BUNDABERG
REGIONAL COUNCIL

Improving Dwelling Resilience to Flood Induced Scour

Guidelines for

Dwellings Constructed within a Flood Hazard Area.

Bundaberg Regional Council

April 2013

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1. Introduction

The Burnett River in Bundaberg reached its highest recorded flood level as a result of ex-tropical cyclone Oswald in January 2013. This event resulted in widespread flooding to the Bundaberg area and extensive damage to buildings, property and infrastructure. In response to this event, Council has prepared a Temporary Local Planning Instrument (TLPI) to facilitate short term planning requirements regarding management of land use issues immediately following the 2013 flood event. A Defined Flood Level (DFL) equal to the 2013 flood event has been adopted by Council in the TLPI.

As part of this response the Burnett River Flood Hazard Code has been established. This Code provides criteria for construction of dwellings within a flood hazard area and the details required for performance and acceptable outcomes.

The Burnett River Flood Hazard Code (Schedule 3 of the TLPI) provides an additional set of provisions to be considered by an assessment manager when assessing development specified in Column 1 of the Table of Assessment at Schedule 2 of the TLPI.

Table 3.1 of Schedule 3 provides criteria for self-assessable development. Performance Outcome PO1 requires that '*Dwelling houses are resilient to flooding'*.

These Guidelines for improving resilience to flood induced scour for Dwellings Constructed within the Bundaberg Flood Hazard Area have been prepared to assist designers in formulating improved flood resilient outcomes.

2. Objectives

The Guideline objectives are to provide:

a) An overview of the scour process;

b) A method to estimate the scour potential due to foundation conditions;

c) A method to estimate the scour potential due to velocity conditions;

d) A method to estimate the site scour risk;

e) References to relevant methods for determining maximum scour depths;

f) Suggestions for possible approaches to reduce the effects of scour damage and associated impacts.

It is noted that these Guidelines' have been developed to assist designers to reduce the effects of scour and as a result improve the resilience of dwellings constructed in flood hazard areas. As such, the Guidelines may help to reduce the risk associated with scour but will not entirely eliminate this risk. Each property should be individually assessed to suit site specific conditions.

In addition to these Guidelines, the structural systems of buildings or other structures should be designed, constructed, connected, maintained and anchored to resist flotation, collapse, and permanent lateral displacement due to action of flood loads associated with the design flood in accordance with the Queensland Development Code and best practice flood design.

The effects of erosion and scour should be included in the calculation of loads on buildings and other structures in flood hazard areas.

3. Introduction to Scour

3.1 Scour Definitions

Given the significant variability in site conditions and flood behaviour, the content provided in this section is of a general nature only and is not a substitute for investigating actual site conditions or undertaking rigorous hydraulic and scour estimates.

Scour is the loss of soil by erosion due to water flow. There are two main types of scour: general scour; and local scour.

General scour is the aggradation or degradation of sediment material not related to the presence of local flow obstacles.

Local Scour is a term frequently used to describe the scour around obstacles that results from increased local flow velocities (flow acceleration). It includes pier scour, abutment scour, and contraction scour. Pier scour is the removal of soil around the foundation of a pier; abutment scour is the removal of soil around an abutment obstruction; and contraction scour is the removal of bed material due to a narrowing of the approach flow.

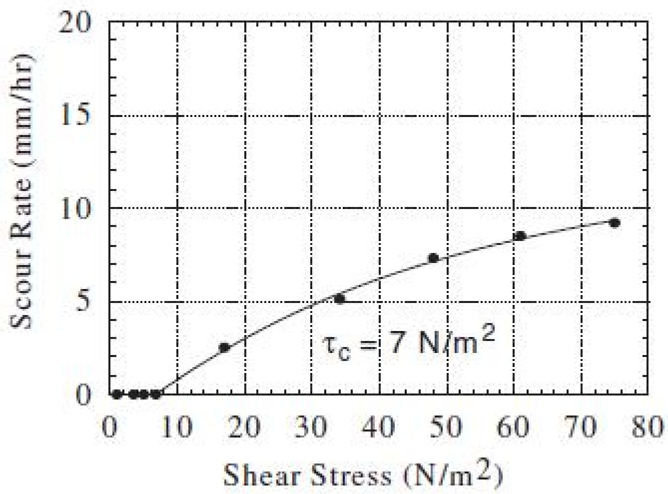
In the context of urban floodplain hydraulics, pier scour can occur around house foundations such as the stumps supporting Queenslander style dwellings; abutment type scour can occur around larger obstructions to flow such as slab on ground buildings; and contraction scour can occur due to constriction of flow between floodplain obstructions such as buildings and fences. The severity of local scour around buildings on a floodplain is affected by a number of factors including:

- Soil erodability; and
- The impact of the building on local flow dynamics.

3.2 Soil Erodability

Erodability is a term used to characterise the rate at which soil is eroded by flowing water. The erodability of a soil is dependent on the relationship between the hydraulic shear stress (τ) applied by the flow velocity on the soil water interface; and the corresponding scour rate ($\dot{z}$) experienced by the soil. This relationship is called the erosion function. An example erosion function for a particular soil is provided in Figure 1.

Figure 1 Example erosion function[1]



The erosion process for exposed[2] non-cohesive soils (larger grained soils, D_{50}>0.075mm) such as sand and gravel differs to that for exposed cohesive soils (finer grained soils, D_{50}<0.075mm) such as silts and clays:

3.2.1 Non-cohesive soils

In the case of coarse grained soils (sands and gravels etc.), erosion occurs particle by particle where the resistance to erosion is primarily influenced by the weight of the soil particles.

In simple terms, the critical shear stress of non-cohesive soils is defined as the shear stress below which no erosion occurs and above which erosion starts. The critical shear stress for non-cohesive soils is related to the size of the soil particles (D_{50}):

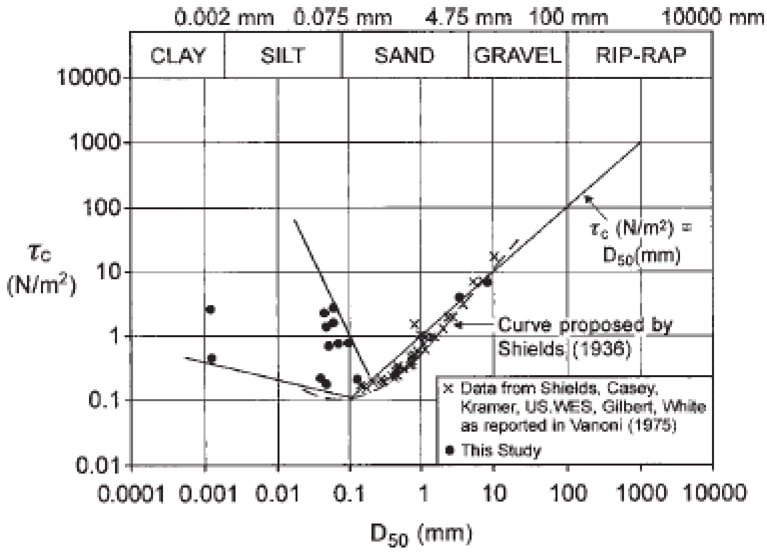
τ_c (N/m^2) = D_{50} (mm) (Equation 1)

Figure 2 illustrates that the critical shear stress for non-cohesive soil is typically in the range 0.1N/m^2 to 5N/m^2.

[1] *Source: Pier and Contraction Scour in Cohesive Soils,* National Cooperative Highway Research Program Report 516, Transportation Research Board of the National Academies, Washington DC 2004.

[2] No ground cover.

Figure 2 Critical Shear Stress versus mean grain diameter[3]



The potential for a soil to be eroded can also be defined by the critical velocity (V_c) for a soil which has been empirically related to the mean grain size D_{50} and depth of approach flow (y):

$$V_c \,(m/s) = 6.19\, y^{1/6}\, D_{50}^{1/3} \qquad \text{(Equation 2)}$$

The range of potential critical velocities for non-cohesive soil particle sizes and approach flow depths is provided in Table 3-1. Table 3-1 indicates that exposed fine to medium grained sandy soils have the potential to be eroded by relatively low velocities (0.2 to 0.7m/s), with the most erodible soils being fine sands with mean grain sizes in the 0.10mm range.

The rate of erosion (ż) of non-cohesive soils above the critical shear stress (or velocity) increases rapidly and can reach tens of thousands of millimetres per hour in a short amount of time. Because the critical shear stress is exceeded quite rapidly, maximum scour depths are reached relatively quickly and a time dependant analysis of the erosion rate (ż) is not generally required when estimating maximum potential scour depths.

[3] *The SRICOS - EFA Method Summary Report*, Texas & AM University, February 2011

Table 3-1 Critical velocities (m/s) in non-cohesive soils

	Flow Depth (m)						
D_{50} (m)	0.10	0.50	1.00	1.50	2.00	2.50	3.00
0.00010	0.20	0.26	0.29	0.31	0.32	0.33	0.35
0.00015	0.22	0.29	0.33	0.35	0.37	0.38	0.39
0.00020	0.25	0.32	0.36	0.39	0.41	0.42	0.43
0.00025	0.27	0.35	0.39	0.42	0.44	0.45	0.47
0.00030	0.28	0.37	0.41	0.44	0.47	0.48	0.50
0.00035	0.30	0.39	0.44	0.47	0.49	0.51	0.52
0.00040	0.31	0.41	0.46	0.49	0.51	0.53	0.55
0.00045	0.32	0.42	0.47	0.51	0.53	0.55	0.57
0.00050	0.33	0.44	0.49	0.53	0.55	0.57	0.59
0.00055	0.35	0.45	0.51	0.54	0.57	0.59	0.61
0.00060	0.36	0.47	0.52	0.56	0.59	0.61	0.63
0.00065	0.37	0.48	0.54	0.57	0.60	0.62	0.64
0.00070	0.37	0.49	0.55	0.59	0.62	0.64	0.66
0.00075	0.38	0.50	0.56	0.60	0.63	0.66	0.68
0.00080	0.39	0.51	0.57	0.61	0.64	0.67	0.69

3.2.2 Cohesive soils

In the case of fine-grained soils (clays, silts and mixtures), erosion can take place particle by particle but also in blocks of particles where the resistance to erosion is influenced by a combination of weight and electromagnetic and electrostatic inter-particle forces. The factors influencing the erodability of cohesive soils are listed in Table 3-2.

Two important parameters help describe the erosion function of cohesive soils: the critical shear stress and the initial slope of the erosion function.

For cohesive soils, although it has been found that the critical shear stress is not related to the soil mean grain size:

- The common range of critical shear stress values for cohesive soils (0.1N/m^2 to 5N/m^2) is comparable to the range obtained in sands (refer Figure 2); and
- The maximum potential scour depths are comparable to sands.

However, in cohesive soil scour - the initial slope of the erosion function can be many times less than the one in sand (e.g. 1,000 times less), and a few days of flood flow may generate only a small fraction of the maximum potential scour depth. Therefore (unlike non-cohesive soils), when estimating maximum likely scour depths for cohesive soils - it is necessary to consider the erosion rate of the soil in the calculations. This may require a soil sample to be collected and laboratory testing to determine the relationship between the erosion rate of the soil and the applied shear stress (i.e. the erosion function).

Table 3-2 Factors influencing the erodability of cohesive soils

When this parameter increases	Erodability
Soil water content	*
Soil unit weight	Decreases
Soil plasticity index	Decreases
Soil undrained shear strength	Decreases
Soil void ratio	Increases
Soil swell	Increases
Soil mean grain size	*
Soil percent passing sieve #200	Decreases
Soil clay minerals	*
Soil dispersion ratio	Increases
Soil-cation exchange capacity	*
Soil sodium absorption ratio	Increases
Soil pH	*
Soil Temperature	Increases
Water Temperature	Increases
Soil Chemical Composition	*

Notes: * unknown.

3.2.3 Erodability and Soil Cover

The potential for soil scour on floodplains is reduced to a certain extent if the soil profile is protected from flowing floodwater by natural or artificial ground covers such as grass or asphalt. Table 3-3 provides a summary of the critical velocity for range of typical ground covers.

Table 3-3 Critical Velocity of Typical Ground Cover

Ground Cover	Minimum Critical Velocity (m/s)	Maximum Critical Velocity (m/s)
Class A turf	1.8	2.4
Class B turf	1.2	2.1
Class C turf	1.0	
Long native grasses	1.2	1.8
Short native and bunch grass	0.9	1.2

Table 3-3 indicates that well established and maintained grass cover has the potential to protect the underlying soil from erosion for approach flow velocities of approximately 1.0m/s. For velocities greater than 1.0m/s, the grass and underlying soil strata may experience scour.

It is recommended that adequate grass cover be maintained across properties to generally reduce the potential for scour. However, the effectiveness immediately adjacent to buildings may be limited.

3.3 Building Impacts

Buildings located in floodplains create an obstruction to flood flows which can cause localised increases in flow velocities, thereby increasing soil erodability and local scour. Building obstructions may exist as wide obstructions or pier type obstructions.

3.3.1 Wide Obstructions

The flow patterns around wide obstructions (e.g. a house, garage or shed) enhancing scour are governed by a complex vortex system including horseshoe shaped vortices with a horizontal axis around the protruding building corners; tornado vortices downstream of the building corners with an essentially vertical axis; and rear vortices (refer Figure 3)[4]. The horsehoe vortex results from downflow along the leading obstruction front, and it erodes along the sides of the scour hole. The tornado vortex lifts particles close to the obstruction corner and the flow carries particles along the obstruction downstream. It is this highly interactive vortex system that adds to the complexity of local scour.

Figure 4 illustrates a typical shear stress distribution experienced at the corners of a building located normal to the direction of flood flow.

