CAPRICORN MUNICIPAL DEVELOPMENT GUIDELINES

SMALL EARTH DAM

D13

DESIGN GUIDELINES

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Keeping the Capricorn Municipal Development Guidelines up-to-date

The Capricorn Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricorn Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using the current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.

GENERAL

D13.01. SCOPE

D13.01.01. Table D13.01.01 shows the applicability of this document for the local governments and councils. ***Applicability***

Table D13.01.01 CMDG D13 Small Earth Dam Document Applicability

Local Government	Applicable?
Banana Shire	No
Central Highlands Regional	No
Gladstone Regional	Yes
Isaac Regional	No
Livingstone Shire	No
Maranoa Regional	No
Rockhampton Regional	No

D13.01.02. This document sets out design considerations associated with non-referable farm dams. For this document, a farm dams refer to private dams that are used to intercept catchment runoff that would otherwise have contributed to streamflow or recharge to aquifers (Discussion Paper: The Hydrologic Impacts of Farm Dams, Engineers Australia).

Under this guideline,

- is applicable for Rural and Rural Residential zones only;
- the height of a dam embankment is limited to 5.0m;
- Storage volume is limited to 20ML; and
- Catchment area shall not exceed 10 km^2

D13.01.03. The following order of priority for interpretation of documents will apply: (Please note that reference to a Guideline or Standard, is reference to the latest version of the relevant document, unless specifically a version number is specifically stated) ***Order of Priority***

1. CMDG D13 Small Earth Dam – Design Specification
2. AS1170 Minimum design loads on structures (SAA Loading Code)
3. AS1289 Set – Method of testing soil for engineering purposes
4. AS3600 Concrete structures
5. AS4678 Earth-retaining Structures
6. Water Act 2000
7. Water Regulation 2016
8. Water Resource Plans under Water Act 2000
9. Environment Protection Act 1994

D13.02. OBJECTIVE

D13.02.01. The aim of design shall be the achievement of acceptable probabilities that the structure being designed is stable, and safe.

D13.02.02. This document is not intended to replace the need for appropriate professional advice, particularly in an areas concerning dam construction where the failure of built structures may endanger life, property or important environmental assets.

D13.03. REFERENCE AND SOURCE DOCUMENTS

(a) Queensland Government Act and Legislation

Water Act 2000

Water Regulation 2016

Water Resource Plans under Water Act 2000

Environment Protection Act 1994

Code for self-assessable developments for taking overland flow water for stock and domestic purposes

Code for self-assessable developments for taking overland flow water using capacity works

(b) CMDG Specifications

D5 - Stormwater Drainage Design

(c) Australian Standards

AS1170	-	Minimum design loads on structures (SAA Loading Code)
AS1289 Set	-	Method of testing soil for engineering purposes
AS3600	-	Concrete structures
AS4678	-	Earth-retaining Structures

Other relevant codes and guidelines with the above.

(d) Other

Queensland Government
- Guidelines for Failure Impact Assessment of Water Dams
- Guidelines on Acceptable Flood Capacity for Water Dams

Healthy Waterways
- Rural Dams

Queensland Government
- Gully Erosion - Facts Land Series

Queensland Murray-Darling Committee
- Farm Dams - tips on maintenance

Eyre Peninsula Natural Resources Management Board
- Farm Dams - A Guide to Siting, Design, Construction an - Management on Eyre Peninsula

Food and Agriculture Organisation of the United Nations
- Manual on Small Earth Dams

Department of Transport and Main Roads

- Manual - Geotechnical Design Standard - Minimum Requirements

Geoscience Australia
- Australian Rainfall and Runoff

Department of Energy and Water Supply
- Queensland Urban Drainage Manual

Landlinks Publication
- Farm Dams Planning Construction and Maintenance by Lewis B. 2002

United States Army Corps of Engineers
- Coastal Engineering Manual
- Hydraulic Design of Spillways
- Seepage analysis and Control of Dam
- Slope Stability

D13.04. DEFENITIONS

D13.04.01. A Referable Dam is a dam or a proposed dam

a. which must have a dam failure impact assessment carried out under the Act

b. for which the assessment states that the dam, or the proposed dam after its construction will have a category 1 or category 2 failure impact rating

c. for which the chief executive has, under section 349, accepted the assessment.

