrete and be not less than 150mm thick on the canal side of the revetment wall and have a width not less than 3m. Isolation joints are to be provided so that the concrete slabs forming the ramp are not supported by the revetment wall and can move independently of the wall.

***End of Ramp***

7. The ramp should not extend below the position of the change in grade at ISLW-0.3m (Canal Cross-Section/Edge Treatment; Figure D8.3).

***Ramp Level***

8. A boat ramp can be constructed with its surface either flush with beach surface or the top of the revetment wall at the point of intersection. There are advantages and disadvantages with each approach which should be evaluated during the determination of a standard design. The following issues should be considered:-

- Boat ramps flush with canal beach:
  - ramp will be recessed into the revetment wall and allotment
  - structural design of the revetment wall will need to allow for recessing
  - allotment surface drainage control could be disrupted.
- Boat ramps flush with top of revetment wall:
  - ramp will be proud of beach profile which could lead to beach scour through groyne action and local wave reflections
  - ramp will constitute an impediment to access for maintenance vehicles (if required).

***Visual Impact***

9. Boat ramps should be designed to minimise their visual impact. Boat ramps having their surfaces level with the canal beach surface are less visually prominent and are therefore preferable, in terms of visual impact, to ramps which project above the beach surface.

10. Adequate provision should be made to ensure that scour does not occur under any part of the ramp, eg. by founding the ramp on stable, non-erodible, material and/or incorporating deeper edge beams.

11. Reference should also be made to the "Boat Launching Ramp Guidelines" (Public Works Department, 1985) and "Design Guidelines for Wharves and Jetties" (Public Works Department, 1990).

***Standard Designs***

12. A standard design could be considered for jetties, pontoons and boat ramps (including the means of shore connection) that are proposed as part of the development or that may be constructed by owners at a later date.

***Aesthetics***

13. Special consideration should be given to the appearance of the structures in the waterway, and guidance can be found in the Department of Planning's "Canal Estate Developments: Design Guidelines" (1991).

***Marinas***

14. Public boat launching facilities and marina facilities are generally regarded as unsuitable to a residential canal development because of the difficulty of ensuring adequate privacy for residents. Such facilities should only be considered where adequate and comprehensive environmental safeguards can be incorporated in the design of the development.

***Public Facilities***

15. Public boat launching facilities and marina facilities shall be developed in accordance with the Public Works Department's "Boat Launching Ramp Guidelines" and "Marina Guidelines" respectively.

***Noise***

16. Where it is proposed to construct public boat launching facilities within a canal development, consideration shall be given to siting of the launching facilities so as to minimise any adverse noise impacts on adjacent development due to the particular hours of use of the facilities.

***Marina Basin***

17. Where it is proposed to construct marina facilities within a canal development, consideration shall be given to siting of the marina and design of the marina so as to maximise tidal exchange between the marina basin and the host waterbody.

18. Ideally, marina basins should be located separately from residential canals and close to the entrance of the overall development.

19. Rectangular marina basins with a ratio of length to breadth greater than 3 should be avoided since internal tidal circulation cells tend to develop which reduce tidal flushing.

20. Marina basins having poorly flushed pockets and coves should be avoided.

21. Rounding of corners within the marina basin will produce greater uniformity in local exchange through the basin, eliminating areas of poor local exchange.

22. For rectangular basins, a single centrally-located entrance produces better flushing behaviour than a single corner-located asymmetric entrance.

***Holding Beaches at Ramps***

23. At public boat launching ramps, consideration should be given to providing holding beaches and boarding jetties or pontoons to facilitate rigging and efficient boarding of craft.

## D8.22 BRIDGES AND STRUCTURES

1. Bridges and structures shall be designed in accordance with the Specification for Structures and Bridge Design. The design life shall be 100 years and the serviceability design flood shall be 1:20 years. The ultimate limit state, that is the capability of the bridge to withstand a flood without collapse, shall be 1:2000 years.

***Narrowing***

2. Where canals are narrowed at bridge locations, it is likely that complete rock protection of the banks and bed of the canal will be required. Lowering of the canal bed to reduce velocities may also be required.

***Clearance***

3. The vertical clearance of any proposed bridge should be checked with the Waterways Authority.

4. Where a canal entrance cuts pedestrian access along a public foreshore (eg. by removing the intertidal area) then a footbridge should be provided to ensure continuance of public access and amenity.

## SPECIAL REQUIREMENTS

**D8.23 RESERVED**

**D8.24 RESERVED**

**D8.25 RESERVED**

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