Figure 3 Flow Behaviour at Wide Obstructions[5]

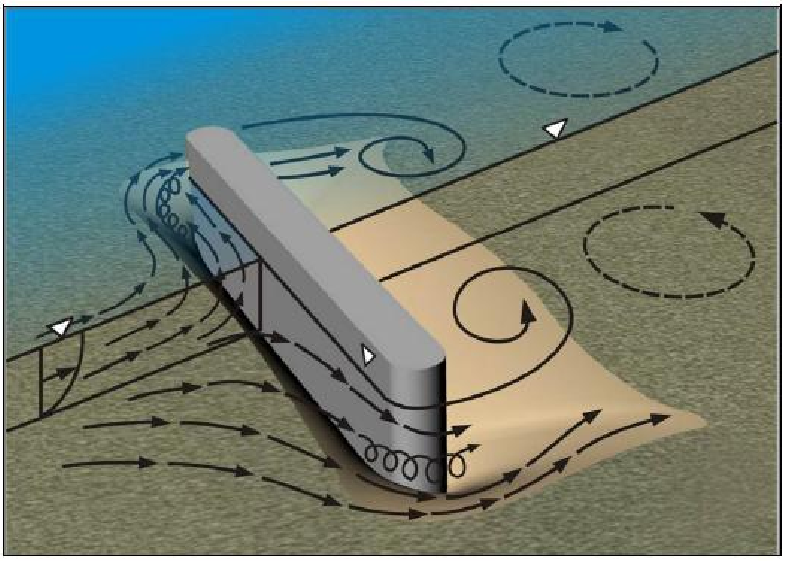
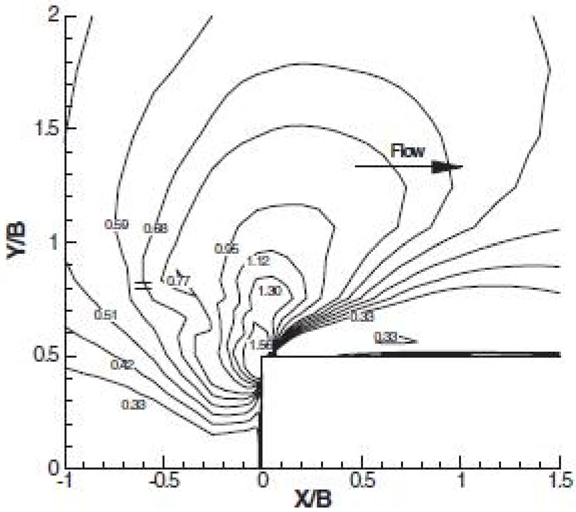


Figure 4 Example shear stress distribution around a building[6]

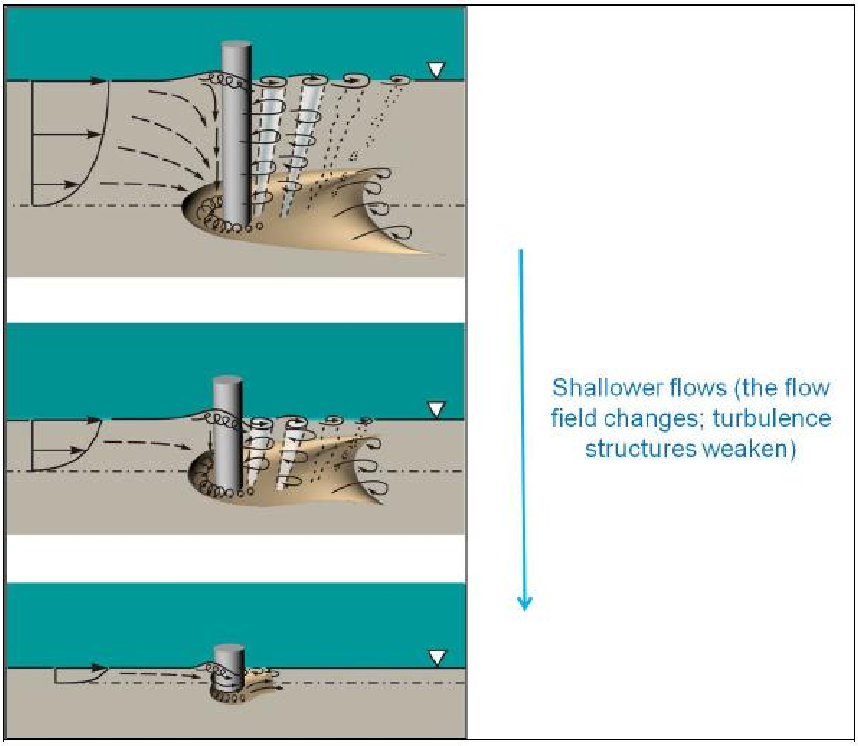


[4] *Building Scour in Floodplains, A.Kohli & W.H. Hager, Water and Maritime Engineering 148 Issue 2.*
[5] *Evaluating Scour at Bridges Fifth Edition, Publication No. FHWA-HIF-12-003, Hydraulic Engineering Circular No. 18, U.S. Department of Transportation Federal Highway Administration, April 2012*
[6] Source: *Pier and Contraction Scour in Cohesive Soils, National Cooperative Highway Research Program Report 516, Transportation Research Board of the National Academies, Washington DC 2004.*

3.3.2 **Pier Obstructions**

Pier type obstructions such as building stumps and piles have the potential to generate localised flow accelerations and associated vortex structures that increase the potential for local pier scour around building footings. Figure 5 illustrates the typical flow patterns that occur in the vicinity of pier obstructions for different flow depths.

Figure 5 Flow behaviour at pier obstructions[7]



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[7] *Evaluating Scour at Bridges Fifth Edition, Publication No. FHWA-HIF-12-003, Hydraulic Engineering Circular No. 18, U.S. Department of Transportation Federal Highway Administration, April 2012*

4. Estimating Scour Potential Due to Foundation Conditions

4.1 General

The scour potential of foundation soils is largely dependent on the geotechnical conditions found at a site. Particle size distribution of the foundation has been found to be an important factor in determining the scour potential of soils. Sandy soils have low cohesion and tend to scour more readily than cohesive soils. Ground cover, in the form of grass or concrete etc, also impacts on the scour potential on foundations. A summary of typical soils in the Bundaberg region is provided in Table 4-1.

Table 4-1 Typical Soils in the Bundaberg Area[8]

Geotechnical conditions	Potential Geotechnical Conditions
Alluvial Gravels	• Gravel materials are expected to be erodible where water velocity is in excess of 3m/s although some gravels may erode at much lower velocities; • Relatively permeable nature of the gravels facilitates drainage of the materials following inundation; • Low shrink-swell potential; and • Minimal loss of strength on saturation.
Alluvial sands and silts	• The sandy and silty nature of this soil type may be erodible where water velocity is in excess of 0.2m/s to 0.6m/s. These soils are therefore considered the most erodible of all soils within the area. • Relatively permeable compared with alluvial and residual clays; • Low shrink/swell potential; and • Minimal loss of strength on saturation, although silts can suffer strength loss and become very mobile.
Alluvial clays and residual clays derived from weathered shale and sandstone	• Clayey soils are typically erodible where water velocity is greater than 1.5m/s; • Relatively impermeable; • Reduction in strength on saturation; • Susceptible to shrink/swell movements; and • Minimal loss of strength on saturation.

4.2 Soils Investigation[9]

To facilitate the determination of the scour potential due to foundation soils the following geotechnical testing is recommended as a minimum requirement for scour potential assessment:

[8] Adapted from: Reducing Vulnerability of Buildings to Flood Damage – Guidance on Building in Flood Prone Areas.
[9] Source: Coffey Geotechnics Pty Ltd Report – Geotechnical Investigation and Reconstruction Recommendations Flood Damaged Areas North Bundaberg, March 2013.

b) Two bore holes must be drilled on the site to depths not less than 1.5 metres. The soil profiles must be logged and presented in a format consistent with the requirements of AS1726.

c) Where the soil profile consists of sands and silty sands to depths greater than 0.5 metres, the site shall be classified as **HIGH** scour risk and no further testing shall be required.

d) Where the soil profile consists of clays and sandy clays to depths greater than 1 metre, two samples from the soils representing the major strata in the upper metre of the profile must be tested for Atterberg Limits at a NATA registered soils laboratory. Where the liquid limit (LL) is greater than 30%, the plasticity index (PI) is greater than 15% and the combination of LL PI plots above the "A" line in the Unified Soils Classification (USC) System plasticity charts, then the site may be classified as **LOW** risk. Where the above criteria are not met, the site shall be classified as **MODERATE** scour risk due to low plasticity clayey surface soils, designated **MOD(C)**.

e) Where the depth of clay and clayey sands is less than 0.5 metres underlain by sands and silty sands, the site shall be classified as **HIGH** scour risk and no further testing shall be required.

f) Where the soil profile consists of sands or silty sands less than 0.5 metres deep overlying clays and clayey sands, then two samples form the clay subsoils representing the major strata in the underlying clayey profile must be tested for Atterberg Limits at a NATA registered soils laboratory. Where the liquid limit (LL) is greater than 30%, the plasticity index (PI) is greater than 15% and the combination of LL and PI plots above the "A" line in the USC plasticity charts, then the site may be classified as **MODERATE** scour risk due to sandy surface soils, designated **MOD(S)**. Where the above plasticity criteria are not met, the site shall be classified as **HIGH** risk.

g) Where the soil profile consists of clay and clayey sands to depths between 0.5 and 1.0 metre deep overlying sands and silty sands, two samples form the soils representing the major strata in the upper profile must be tested for Atterberg Limits at a NATA registered soils laboratory. Where the liquid limit (LL) is greater than 30%, the plasticity index (PI) is greater than 15% and the combination of LL and PI plots above the "A" line in the USC plasticity charts, then the site may be classified as **MODERATE** scour risk due to shallow clayey surface soils, designated **MOD(C)**. Where the above plasticity criteria are not met, the site shall be classified as **HIGH** risk.

A flow chart showing the decision making process detailed above is included in Appendix A. USC Plasticity Charts to be used are included in Appendix B.

4.3 Scour Risk Rating

Based on the outcomes of the soils investigation the site can be assigned a Scour Risk Rating (due to foundation conditions) as described in Table 4-2.

Table 4-2 Foundation Condition Risk

Foundation Condition Risks
Low
Mod C
Mod S
High

5. Estimating Scour Potential Due to Velocity Conditions

5.1 General

As discussed in Section 3, the potential for scour of foundation soils is also directly related to the velocity of the flood water over the site. Flowing flood waters can develop sufficient shear stress to mobilise soil particles and initiate scouring and erosion. Local factors that may constrict, channelise or direct flows can increase the velocity of flood waters and increase local scour. Such localised factors include buildings, fences, blockages, outbuildings, large trees and the like.

5.2 Velocity Data

Hydraulic modelling of the Flood Hazard Area has been completed by Council to determine likely flood velocities and depth of flood water for the DFL. Council can in most instances provide the following information for a given site:

a) Flood level;

b) Ground level;

c) Velocity of flood water.

5.3 Velocity Risk Rating

Based on the likely flood velocity, the site can be assigned a Velocity Rating (due to flood velocity) as per the table below:

Table 5-1 Flood Velocity Rating

Velocity Rating	Velocity (m/s)
1	less than 0.3
2	0.3 to less than 0.5
3	0.5 to less than 1.0
4	1.0 to less than 1.5
5	1.5 to less than 2.25

6. Site Scour Risk Rating

The combined effects of the scour potential due to foundation conditions and the velocity conditions shall be used to estimate an overall scour risk factor for the site.

Table 6.1 can be used to determine the overall scour risk factor for the site.

Table 6-1 Scour Risk Factor

Scour Risk Factor					
Foundation Condition Risk (from Table 4-2)	Flood Velocity Rating (From Table 5-1) m/s				
	1	2	3	4	5
	less than 0.3	0.3 to less than 0.5	0.5 to less than 1.0	1.0 to less than 1.5	1.5 to less than 2.25
Low	NIL	LOW	LOW	MED	HIGH
Mod S	LOW	MED	MED	HIGH	HIGH
Mod C	LOW	MED	MED	HIGH	HIGH
High	MED	MED	HIGH	EXTREME	EXTREME

7. Design of Scour Risk Reduction Measures

7.1 General

These Guidelines provide design suggestions with respect to the provision of scour risk reduction measures for dwellings.

7.2 Suggested Measures for Improved Resilience

The following suggested measures for improved resilience are offered by these guidelines:

7.2.1 Highset 'Queenslander' style dwelling

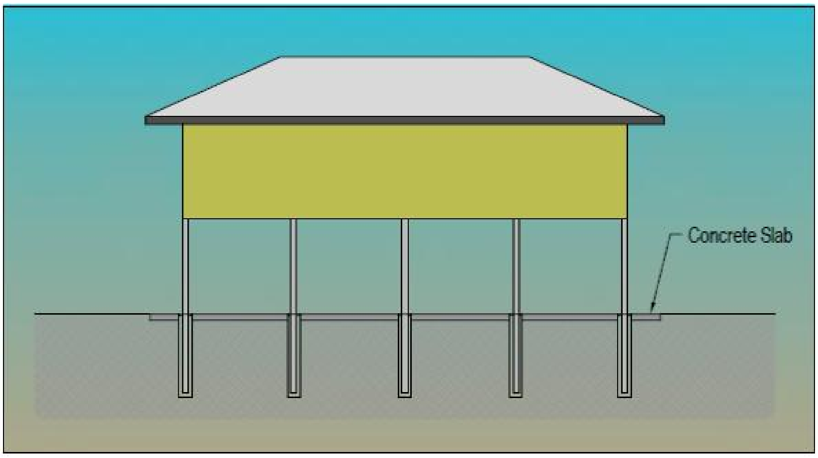


Figure 6 Option A – Concrete Ground Slab

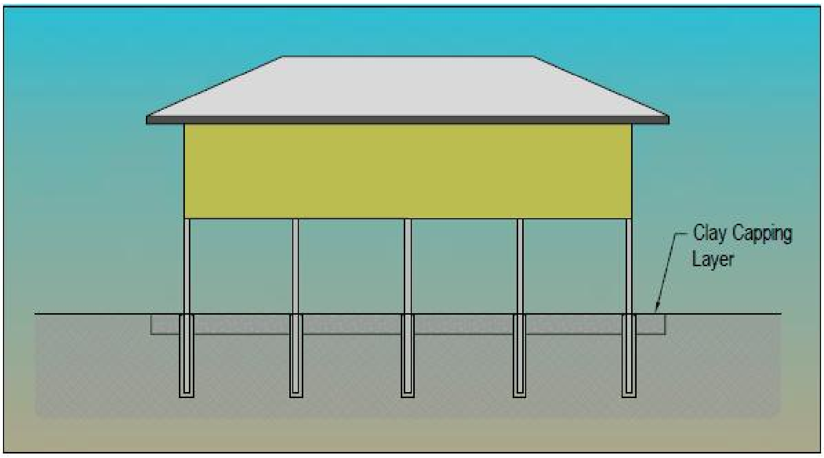


Figure 7 Option B – Clay Capping Layer

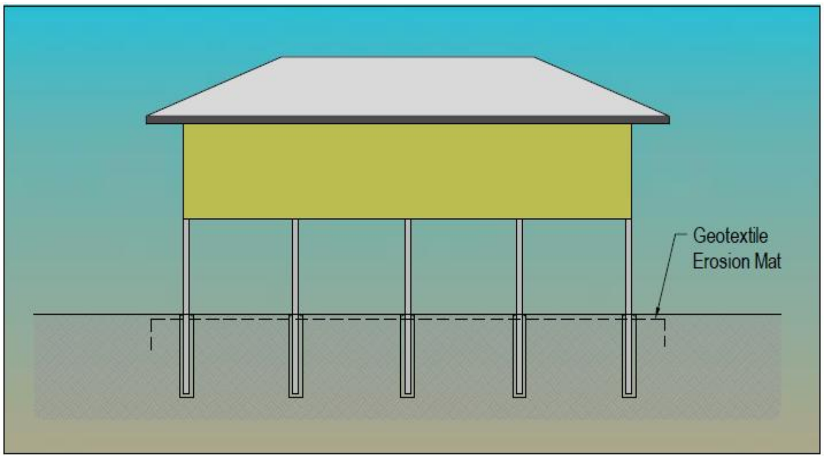


Figure 8 Option C – Geotextile Erosion Mat

7.2.2 Slab on Ground Style Dwelling

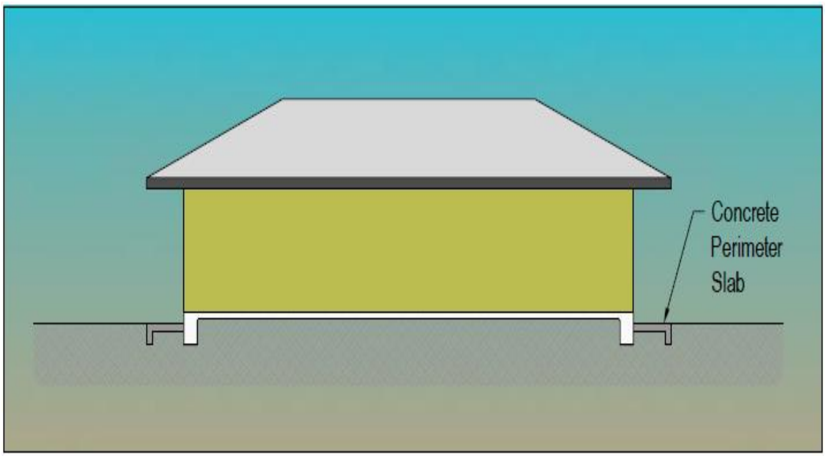


Figure 9 Option A – Concrete Perimeter Slab

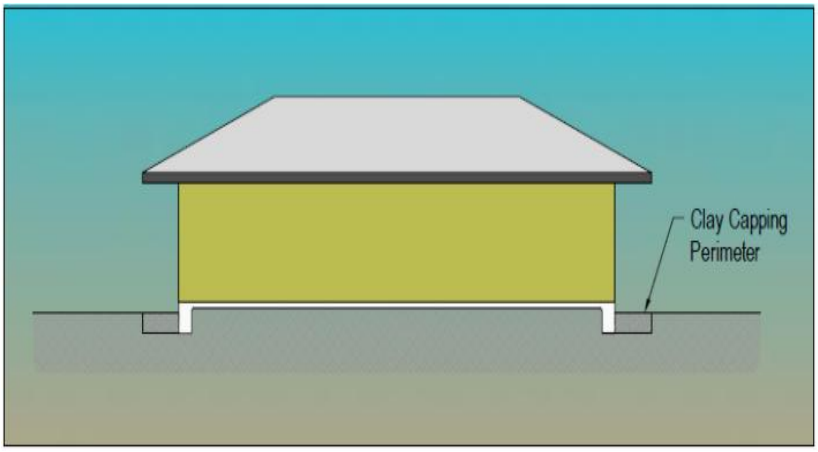


Figure 10 Option B – Clay Capping Perimeter

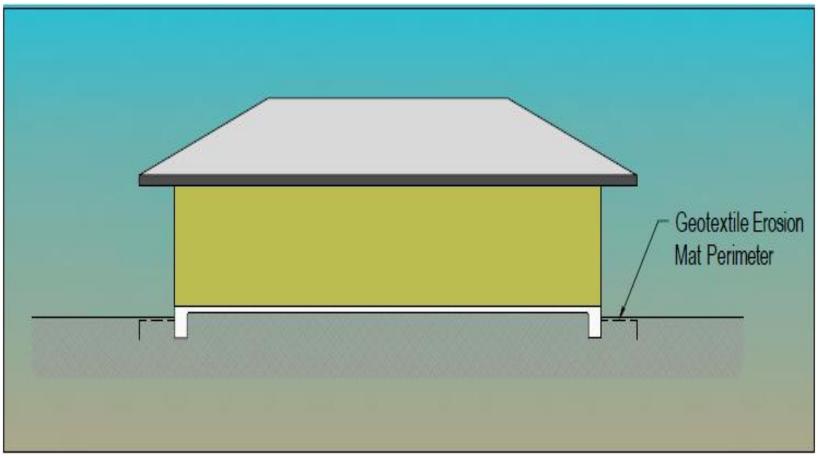


Figure 11 Option C – Geotextile Erosion Mat Perimeter

The procedure for improving dwelling resilience to flood induced scour using the options suggested is:

a) Estimate the scour risk rating due to foundation conditions;

b) Estimate the site velocity conditions;

c) Estimate the Site Scour Risk;

d) Select the appropriate improved resilience option;

e) Design and detail the selected improved resilience option in accordance with the Technical Notes included in Appendix C;

f) Footings contained within the improved resilience option zone may then be designed in accordance with AS2870 – Residential Slabs and Footings.

Table 7-1 Improved Resilience Treatment / Dwelling Footing

Option	Improved Resilience Treatment	Dwelling Footing
A	Concrete Ground / Perimeter Slab	In accordance with AS2870
B	Clay Capping Layer / Perimeter	In accordance with AS2870
C	Geotextile Erosion Mat / Perimeter	In accordance with AS2870

A Flow Chart showing the decision making process involved in providing an improved resilience treatment in accordance with these Guidelines is included in Appendix D.

7.3 Footing Design - Unprotected Soils

In floodplain areas with a moderate to extreme risk of soil scour, construction of buildings is not recommended unless the building design incorporates appropriate improved resilience measures such as those outlined in Section 7.2. However, if a decision is made to proceed with construction of a building without improved resilience treatment - it is recommended that at a minimum:

- Building footings be designed using a first principles approach by a registered professional engineer with expertise in hydraulic, geo-technical, and structural design; and
- Footings be constructed to a depth greater than the sites maximum potential scour depth.

A suggested procedure for footing design for dwellings on un-protected soils is:

a) Estimate the scour risk rating due to foundation conditions in accordance with the methodology in Section 4;

b) Obtain potential site velocity and depth conditions from Council;

c) Estimate the Site Scour Risk (refer Section 6, Table 6-1);

d) Estimate the maximum potential scour depth (refer Section 7.3.1 below);

e) Design the required dwelling footing assuming the loss of foundation support equal to the scour depth. Figure 12 and 13 provide examples of suggested footing designs.

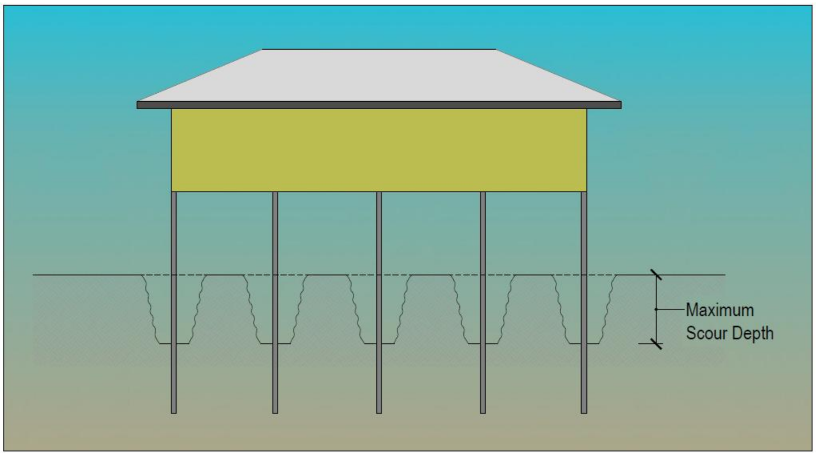


Figure 12 Unprotected Soil Treatment – 'Queenslander' Style Dwelling

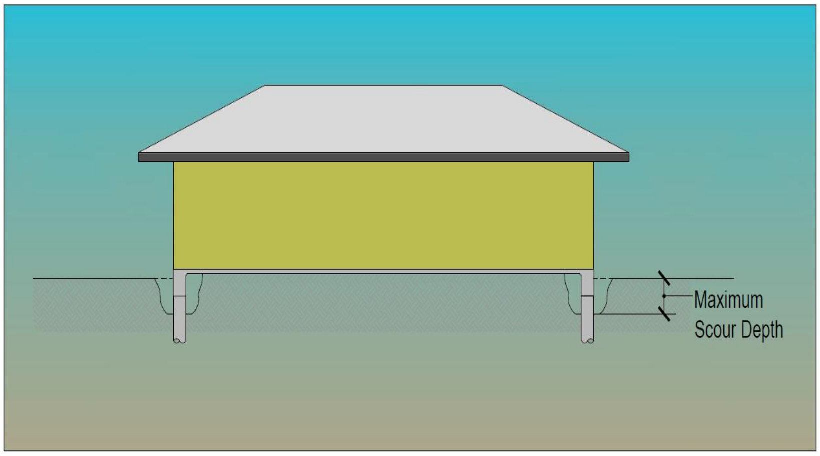


Figure 13 Unprotected Soil Treatment – Slab on Ground Style Dwelling

7.3.1 Estimation of Maximum Potential Scour Depths

Local scour around building foundations is a complex process that can be caused by a number of mechanisms including an acceleration of flow and resulting vortices induced by obstructions to the flow (refer Figures 3.0 and 5.0), pressure flow under superstructures, and contraction of flow between structures. Laboratory tests and field investigations by a number of authors indicate that the depth of local scour is affected by a number of parameters including: flow velocity, depth of flow, approach flow angle, width and shape of the structure, soil classification and soil particle size distribution.

Given the complexity and uncertainty associated with the scour process, it is recommended that consideration be given to the following approaches when estimating maximum potential scour depths:

- Actual scour depths experienced during historical flood events;
- Empirically based maximum scour depth estimates based on flood velocity and soil conditions;
- Potential scour depths based on geotechnical investigations.

7.3.2 Actual Historic Scour Depths

January, 2013 Bundaberg Flood

In January 2013, a major flood event (9.53m AHD at the Targo Street Flood Gauge) inundated the City of Bundaberg. During this event, parts of North Bundaberg experienced local flood depths of up to 3.0m and flood velocities of up to 3.0m/s. A number of dwellings mostly located in sandy alluvial soils experienced significant damage resulting from scour induced foundation failure. Post flood observations indicated scour depths of up to 3 metres were evident around and under dwellings.

If buildings (or building extensions) are proposed to be constructed without suitable scour protection measures in floodplain areas with a moderate to extreme scour risk rating, it is recommended that foundations be constructed to depths greater than maximum scour depths experienced during historical flood events.

7.3.3 Empirically Based Maximum Scour Depth Estimates

Currently, there is no direct practical method for estimating local scour depths in the immediate vicinity of buildings. An extensive literature search indicates that an alternate methodology for estimating potential scour depths at buildings is to adapt the scour effects on buildings from known effects on bridge piers or abutments that are geometrically and hydraulically similar.

Local pier scour, contraction scour and abutment scour methods that could be used in lieu of readily available building scour approaches to estimate potential scour depths can be found in the following references:

Non-Cohesive Soil Scour

- *Evaluating Scour at Bridges Fifth Edition, Publication No. FHWA-HIF-12-003, Hydraulic Engineering Circular No. 18, U.S. Department of Transportation Federal Highway Administration, April 2012.*

  http://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif12003.pdf
- *Florida Department of Transportation Bridge Scour Manual, May 2005.*

  http://www.dot.state.fl.us/rddesign/dr/Bridgescour/FDOT-Scour-Manual-6-2-2005-Final.pdf
- *Scour at Wide Piers and Long Skewed Piers, National Cooperative Highway Research Program Report 568, Transportation Research Board of the National Academies, Washington DC 2011.*

Cohesive Soil Scour

- *Pier and Contraction Scour in Cohesive Soils, National Cooperative Highway Research Program Report 516, Transportation Research Board of the National Academies, Washington DC 2004.*

  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_516.pdf

It is noted that in applying the methods contained in the above non-cohesive and cohesive soil scour references:

- Local site specific flood depths and velocities can be obtained from Council’s existing flood level and velocity database;

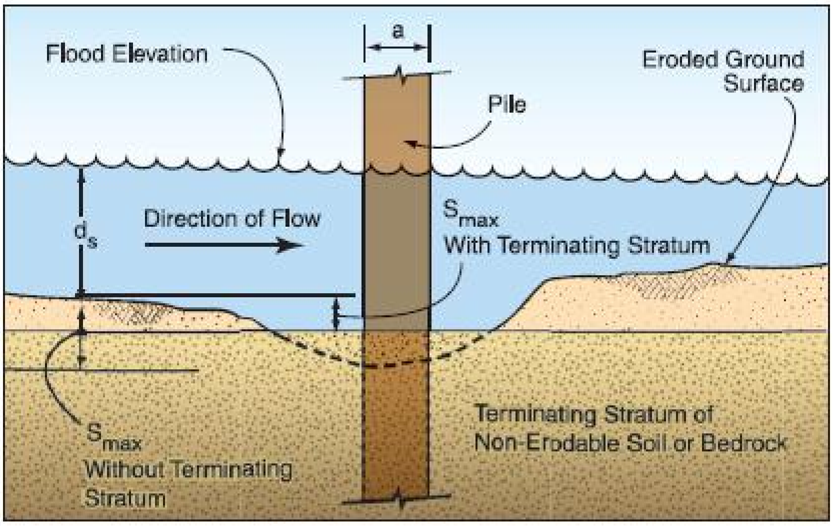
- Soil data should be obtained from geotechnical soil testing and NATA registered soil laboratory analysis;
- Estimation of the scour depth around a single pier or pile will require use of local bridge pier scour formulas;
- Estimation of the scour depth around a group of foundations (e.g. several piles) will require use of formulas applicable to multiple or complex pier groups; and
- Estimation of the scour depth around slab on ground type dwellings or enclosed foundations will require the building to be approximated as a wide pier or single abutment type structure.

7.3.4 Additional Geotechnical Investigations

Additional geotechnical investigations (i.e. a greater density of site sampling) using the methods outlined in Section 4 could be undertaken to better determine the spatial variability of soils at higher risk of scour across the proposed building site.