Referable Dam

D13.04.02. A dam is non-referable if an impact assessment demonstrates there would be less than two people are at risk if the dam was to fail and the assessment is accepted by the chief executive.

Non-referable Dam

D13.05. DESIGN REQUIREMENTS

D13.05.01. Design storage volume shall be determined in accordance with the following;

I. Code for self-assessable developments and taking overland flow water for stock and domestic purposes, and

II. Code for self-assessable developments and taking overland flow water using limited capacity works.

Design Storage Volume

Following tables provides design storage volume by above documents.

Table D13.05.01: Design Storage Volume - Gladstone Regional Council

	Water Plan (Fitzroy Basin) 2011	Water Plan (Baffle Creek Basin) 2010	Water Plan (Boyne River Basin) 2013	Water Plan (Calliope River Basin) 2006
Limited Capacity Works	5ML	20 ML	No Limit	5ML
Stock and Domestic Purposes	The Applicant shall demonstrate the demand of water by completing 'Part F Annual Water Requirement Worksheet' on the notification form, based on the number of households on the parcel of land or the number of stock normally depastured on the land			

D13.05.02. Location of a farm dam shall be in accordance with Farm Dams - A Guide to Siting, Design, Construction and Management on Eyre Peninsula. ***Site Selection***

D13.05.03. A height distance of minimum 0.9m including 0.3m depth for wave action shall be maintained between the crest of dam and full supply level (FSL). ***Freeboard for dam***

D13.05.04. The foundation materials shall comprise impermeable clay or rock. Where impermeable material is not found, a liner with imported clay or heavy duty plastic sheeting shall be used. ***Base Material***

D13.05.05. Suitability of clayey material for foundation and bank material shall be in accordance with Table D13.05.02: Suitability of Clayey Material. ***Material Properties***

Table D13.05.02: Suitability of Clayey Material

FACTORS	DESIRABLE OUTCOME
Clay content	Minimum 30%
Slaking	Low Slaking
Dispersion	Low to moderate
Linear shrinkage	<15%
Organic matter	Negligible - except for top soil used to protect exposed faces of dam walls
Permeability	< 1x10-9 meters/ sec

D13.05.06. Construction methodology shall be in accordance with Manual on Small Earth Dams – A Guide to Siting, Design and Construction, and Farm Dams - A Guide to Siting, Design, Construction, and Management on Eyre Peninsula.

D13.05.07. Thickness of compacted layer shall not exceed 150mm and maximum size of particle shall not exceed 50mm.

D13.05.08. The compaction effort achieved should be 98% of standard maximum dry density (MDD) on an average with a minimum compaction effort of 95% of standard maximum dry density (MDD) shall be achieved. ***Compaction for Embankment dam***

D13.05.09. In order to protect dam wall from shrinkage cracks and erosion, necessary measures shall be required to taken both in construction and operation stage of a dam. Manual on Small Earth Dams and of Farm Dam - A Guide to Siting, Design, Construction and Management on Eyre Peninsula shall be considered as a guideline for reducing shrinkage cracks and erosion. ***Shrinkage Cracks and Erosion***

D13.05.10. Sides slope shall not be steeper than with Table D13.05.03: Side Slope. ***Side Slope***

Table D13.05.03: Sides Slope

DAM EMBANKMENT		**Upstream**	**Downstream**
Homogeneous Embankment		3(H):1(V)	2(H):1(V)
Zoned Embankment	Embankment	2.5(H): 1(V)	2(H):1(V)
	Core	1(H):1(V)	1(H):1(V)
Diaphragm Embankment		3(H):1(V)	2(H):1(V)
Excavated Tank		3(H):1(V)	

D13.05.11. All designs, drawings shall be conducted under supervision of an RPEQ experienced in this field and shall be certified by an RPEQ qualified in this field. ***Certification***

D13.06. DAM EMBANKMENT

D13.06.01. Where an embankment(s) is used to store dam water, dam embankment shall be designed considering homogeneous dam, or zoned dam, or diaphragm dam or mixture of those. Stability analysis and design shall be conducted under supervision of a Registered Professional Engineer Queensland (RPEQ) experienced in this field and shall be checked in accordance with Geotechnical Design Standard - Minimum Requirements.