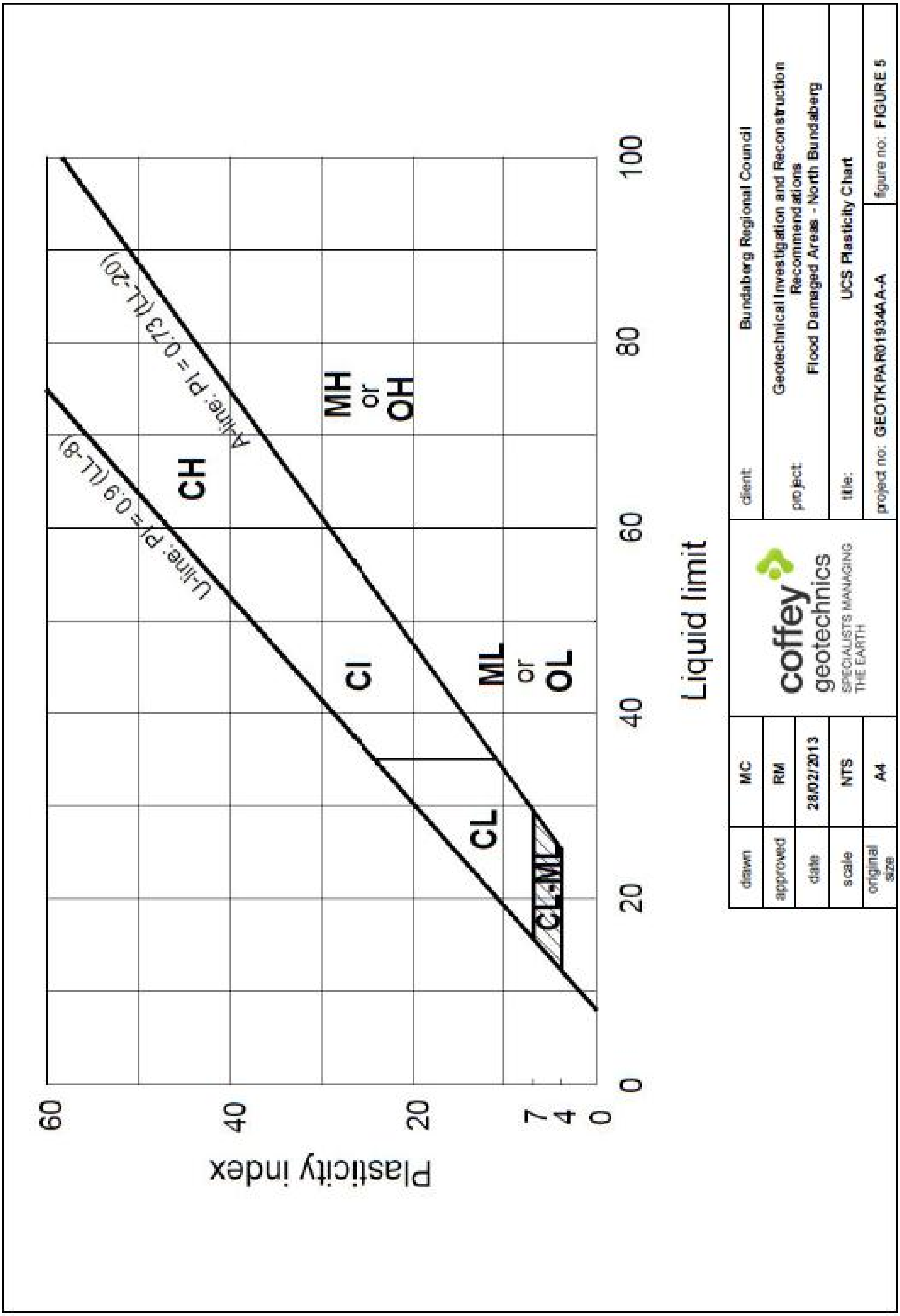
If buildings (or building extensions) are proposed to be constructed without suitable measures for improved scour resilience in floodplain areas with a moderate to extreme scour risk rating, it is recommended that footings be constructed to the terminating stratum of non-erodible soil.

Figure 14 Pile Foundation Terminating in Non-Erodible Soil Depth

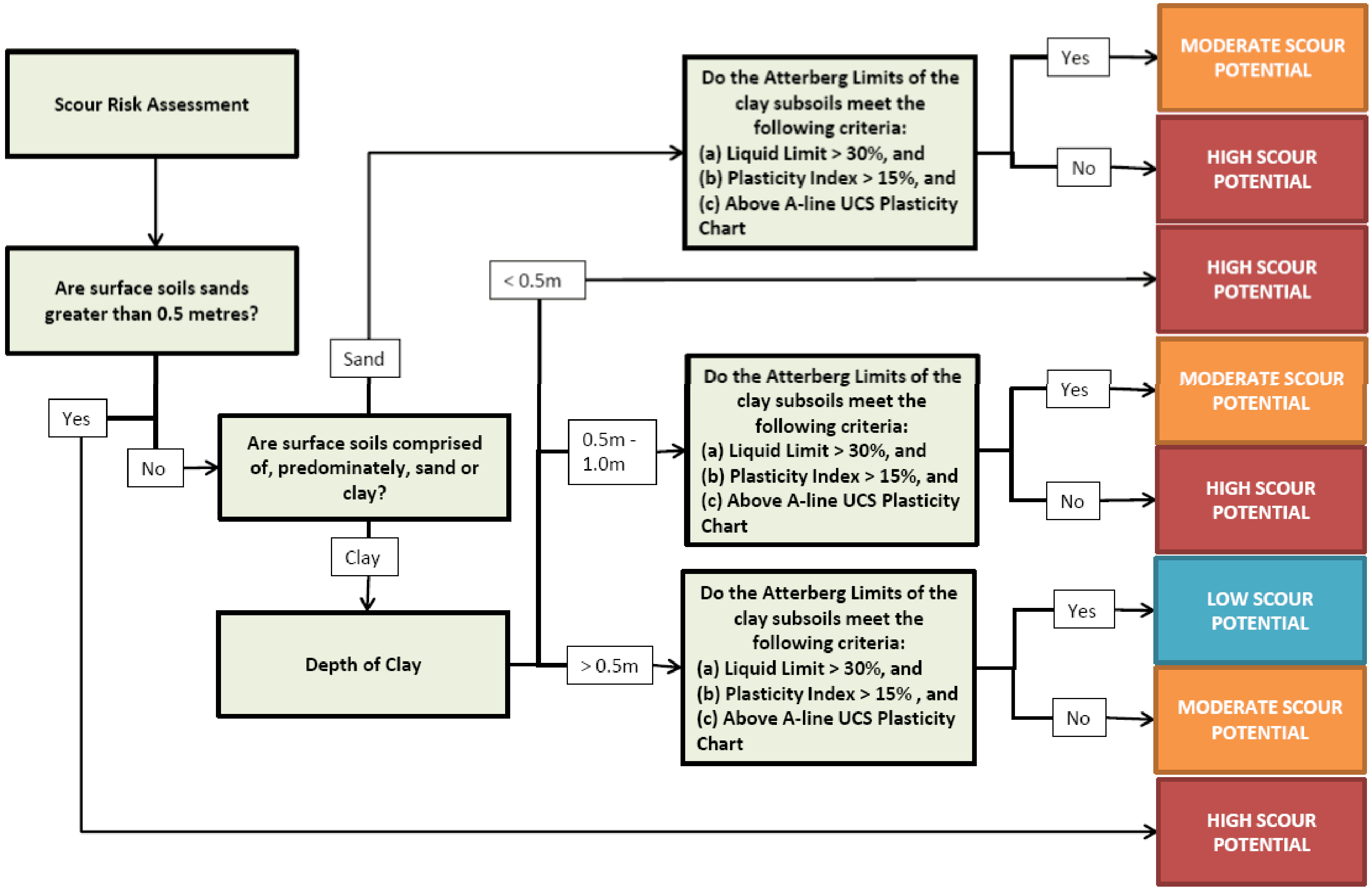


Appendices

Appendix A – USC Plasticity Charts


Plasticity index
60
40
20
7
4
0
Liquid limit
0
20
40
60
80
100
U-line: PI = 0.9 (LL-8)
A-line: PI = 0.73 (LL-20)
CL-ML
CL
CI
ML or OL
CH
MH or OH
drawn MC
approved RM
date 28/02/2013
scale NTS
original size A4
coffey geotechnics
SPECIALISTS MANAGING THE EARTH
client: Bundaberg Regional Council
project: Geotechnical Investigation and Reconstruction Recommendations Flood Damaged Areas - North Bundaberg
title: UCS Plasticity Chart
project no: GEOTKPAR01934AA-A
figure no: FIGURE 5

Appendix B – Soils Investigation Flow Chart



drawn	MC	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	Bundaberg Regional Council
approved	RM		project:	Geotechnical Investigation and Reconstruction Recommendations Flood Damaged Areas - North Bundaberg
date	28/02/2013			
scale	NTS		title:	Scour Risk Assessment Flow Chart
original size	A4		project no: GEOTKPAR01934AA-A	figure no: FIGURE 6

Appendix C – Technical Notes – Improved Resilience Treatments

7.2.1 Highset 'Queenslander' Style Dwelling

Option A Concrete Ground Slab

Option B Clay Capping Layer

Option C Geotextile Erosion Mat

7.2.2 Slab on Ground Style Dwelling

Option A Concrete Perimeter Slab

Option B Clay Capping Perimeter

Option C Geotextile Erosion Mat Perimeter

1. Introduction

This technical note deals with the provision of improved scour resilience in the form of a concrete ground slab for highset Queenslander style dwellings.

This technical note shall be read in conjunction with Bundaberg Regional Council's Guidelines for Dwellings constructed within a Flood Hazard Area (Guidelines).

2. Site Scour Risk

A site scour risk assessment in accordance with the Guidelines is required to be undertaken to provide input to this technical note.

3. Improved Resilience Treatment

Highset 'Queenslander' style dwellings typically consist of timber framed construction (floors, walls and roofs) elevated above the existing ground level and supported on a grillage of support posts / stumps. Typically these support posts / stumps would be of either timber, steel or concrete construction. Flood waters flowing around these support posts / stumps can result in mobilisation of the foundation material leading to scouring. The risk of scour is dependent on a combination of the foundation conditions and flood water velocity.

An effective method to improve the resilience of the dwelling from the effects of scour is via the provision of a concrete ground slab to the footprint of the dwelling.

4. Concrete Ground Slab Typical Details

Typical details for the provision of an improved resilience treatment in the form of a concrete ground slab are indicated in figures 1.0 and 2.0 below:

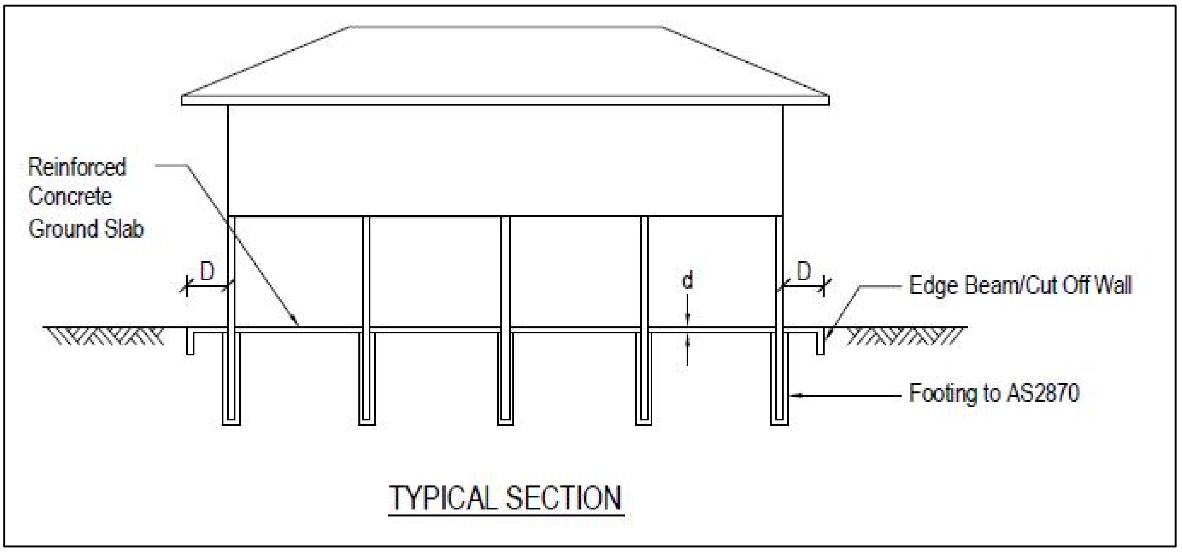


Figure 1.0 Typical Section

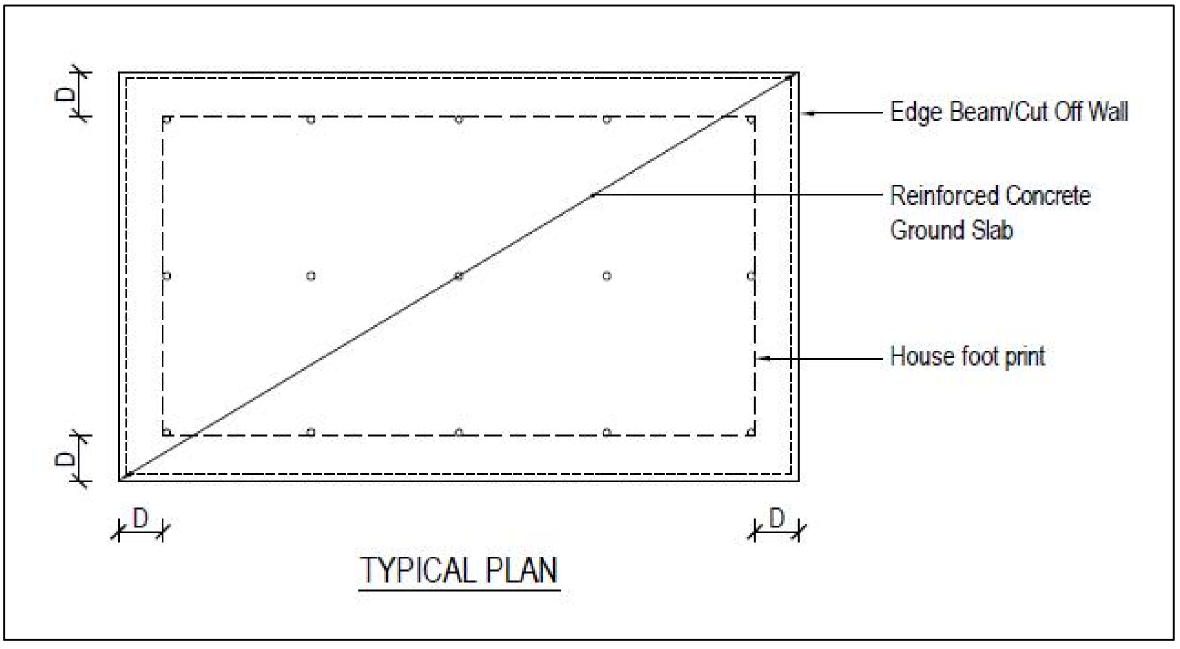


Figure 2.0 Typical Plan

Based on the outcomes of the site scour risk assessment additional construction parameters can be selected from Table 1.0 below:

Table 1

Scour Risk Factor	Slab Details					
	D (mm)	d (mm)	Slab Reinforcement	Edge Beam	Cut Off Wall	Slab Joints
NIL	N/A	N/A	N/A	N/A	N/A	N/A
LOW	1200	100	SL72min	Yes	--	Type & locations to Engineer's detail
MED	1500	100	SL72min	Yes	--	Type & locations to Engineer's detail
HIGH	1800	100	SL72min	--	YES	Type & locations to Engineer's detail
EXTREME	2100	100	SL72min	--	YES	Type & locations to Engineer's detail

Typical details pertaining to the cut off walls, edge beams and post / stump trimming details are indicated in figures 3.0, 4.0 and 5.0 below:

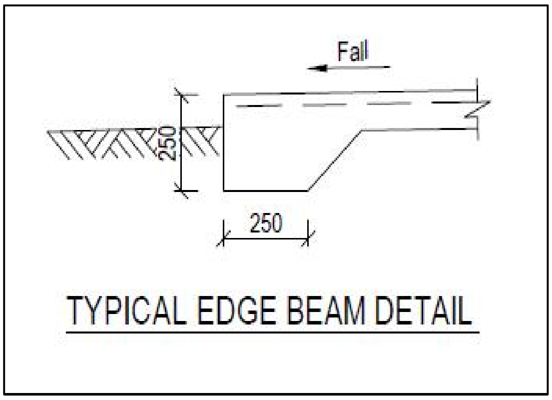


Figure 3.0 Typical Edge Beam Detail

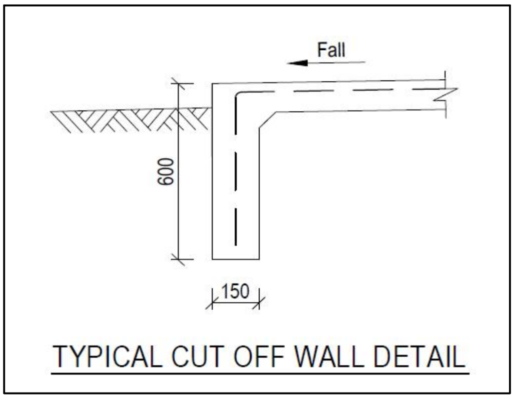


Figure 4.0 Typical Cut Off Wall Detail

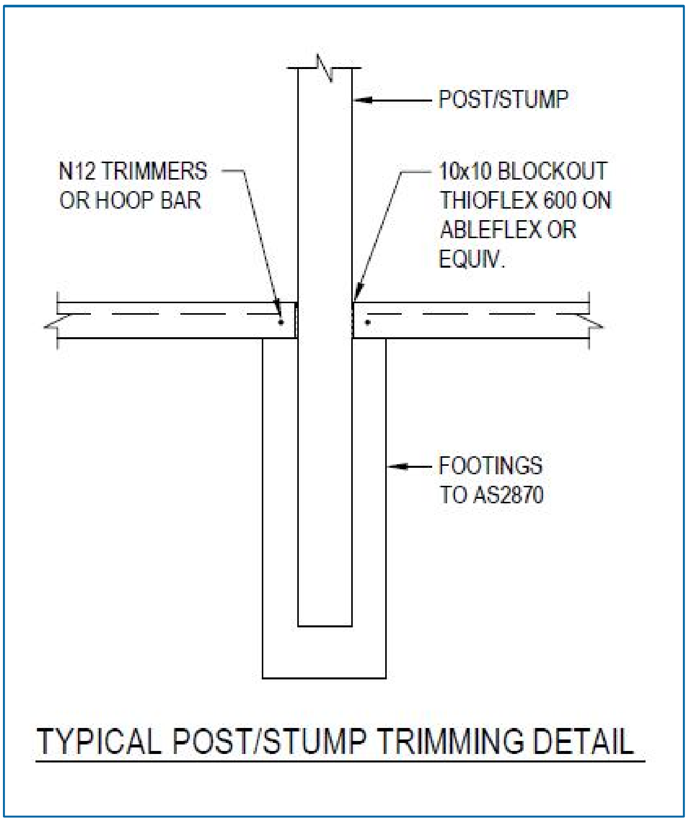


Figure 5.0 Typical Post / Stump Trimming Detail

5. Dwelling Footings

Dwelling footings contained within the concrete ground slab improved resilience treatment can be designed in accordance with AS2870 – Residential Slabs & Footings.

6. Concrete Notes

6.1 Concrete Mix

C1 Workmanship and materials to comply with AS3600, AS2870, AS3610, AS1379, AS1478, AS3582 and AS3972.

C2 Wet concrete to be uniform, homogeneous, cohesive and able to work readily into corners and around reinforcement completely filling formwork without segregation, excess free water on surface, loss of material or contamination.

Concrete to have good dimensional stability and able to resist plastic settlement cracking, thermal cracking and shrinkage cracking.

C3 Finished concrete to be durable, dense, homogeneous mass completely filling formwork, embedding reinforcement and tendons, and free of stone pockets, of uniform colour and texture, with low permeability and adequate but not excessive strength for grade.

C4 Quality of concrete elements to be as follows:

Table 2

Structural Element	Slab on Ground
Strength grade (MPa)	N25
Max. Aggregate Size (mm)	20
Slump (mm)	80

For general blended cement (GB) containing ordinary Portland cement plus at least 5% supplementary cementitious materials:

- Silica fume to be less than 10%, or
- Flyash to be less than 25%, or
- Ground granulated blast furnace slag to be less than 40%.

For double blended cement total supplementary cementitious material must be less than smaller of percentages given above for constituents included.

For triple blended cement total supplementary cementitious material must be less than 40%.

Supplementary cementitious materials specified in table above are in addition to materials incorporated in GB cement.

Admixtures to comply with AS1478. Admixtures must not reduce strength of concrete below specified value. Use admixtures in accordance with manufacturer's recommendations. Concrete additives shall not enhance corrosion of reinforcement, nor be detrimental to concrete or steel during expected life of structure.

Mix concrete to ensure uniform distribution of constituents.

6.2 Placing of Concrete

C5 Remove free water, dust and debris, stains etc from forms, excavations etc before placing concrete. In hot conditions dampen formwork and/or sub-grade before placing concrete.

C6 Elapsed time between wetting of mix and discharge of concrete at site must be as short as possible and comply with the following:

Table 3

Concrete Temperature at Time of Discharge (^{o}C)	Maximum Elapsed Time (Hours)
10 – 24	2.00
24 – 27	1.50
27 – 30	1.00
30 – 32	0.75

C7 Use placement methods that will minimise plastic settlement and shrinkage cracking.

Protect fresh concrete from premature drying – particularly in hot, windy or dry (low humidity) conditions. Excessively hot or cold temperatures, rain, etc. provide wind breaks. Maintain concrete at a reasonably constant temperature with minimum moisture loss for curing period.

For concrete with water cement ratio less than 0.5 in hot, windy or dry (low humidity) conditions spray exposed surfaces of fresh concrete with fog spray application of aliphatic alcohol retardant immediately after placement to reduce risk of plastic shrinkage cracking. In severe climatic conditions consider revibrating concrete before it reaches initial set.

Commence curing of concrete to AS3600 as soon as possible after placing and finishing or stripping, and within one hour. Acceptable methods of curing include:

- Ponding or continuous sprinkling with water (moist curing);
- An impermeable membrane;
- An absorptive cover kept continuously wet and covered by impermeable membrane.

6.3 Reinforcement Cover

C8 Provide minimum clear cover to reinforcement as shown below:

Table 4:

Location	Cover (mm)
Underside of slab on ground (not protected by vapour barrier)	40
Underside of slab on ground (protected by vapour barrier)	30
Top of slab on ground.	40

1. Introduction

This technical note deals with the provision of improved scour resilience in the form of a clay capping layer for highset Queenslander style dwellings.

This technical note shall be read in conjunction with Bundaberg Regional Council’s Guidelines for Dwellings constructed within a Flood Hazard Area (Guidelines).

2. Site Scour Risk

A site scour risk assessment in accordance with the Guidelines is required to be undertaken to provide input to this technical note.

3. Improved Resilience Treatment

Highset ‘Queenslander’ style dwellings typically consist of timber framed construction (floors, walls and roofs) elevated above the existing ground level and supported on a grillage of support posts / stumps. Typically these support posts / stumps would be of either timber, steel or concrete construction. Flood waters flowing around these support posts / stumps can result in mobilisation of the foundation material leading to scouring. The risk of scour is dependent on a combination of the foundation conditions and flood water velocity.

An effective method to improve the resilience of the dwelling from the effects of scour is via the provision of a clay capping layer to the footprint of the dwelling.

4. Clay Capping Layer Typical Details

Typical details for the provision of an improved resilience treatment in the form of a clay capping layer are indicated in figures 1.0 and 2.0 below:

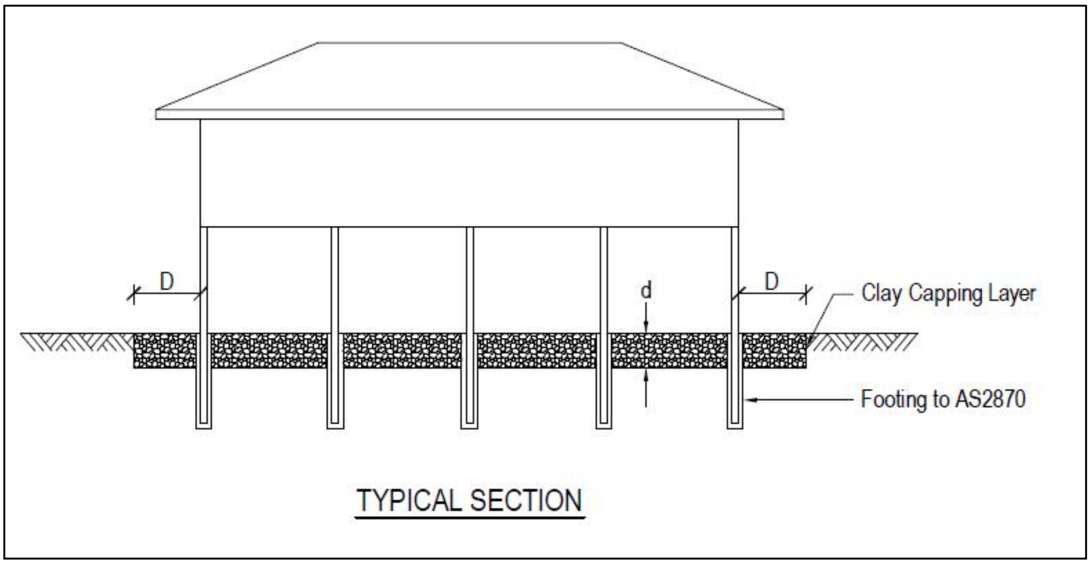


Figure 1.0 Typical Section

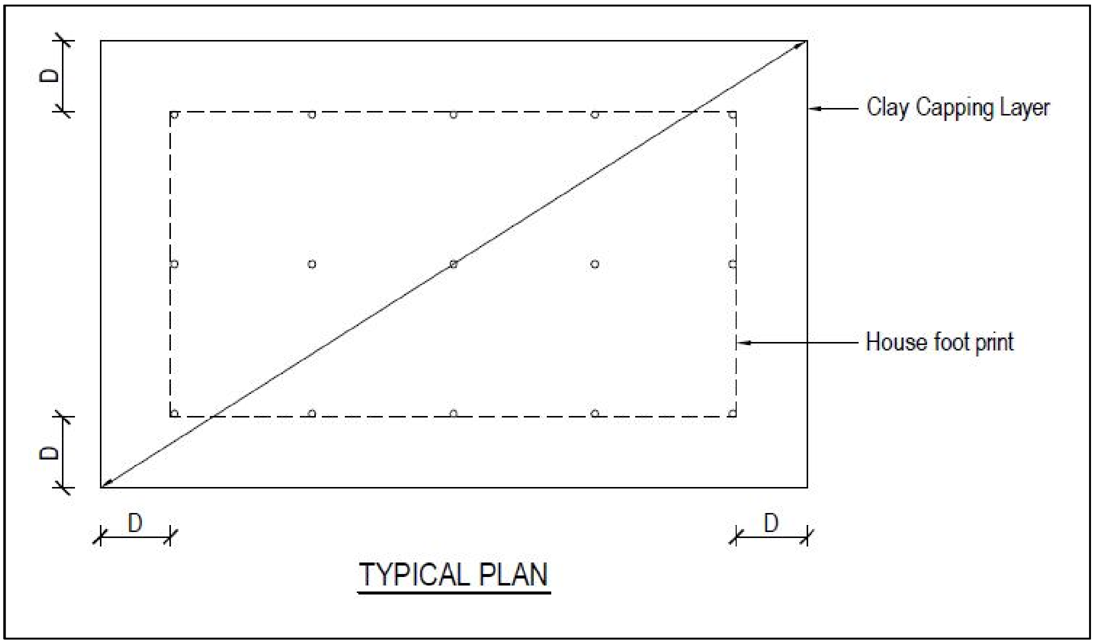


Figure 2.0 Typical Plan

Based on the outcomes of the site scour risk assessment additional construction parameters can be selected from Table 1.0 below:

Table 1

Clay Capping Layer Details		
Scour Risk Factor	**D (mm)**	**d (mm)**
NIL	N/A	N/A
LOW	1200	600
MED	1500	750
HIGH	2000	900
EXTREME	Clay capping layer not recommended for scour risk factor EXTREME	

5. Dwelling Footings

Dwelling footings contained within the clay capping layer improved resilience treatment can be designed in accordance with AS2870 – Residential Slabs & Footings.

6. Clay Capping Layer Notes

6.1 Materials

M1 Clay capping material shall consist of an imported clay or sandy clay material.

M2 The imported material shall be stable, free from organic material and free from chemical or radioactive contaminants.

M3 The clay capping material shall conform with the following properties:

- Non-dispersive;
- Liquid Limit (LL) > 30%;
- Plasticity Index (PI) > 12%;
- LL and PI to plot above the A-line on the UCS Plasticity Chart;
- Silty fines content > 30%;
- Limitation of stone size – no stone over 50mm greatest dimension;
- Soaked CBR – 10 minimum.

6.2 Construction

C1 Preparation, excavation, placement and compaction works are to be carried out in accordance with AS3798 – Guidelines on Earthworks for Commercial & Residential Development.

C2 Soil containing grass, root or organic material shall be stripped from the capping layer footprint.

C3 The excavated subgrade should be inspected and proof rolled to check for areas of unsuitable subgrade or soft areas.

C4 Unsuitable subgrade areas should be removed and replaced with compacted fill material. Material complying with the properties of the clay capping material is suitable for subgrade replacement.

C5 The clay capping material shall be built up in layers not exceeding 200mm uncompacted depth. Care should be taken to ensure that compacted layers are properly bound to the underlying layers.

C6 Clay capping material shall be placed and compacted at or near optimum moisture content.

C7 Clay capping layer is to be compacted to achieve a minimum relative compaction of 95% MDD at standard compactive effort.

C8 Frequency of testing of field density shall be in accordance with AS3790 Table 8.1.

C9 The finished surface of the clay capping layer shall ensure that the surface is free draining.

1. Introduction

This technical note deals with the provision of improved scour resilience in the form of a geotextile erosion mat for highset Queenslander style dwellings.

This technical note shall be read in conjunction with Bundaberg Regional Council's Guidelines for Dwellings constructed within a Flood Hazard Area (Guidelines).

2. Site Scour Risk

A site scour risk assessment in accordance with the Guidelines is required to be undertaken to provide input to this technical note.

3. Improved Resilience Treatment

Highset 'Queenslander' style dwellings typically consist of timber framed construction (floors, walls and roofs) elevated above the existing ground level and supported on a grillage of support posts / stumps. Typically these support posts / stumps would be of either timber, steel or concrete construction. Flood waters flowing around these support posts / stumps can result in mobilisation of the foundation material leading to scouring. The risk of scour is dependent on a combination of the foundation conditions and flood water velocity.

An effective method to improve the resilience of the dwelling from the effects of scour is via the provision of a geotextile erosion mat to the footprint of the dwelling.