D13.06.02. The upstream rock pitching shall be designed for impact from wave action and downstream rock pitching shall be designed against uplift pressure and shall be designed in accordance with Part VI of USACE Coastal Engineering Manual

D13.06.03. Typical dams section are shown in Figure D13.06.01 (a), 13.06.01 (b), D13.06.01 (c).

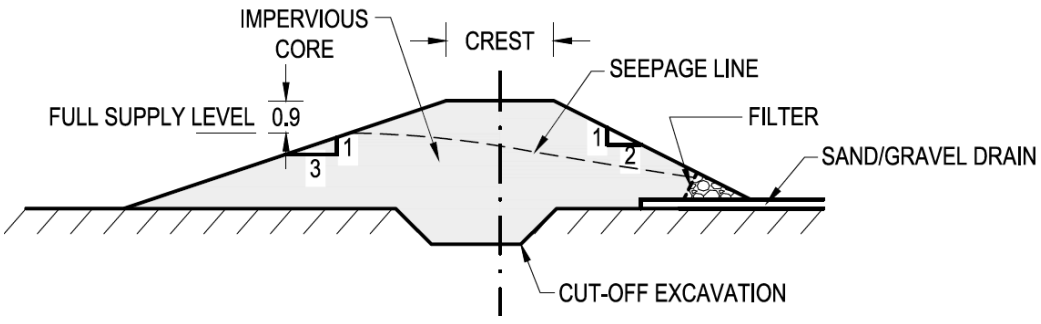

Figure D13.06.01(a): Typical Cross-Section Homogeneous Dam

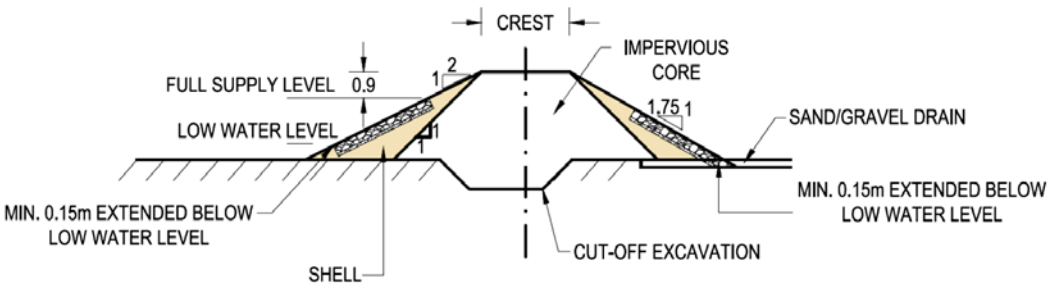

Figure D13.06.01(b): Typical Cross-Section Zoned Dam

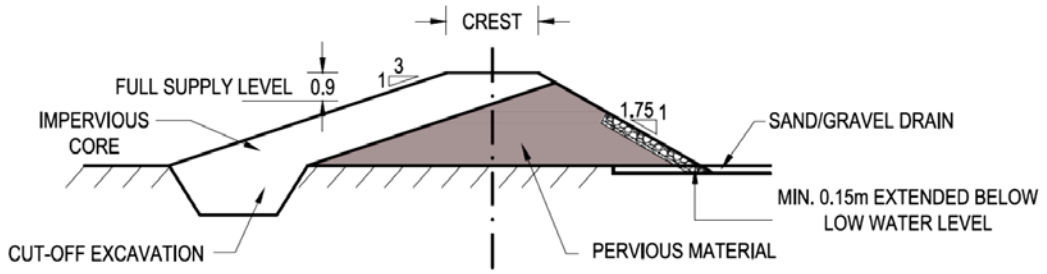

Figure D13.06.01(c): Typical Cross-Section Diaphragm Dam

D13.06.04. Generally materials for dam embankment shall be in accordance with Table D13.06.01: Material for Dam Embankment (Unified Soil Classification Group).

Material for Dam Embankment

Table D13.06.01: Material for Dam Embankment (Unified Soil Classification Group)

LOCATION	SOIL TYPE
IMPERVIOUS CORE	Clayey gravel (GC)
	Clayey sand (SC)
	Low liquid limit Clay (CL)
	High liquid limit Clay (CH)
SHELL	Well graded Gravel (GW)
	Poorly graded Gravel (GP)
PERVIOUS MATERIAL	Well graded Gravel (GW)
	Poorly graded Gravel(GP)
	Well graded Sand (SW)

D13.06.05. The size cut-off trench for dam embankments shall be in accordance with Manual on Small Earth Dams.

Cut-off Trench

D13.06.06. Where clay blanket is required (e.g. Diaphragm embankment), minimum 0.6m thick clay blanket shall be provided for new constructions. To improve impermeability of an existing embankment, minimum 0.6m clay blanket shall be reinstated.

Clay Blanket thickness

D13.06.07. In order to reduce the risk of structural failure of a dam embankment, seepage exit height at the downstream side of the embankment shall be kept low.

D13.06.08. Spillways shall be designed to carry peak flood flow for 1% AEP (1 in 100 years ARI). The minimum inlet width of spillways shall be determined using equation for broad-crested weir.

Q (at AEP 1%, m3/s) = 1.7 x B x D1.5

Where;

B (m) = minimum width of Broad-crested weir and

D (m) = Depth of flow.

D13.06.09. Minimum freeboard of 0.6m shall be maintained from the top of water surface at AEP 1% to lowest top of bank. As a guideline, inlet and outlet width of a spillway can be determined in accordance with Table 10 and 11 of Farm Dam - A Guide to Siting, Design, Construction and Management on Eyre Peninsula.

Spillways width and Freeboard

D13.06.10. The minimum crest width for a dam embankment shall be in accordance with Table 7 of Farm Dam - A Guide to Siting, Design, Construction and Management on Eyre Peninsula.

Crest Width

D13.06.11. Excess water from an embankment dam or a spillway shall be diverted to the natural flow path of the overland flow.

Erosion control measures against flow velocity at the

- inlet of the spillway,
- spillway, and
- at the outlet of spillway

shall be designed and constructed in accordance with referenced documents and sound engineering practice.

D13.06.12. Table D13.06.02 should be used as a guideline for discharges and velocities for earth dam spillways

Table D13.06.02: Guideline discharges and velocities for earth dam spillways

Type of Surface	**Sandy to Sandy Loam**	**Sandy Loam to Sandy Clay Loam**	**Sandy Clay Loam**	**Light Clay**	**Heavy clay Gravel friable rock**	**Hard rock**
Maximum velocity (m/s)	0.30	0.60	0.75	1.00	1.25	1.50
Flow depth (m) at spillway entrance	0.15	0.30	0.50	0.60	0.75	1.50
Discharge (m^3/s per metre width)	0.05	0.20	0.35	0.60	1.00	2.50

D13.07. EXCAVATED TANK

D13.07.01. If unsuitable material is encountered at an excavated tank location, minimum 0.6m thick clay blanket as specified in section D13.05.05 shall be used. To improve impermeability of an existing tank, minimum 0.6m clay blanket shall be maintained. ***Clay Blanket thickness and property***

D13.07.02. Safety fencing shall be provided around excavated tank in accordance with QUDM, AS 1926.1, and AS 1926.2. Fence height of 1.2m is considered to be appropriate. ***Fence***

D13.08. MAINTENANCE

D13.08.01. Maintenance works on existing dam shall be conducted in accordance with Farm Dams - tips on maintenance, Manual on small earth dams, and Farm Dam - A Guide to Siting, Design, Construction and Management on Eyre Peninsula ***Maintenance***