4. Geotextile Erosion Mat Details

Typical details for the provision of an improved resilience treatment in the form of a geotextile erosion mat are indicated in figures 1.0 and 2.0 below:

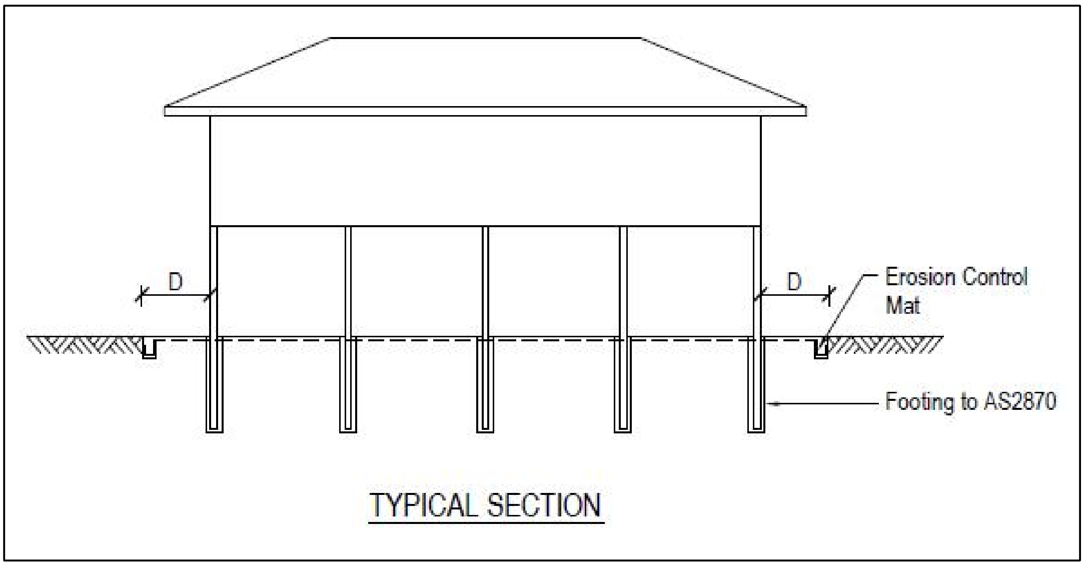


Figure 1.0 Typical Section

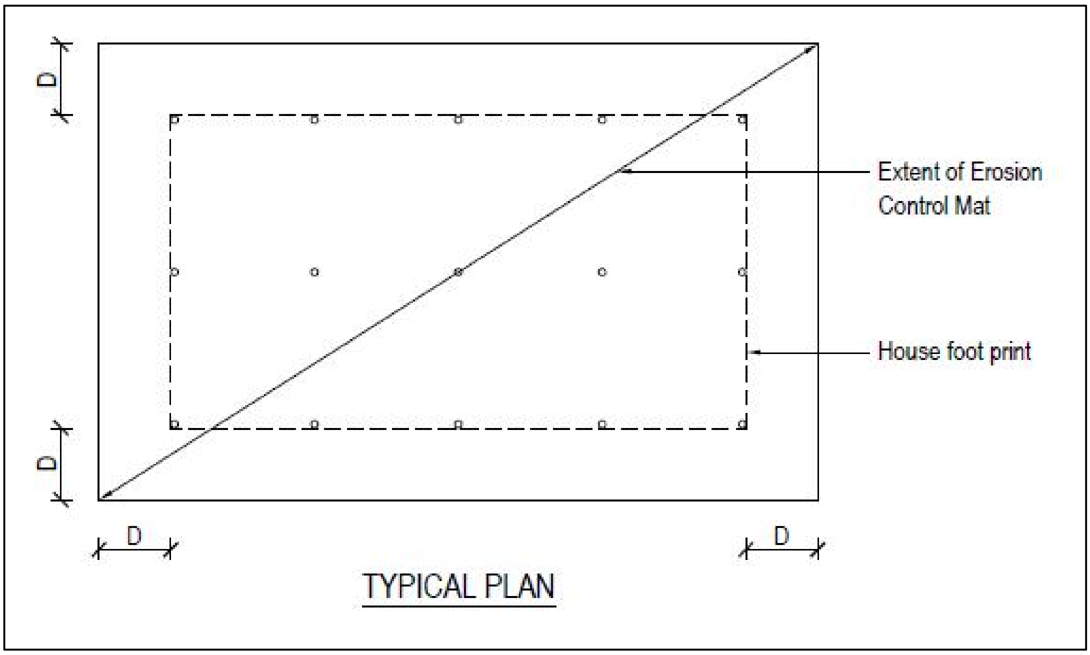


Figure 2.0 Typical Plan

Based on the outcomes of the site scour risk assessment additional construction parameters can be selected from Table 1.0 below:

Table 1

Erosion Mat Details		
Scour Risk Factor	**D (mm)**	**Cut Off Wall**
NIL	N/A	N/A
LOW	1500	Yes
MED	2000	Yes
HIGH	Erosion Mat not suitable for scour risk factor HIGH or EXTREME	
EXTREME		

Typical details pertaining to the cut off walls, edge beams and post / stump details are indicated in figures 3.0, 4.0 and 5.0 below:

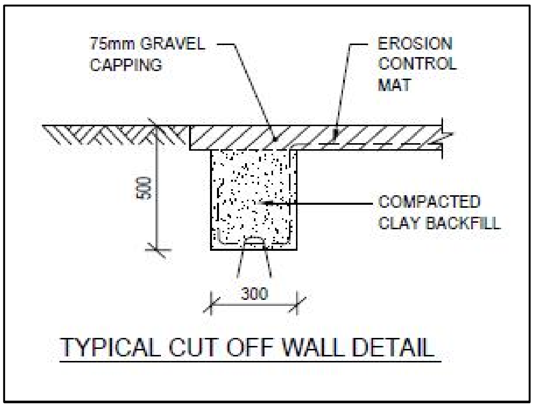


Figure 3.0 Typical Cut Off Wall Detail

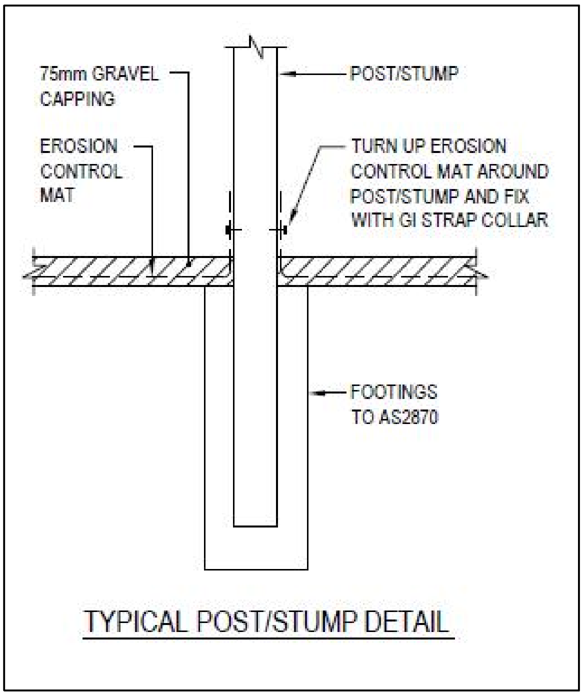


Figure 4.0 Typical Post / Stump Detail

5. Dwelling Footings

Dwelling footings contained within the geotextile erosion mat improved resilience treatment can be designed in accordance with AS2870 – Residential Slabs & Footings.

6. Geotextile Erosion Control Mat Notes

6.1 Geotextile Erosion Control Mat

M1 Geotextile erosion control mat to be Geofabrics Australia Grassroots synthetic erosion control matting or equivalent.

M2 Synthetic fibres made from UV-stable polypropylene, needle punched onto synthetic scrim.

M3 Scrim to be black polypropylene mesh 4 x 4mm squares, weight 80gsm:

- Tensile Strength Cross Directional (CD): not less than 5KN/m^2.
- Machine Directional (MD): not less than 5KN/m^2.

M4 Mat density: 380 – 400 gsm/m^2.

6.2 Laying

L1 Strip area to remove vegetation and top soil, minimum depth 50mm.

L2 Provide 500mm deep x 300mm wide cut off to perimeter of mat. Lay mat to the base of cut off wall and pin and backfill.

L3 Roll mat out to cover required area. Laying pattern should mimic a fish scale pattern. Overlay mats by a minimum of 100mm and pin.

L4 Do not pull the surface of the mat tightly across the soil surface. Allow it to contour to the soil profile and into undulations.

6.3 Fixing

F1 Fix mat to underlying foundation with mat manufacturer's fastening pins.

F2 Fastening pins to be 300mm x 30mm x 300mm (leg x bridge x leg) ⊓ pins.

F3 Wire diameter of fastening pins to be 4mm.

F4 Fix mat to cut off wall base with pins at 300mm intervals.

F5 Fix mat at overlaps with pins at 300mm intervals.

F6 Minimum pinning frequency of mat to foundation is 4 pins per square metre.

7. Gravel Capping Layer Notes

G1 Gravel capping layer quality to conform with Department of Transport and Main Roads Technical Specification MRTS05 – Type 2.5 Unbound Pavement Material.

G2 Gravel capping layer to be compacted to achieve a minimum compaction standard of 95% MDD (standard compaction).

1. Introduction

This technical note deals with the provision of improved scour resilience in the form of a concrete perimeter slab for slab on ground style dwellings.

This technical note shall be read in conjunction with Bundaberg Regional Council's Guidelines for Dwellings constructed within a Flood Hazard Area (Guidelines).

2. Site Scour Risk

A site scour risk assessment in accordance with the Guidelines is required to be undertaken to provide input to this technical note.

3. Improved Resilience Treatment

Slab on ground style dwellings typically consist of timber, steel, masonry or masonry veneer external wall construction with raftered or trussed roofs. The superstructure is supported on concrete ground beams and slab on ground construction.

Flood waters flowing around the perimeter of slab on ground construction can result in mobilisation of the foundation material leading to scouring. The risk of scour is dependent on a combination of the foundation conditions and flood water velocity.

An effective method to improve the resilience of the dwelling from the effects of scour is via the provision of a concrete perimeter slab to the footprint of the dwelling.

4. Concrete Perimeter Slab Typical Details

Typical details for the provision of an improved resilience treatment in the form of a concrete perimeter slab are indicated in figures 1.0 and 2.0 below:

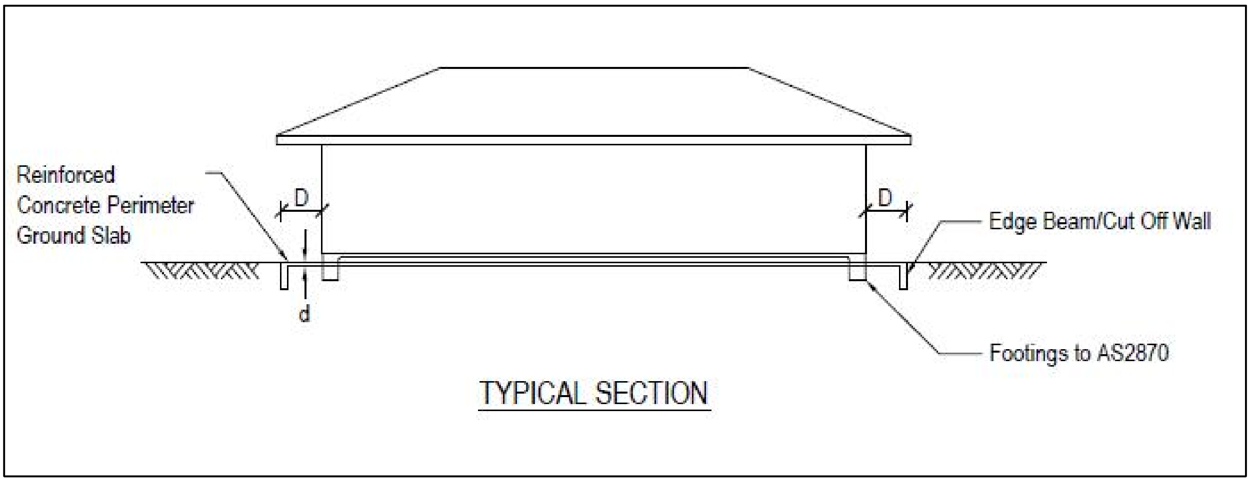


Figure 1.0 Typical Section

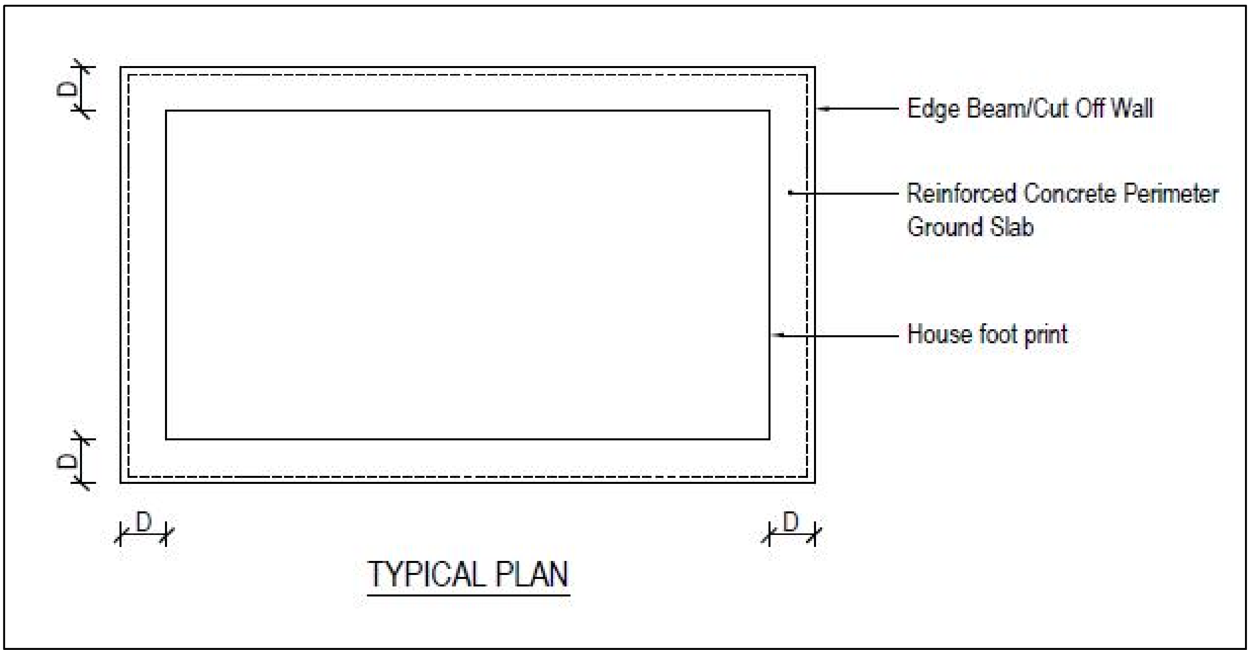


Figure 2.0 Typical Plan

Based on the outcomes of the site scour risk assessment additional construction parameters can be selected from Table 1.0 below:

Table 1

Scour Risk Factor	Slab Details					
	D (mm)	d (mm)	Slab Reinforcement	Edge Beam	Cut Off Wall	Slab Joints
NIL	N/A	N/A	N/A	N/A	N/A	N/A
LOW	1200	100	SL72min	Yes	--	Type & locations to Engineer's detail
MED	1500	100	SL72min	Yes	--	Type & locations to Engineer's detail
HIGH	1800	100	SL72min	--	YES	Type & locations to Engineer's detail
EXTREME	2100	100	SL72min	--	YES	Type & locations to Engineer's detail

Typical details pertaining to the cut off walls, edge beams and dwelling junction details are indicated in figures 3.0, 4.0 and 5.0 below:

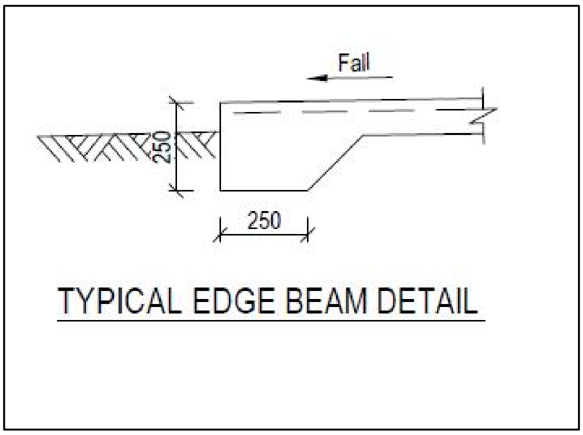


Figure 3.0 Typical Edge Beam Detail

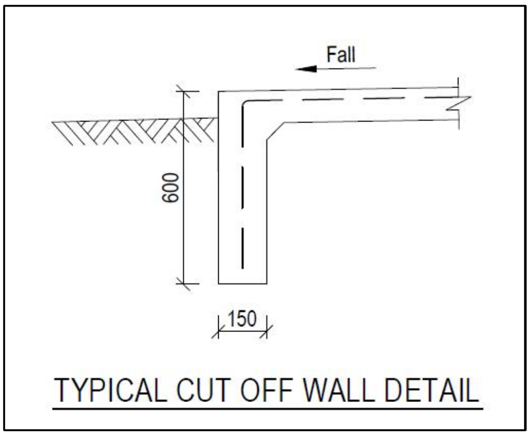


Figure 4.0 Typical Cut Off Wall Detail

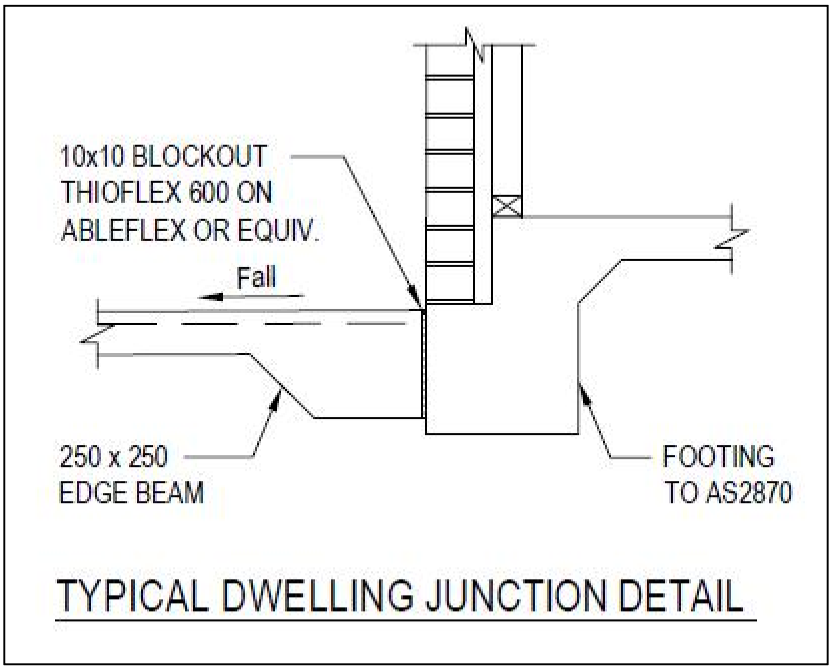


Figure 5.0 Typical Dwelling Junction Detail

5. Dwelling Footings

Dwelling footings contained within the concrete perimeter slab improved resilience treatment can be designed in accordance with AS2870 – Residential Slabs & Footings.

6. Concrete Notes

6.1 Concrete Mix

C1 Workmanship and materials to comply with AS3600, AS2870, AS3610, AS1379, AS1478, AS3582 and AS3972.

C2 Wet concrete to be uniform, homogeneous, cohesive and able to work readily into corners and around reinforcement completely filling formwork without segregation, excess free water on surface, loss of material or contamination.

Concrete to have good dimensional stability and able to resist plastic settlement cracking, thermal cracking and shrinkage cracking.

C3 Finished concrete to be durable, dense, homogeneous mass completely filling formwork, embedding reinforcement and tendons, and free of stone pockets, of uniform colour and texture, with low permeability and adequate but not excessive strength for grade.

C4 Quality of concrete elements to be as follows:

Table 2

Structural Element	Slab on Ground
Strength grade (MPa)	N25
Max. Aggregate Size (mm)	20
Slump (mm)	80

For general blended cement (GB) containing ordinary Portland cement plus at least 5% supplementary cementitious materials:

- Silica fume to be less than 10%, or
- Flyash to be less than 25%, or
- Ground granulated blast furnace slag to be less than 40%.

For double blended cement total supplementary cementitious material must be less than smaller of percentages given above for constituents included.

For triple blended cement total supplementary cementitious material must be less than 40%.

Supplementary cementitious materials specified in table above are in addition to materials incorporated in GB cement.

Admixtures to comply with AS1478. Admixtures must not reduce strength of concrete below specified value. Use admixtures in accordance with manufacturer's recommendations. Concrete additives shall not enhance corrosion of reinforcement, nor be detrimental to concrete or steel during expected life of structure.

Mix concrete to ensure uniform distribution of constituents.

6.2 Placing of Concrete

C5 Remove free water, dust and debris, stains etc from forms, excavations etc before placing concrete. In hot conditions dampen formwork and/or sub-grade before placing concrete.

C6 Elapsed time between wetting of mix and discharge of concrete at site must be as short as possible and comply with the following:

Table 3

Concrete Temperature at Time of Discharge (°C)	Maximum Elapsed Time (Hours)
10 – 24	2.00
24 – 27	1.50
27 – 30	1.00
30 – 32	0.75

C7 Use placement methods that will minimise plastic settlement and shrinkage cracking.

Protect fresh concrete from premature drying – particularly in hot, windy or dry (low humidity) conditions. Excessively hot or cold temperatures, rain, etc. provide wind breaks. Maintain concrete at a reasonably constant temperature with minimum moisture loss for curing period.

For concrete with water cement ratio less than 0.5 in hot, windy or dry (low humidity) conditions spray exposed surfaces of fresh concrete with fog spray application of aliphatic alcohol retardant immediately after placement to reduce risk of plastic shrinkage cracking. In severe climatic conditions consider revibrating concrete before it reaches initial set.

Commence curing of concrete to AS3600 as soon as possible after placing and finishing or stripping, and within one hour. Acceptable methods of curing include:

- Ponding or continuous sprinkling with water (moist curing);
- An impermeable membrane;
- An absorptive cover kept continuously wet and covered by impermeable membrane.

6.3 Reinforcement Cover

C8 Provide minimum clear cover to reinforcement as shown below:

Table 4

Location	Cover (mm)
Underside of slab on ground (not protected by vapour barrier)	40
Underside of slab on ground (protected by vapour barrier)	30
Top of slab on ground.	40

1. Introduction

This technical note deals with the provision of improved scour resilience in the form of a clay capping perimeter for slab on ground style dwellings.

This technical note shall be read in conjunction with Bundaberg Regional Council's Guidelines for Dwellings constructed within a Flood Hazard Area (Guidelines).

2. Site Scour Risk

A site scour risk assessment in accordance with the Guidelines is required to be undertaken to provide input to this technical note.

3. Improved Resilience Treatment

Slab on ground style dwellings typically consist of timber, steel, masonry or masonry veneer external wall construction with raftered or trussed roofs. The superstructure is supported on concrete ground beams and slab on ground construction.

Flood waters flowing around the perimeter of slab on ground construction can result in mobilisation of the foundation material leading to scouring. The risk of scour is dependent on a combination of the foundation conditions and flood water velocity.

An effective method to improve the resilience of the dwelling from the effects of scour is via the provision of a clay capping perimeter to the footprint of the dwelling.

4. Clay Capping Perimeter Typical Details

Typical details for the provision of an improved resilience treatment in the form of a clay capping perimeter are indicated in figures 1.0 and 2.0 below:

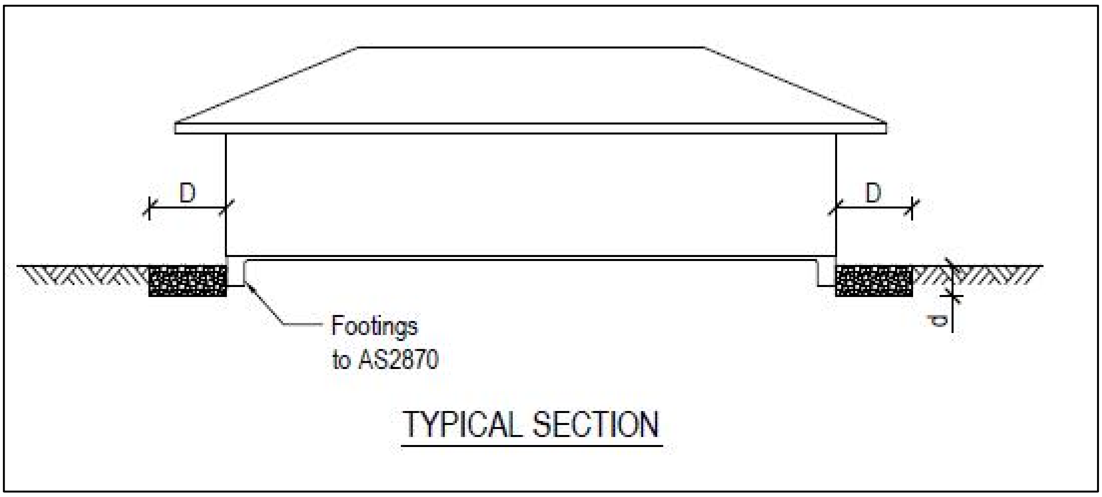


Figure 1.0 Typical Section

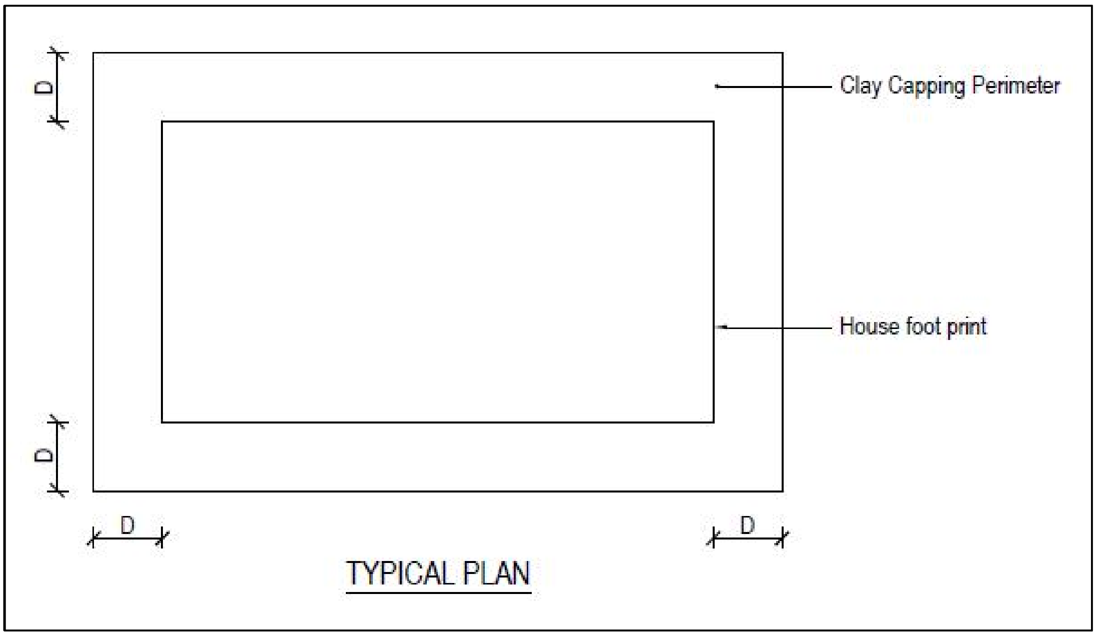


Figure 2.0 Typical Plan

Based on the outcomes of the site scour risk assessment additional construction parameters can be selected from Table 1.0 below:

Table 1

Clay Capping Perimeter Details		
Scour Risk Factor	**D (mm)**	**d (mm)**
NIL	N/A	N/A
LOW	1200	600
MED	1500	750
HIGH	2000	900
EXTREME	Clay capping perimeter not recommended for scour risk factor EXTREME	

5. Dwelling Footings

Dwelling footings contained within the clay capping perimeter improved resilience treatment can be designed in accordance with AS2870 – Residential Slabs & Footings.

6. Clay Capping Perimeter Notes

6.1 Materials

M1 Clay capping perimeter material shall consist of an imported clay or sandy clay material.

M2 The imported material shall be stable, free from organic material and free from chemical or radioactive contaminants.

M3 The clay capping perimeter material shall conform with the following properties:

- Non-dispersive;
- Liquid Limit (LL) > 30%;
- Plasticity Index (PI) > 12%;
- LL and PI to plot above the A-line on the UCS Plasticity Chart;
- Silty fines content > 30%;
- Limitation of stone size – no stone over 50mm greatest dimension;
- Soaked CBR – 10 minimum.

6.2 Construction

C1 Preparation, excavation, placement and compaction works are to be carried out in accordance with AS3798 – Guidelines on Earthworks for Commercial & Residential Development.

C2 Soil containing grass, root or organic material shall be stripped from the capping layer footprint.

C3 The excavated subgrade should be inspected and proof rolled to check for areas of unsuitable subgrade or soft areas.

C4 Unsuitable subgrade areas should be removed and replaced with compacted fill material. Material complying with the properties of the clay capping perimeter material is suitable for subgrade replacement.

C5 The clay capping perimeter material shall be built up in layers not exceeding 200mm uncompacted depth. Care should be taken to ensure that compacted layers are properly bound to the underlying layers.

C6 Clay capping perimeter material shall be placed and compacted at or near optimum moisture content.

C7 Clay capping layer is to be compacted to achieve a minimum relative compaction of 95% MDD at standard compactive effort.

C8 Frequency of testing of field density shall be in accordance with AS3790 Table 8.1.

C9 The finished surface of the clay capping layer shall ensure that the surface is free draining.

C10 The clay capping perimeter is to be top soiled and turfed on completion.

1. Introduction

This technical note deals with the provision of improved scour resilience in the form of a geotextile erosion mat slab on ground style dwellings.

This technical note shall be read in conjunction with Bundaberg Regional Council's Guidelines for Dwellings constructed within a Flood Hazard Area (Guidelines).

2. Site Scour Risk

A site scour risk assessment in accordance with the Guidelines is required to be undertaken to provide input to this technical note.

3. Improved Resilience Treatment

Slab on ground style dwellings typically consist of timber, steel, masonry or masonry veneer external wall construction with raftered or trussed roofs. The superstructure is supported on concrete ground beams and slab on ground construction. Flood waters flowing around the perimeter of slab on ground construction can result in mobilisation of the foundation material leading to scouring. The risk of scour is dependent on a combination of the foundation conditions and flood water velocity.

An effective method to improve the resilience of the dwelling from the effects of scour is via the provision of geotextile erosion mat perimeter to the footprint of the dwelling.

4. Geotextile Erosion Mat Perimeter Typical Details

Typical details for the provision of an improved resilience treatment in the form of a geotextile erosion mat perimeter are indicated in figures 1.0 and 2.0 below:

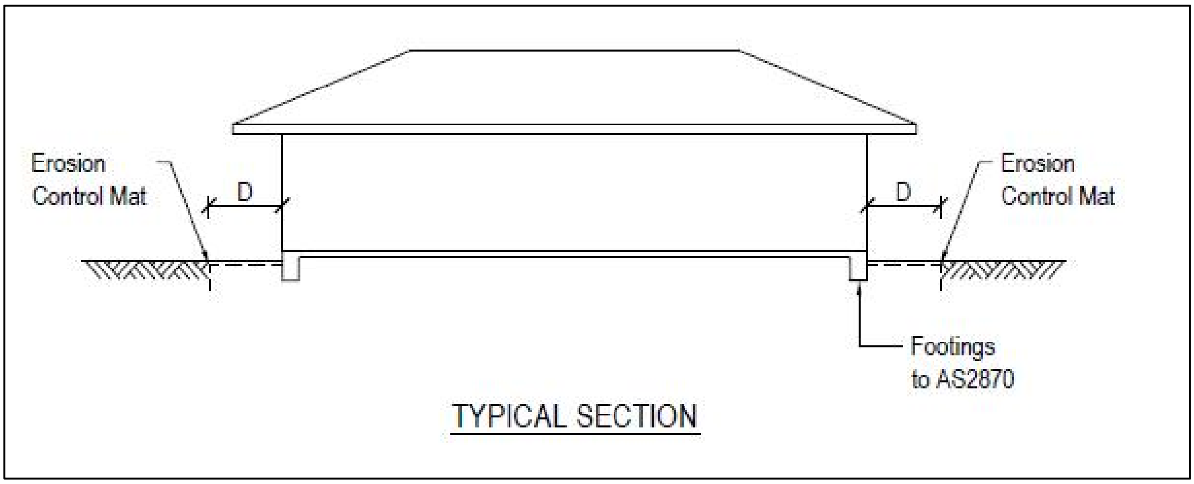


Figure 1.0 Typical Section

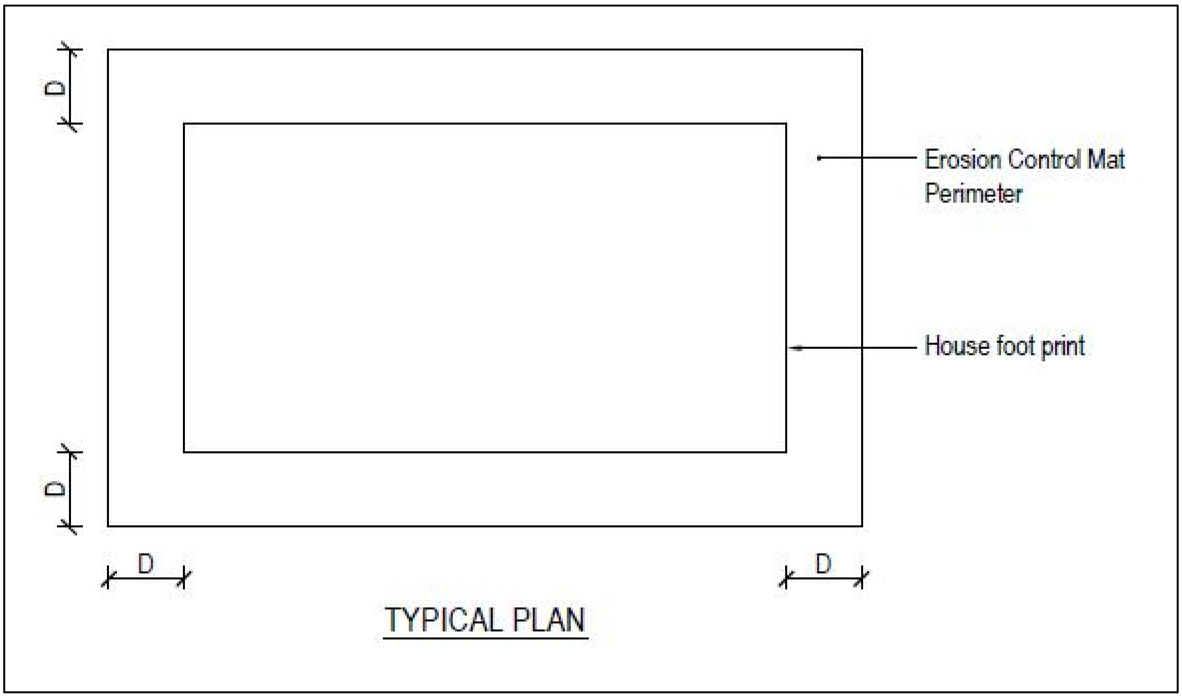


Figure 2.0 Typical Plan

Based on the outcomes of the site scour risk assessment additional construction parameters can be selected from Table 1.0 below:

Table 1

Erosion Mat Details		
Scour Risk Factor	D (mm)	Cut Off Wall
NIL	N/A	N/A
LOW	1500	Yes
MED	2000	Yes
HIGH	Erosion Mat not suitable for scour risk factor HIGH or EXTREME	
EXTREME		

Typical details pertaining to the cut off walls and dwelling junction details are indicated in figures 3.0, 4.0 and 5.0 below:

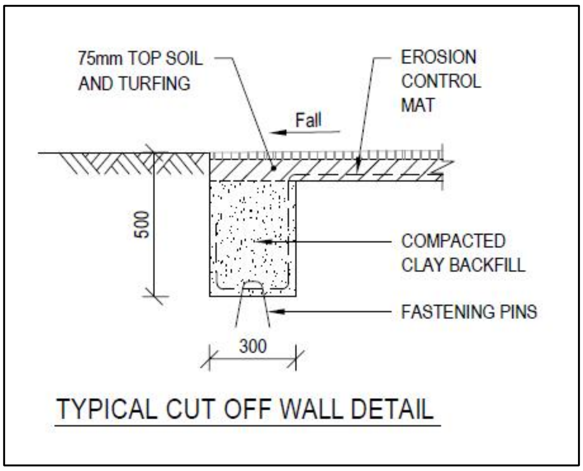


Figure 3.0 Cut Off Wall Details

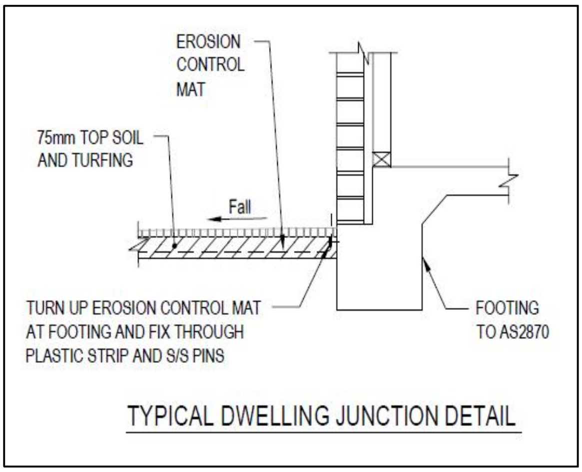


Figure 4.0 Dwelling Junction Detail

5. Dwelling Footings

Dwelling footings contained within the geotextile erosion mat perimeter improved resilience treatment can be designed in accordance with AS2870 – Residential Slabs & Footings.

6. Geotextile Erosion Control Mat Notes

6.1 Geotextile Erosion Control Mat

M1 Geotextile erosion control mat to be Geofabrics Australia Grassroots synthetic erosion control matting or equivalent.

M2 Synthetic fibres made from UV-stable polypropylene, needle punched onto synthetic scrim.

M3 Scrim to be black polypropylene mesh 4 x 4mm squares, weight 80gsm:

- Tensile Strength Cross Directional (CD): not less than 5KN/m^2.
- Machine Directional (MD): not less than 5KN/m^2.

M4 Mat density: 380 – 400 gsm/m^2.

6.2 Laying

L1 Strip area to remove vegetation and top soil, minimum depth 50mm.

L2 Provide 500mm deep x 300mm wide cut off to perimeter of mat. Lay mat to the base of cut off wall and pin and backfill.

L3 Roll mat out to cover required area. Laying pattern should mimic a fish scale pattern. Overlay mats by a minimum of 100mm and pin.

L4 Do not pull the surface of the mat tightly across the soil surface. Allow it to contour to the soil profile and into undulations.

6.3 Fixing

F1 Fix mat to underlying foundation with mat manufacturer's fastening pins.

F2 Fastening pins to be 300mm x 30mm x 300mm (leg x bridge x leg) ⊓ pins.

F3 Wire diameter of fastening pins to be 4mm.

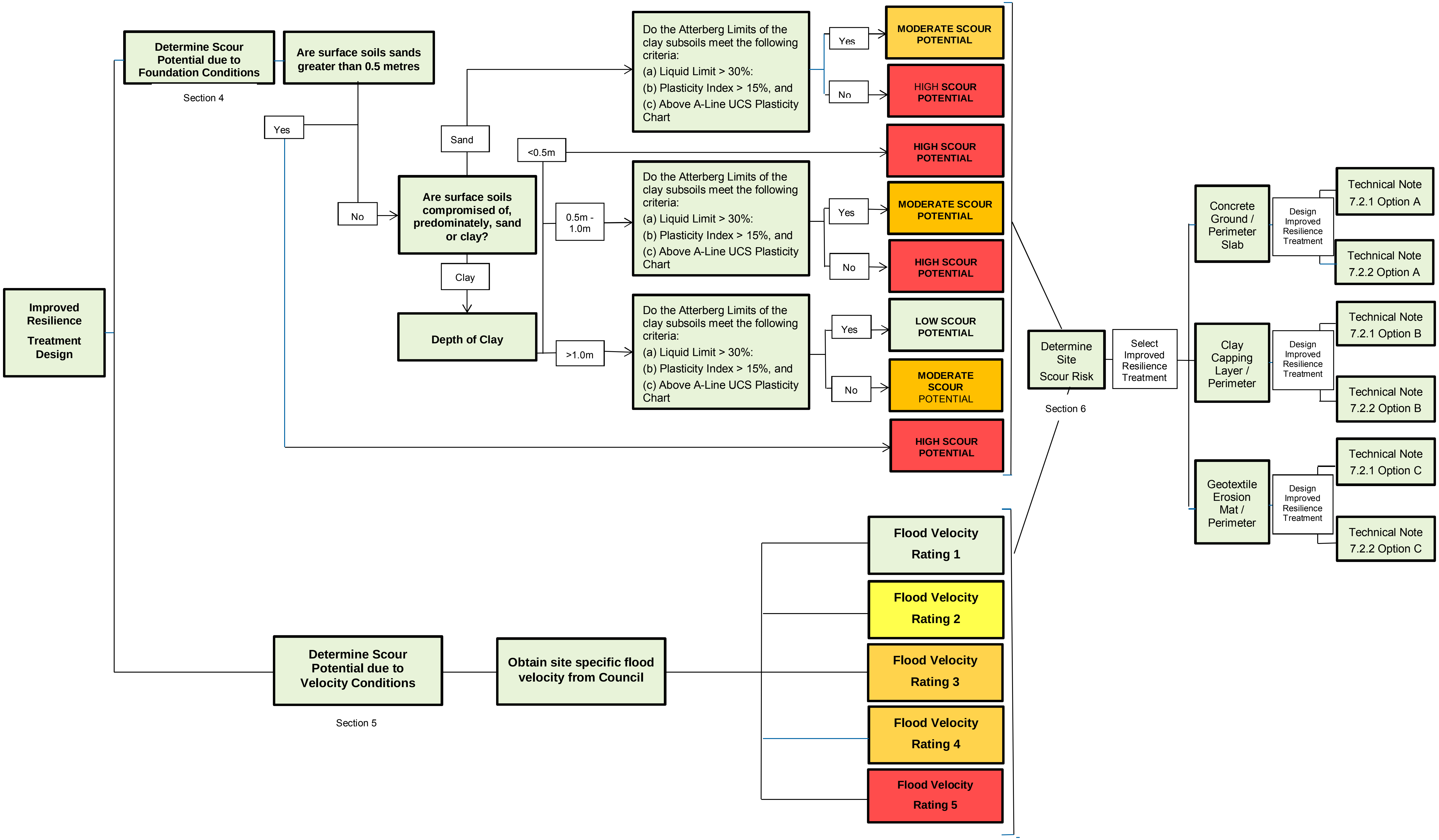
F4 Fix mat to cut off wall base with pins at 300mm intervals.

F5 Fix mat at overlaps with pins at 300mm intervals.

F6 Minimum pinning frequency of mat to foundation is 4 pins per square metre.

Appendix D – Improved Resilience Treatment Design Flow Chart

Improved Resilience Treatment Design - Flow Chart



Disclaimers

These Guidelines have been prepared for Bundaberg Regional Council and may only be used and relied on by Bundaberg Regional Council for the purpose of assisting building designers in understanding the effects of flood induced scour as it relates to residential dwellings constructed in the Bundaberg Regional Council Flood Hazard Area.

No responsibility exists to any person other than Bundaberg Regional Council arising in connection with this Report. Implied warranties and conditions are excluded to the extent legally permissible.

The services undertaken in connection with preparing these Guidelines were limited to those specifically detailed in the Guidelines and are subject to the scope limitations set out in the Guidelines.

The opinions, conclusions and any recommendations in these Guidelines are based on conditions encountered and information reviewed at the date of preparation of the Guidelines. No party is responsible or under an obligation to update these Guidelines to account for events or changes occurring subsequent to the date that the Guidelines were prepared.

The opinions, conclusions and any recommendations in these Guidelines are based on assumptions described in the Guidelines and no liability will arise from any of the assumptions being incorrect.

These Guidelines have been prepared on the basis of information provided by Bundaberg Regional Council and third parties, which has not been independently verified or checked beyond the agreed scope of work. No liability will arise in connection with such unverified information, including errors and omissions in the Guidelines, which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in these Guidelines are based on information obtained from, and testing undertaken at various locations in the Flood Hazard Area. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points. Investigations undertaken in respect of these Guidelines are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified.

Document Status

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