

MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS



**Shellharbour
City Council**

Shell Cove Detention Basin
Emergency Plan
Final

Dam Summary Information Sheet

General Dam Information					
Name of Dam	Shellcove Estate Detention Basin 1		Dam ID Number	766	
Description/Purpose	Flood retarding and detention basin serving a 55ha catchment to protect downstream residential, commercial, and tourist developments from flash flooding.				
Dam Storage Contents	Water / Stormwater runoff. Capacity: 5ML storage on sunny day 33ML storage at dam crest level No hazardous materials are specified in the Emergency Plan.				
Owner	Shellharbour City Council				
Main Emergency Contact	LEMO Melinda Fitzgerald (Primary LEMO) Ph: (02) 4221 6061, Mobile: 0437 236 246				
After Hours Contact	Ph: 02 4221 6111 (Council After-Hours Emergency Duty Officer) LEMO Melinda Fitzgerald (Primary LEMO): Ph: (02) 4221 6061, Mobile: 0437 236 246 Donna-Cherie Baxter (Secondary LEMO): Ph: (02) 4221 6318, Mobile: 0436 808 308				
Location of Dam	Between Hayman Cres and Norfolk Cres, Shell Cove, NSW	Latitude	-34.59	Longitude	150.86
River/Stream/Catchment	Shell Cove catchment (55ha catchment area)				
Towns Impacted	Shell Cove (specifically downstream residential areas including Hinchinbrook Drive, Mystics Drive, and newly developed areas downstream of Shallows Road).				
LGA's Impacted	Shellharbour City Council LGA				
Alert Levels – Key Response Levels					
White Alert The lowest level of dam safety emergency and is assigned for unusual incidents which have the potential to threaten the dam.	Flood Storage RL 25.7m AHD (water level reaches uncontrolled spillway level) OR serious structural damage (such as cracking, severe erosion, piping signs) without imminent flow through the embankment.				

Amber Alert The second highest level of dam safety emergency assigned when dam integrity is compromised.	Flood Storage RL 26.5m AHD (water level rises to 0.5m below the embankment crest) OR serious structural damage occurring concurrently with flood flow with imminent flow through the embankment.				
Red Alert The highest level of dam safety emergency assigned when the dam is failing, or failure is imminent.	Flood Storage RL 27.0m AHD (water level reaches the top of the embankment crest) OR serious structural damage causing uncontrolled flow through the embankment.				
Downstream Communities and Consequences					
Downstream Communities	Dwellings and properties on Hinchinbrook Drive, Mystics Drive, Shallows Road, and newly developed commercial and tourist properties downstream of Shallows Road.				
‘Sunny Day’ Failure (SDF) <i>[Floods caused by the unexpected failure of the dam that may happen at any time and may not involve a rainfall event - including Earthquakes]</i>	<i>Sunny Day failure was investigated and it was identified that the level differential between the permanent water level and the toe of dam is only 1m (i.e. the permanent water level is 23.0m AHD and the toe of the dam is 22.0m AHD) and the permanent water volume is only 5ML. For these conditions Sunny Day failure is considered highly unlikely and in the event of a breach the resulting flood wave is expected to be relatively insignificant. Hence detailed hydraulic modelling of the Sunny Day failure was not considered necessary.</i>				
Consequence Summary	Consequence Category	Population at Risk (PAR)	Potential Loss of Life (PLL)	Number of Dwellings	Flood Wave Depth and Travel Time
	N/A	-	-	-	-
‘Dam Crest Flood (DCF) / Frequent Flooding <i>[Floods that are more frequent than a PMF and when they occur put downstream communities at risk]</i>	<i>The water level was found to overtop the spillway weir in the 2 year ARI flood and the dam embankment was found to overtop in the 20,000 year ARI flood. The peak flow increases from 37m³/s to 81m³/s in the 20,000 year ARI event (Dam Crest Flood) for outflow hydrographs from the dam for the Break and No Break scenarios. From the assessment it is evident that the land affected by dam break impact is not significantly different for the PMF and 20,000 Year ARI. In general, the extent of impact does not extend beyond Shallows Drive.</i>				
Consequence Summary	Consequence Category	Population at Risk (PAR)	Potential Loss of Life (PLL)	Number of Dwellings	Flood Wave Depth and Travel Time
	Significant	Day: 6 Night: 3.3	0.132 Embankment overtopping is 6.64x10 ⁻⁷ . Spillway scour and overtopping is 6.64x10 ⁻⁶ .	1	Travel time is very rapid. Estimated flood warning time is 0.25 hours (15 minutes) for overtopping failure. Runoff is conveyed downstream to Shellharbour swamp via a tributary with a 100ha catchment. High-intensity rain triggers are 50mm/h.
‘Probable Maximum Flood’ Failure (PMF)	<i>PMF assumed to have an ARI of 1,000,000 Years. The peak flow increases from 65m³/s to 112m³/s in the PMF event for outflow hydrographs from the dam for the Break and No Break scenarios.</i>				

[The extreme flood for the catchment, typically presented as with and without dam failure]		From the assessment it is evident that the land affected by dam break impact is not significantly different for the PMF and 20,000 Year ARI. In general, the extent of impact does not extend beyond Shallows Drive.			
Consequence Summary	Consequence Category	Population at Risk (PAR)	Potential Loss of Life (PLL)	Number of Dwellings	Flood Wave Depth and Travel Time
	Significant	Day: 0 Night: 13.2	0.132 Fatality rate of 0.01 is adopted based on Graham's low severity and no warning.	4	In extreme PMF, water level rises at up to 0.21m per minute. This results in as little as 19 minutes between rainfall start and Red Alert. Warning times are 0.25 hours (15 minutes) for overtopping failure. Travel time to public reserves is < 15 minutes.
Dam Characteristics and Hydrological Information					
Type/Description	Homogenous Earth Fill embankment		Outlet/Spillway	Uncontrolled spillway weir in the center of the embankment	
Height	5.0m		Inlet Works	Open retarding basin storage area	
Crest Level	27.0m AHD		Outlet Works	Gravity discharge / Uncontrolled spillway 900mm concrete pipe	
Crest Width	5.0m		Spillway Type	Uncontrolled weir -- Homogenous Earth Fill	
Crest Length	40.0m		Spillway Gated	No	
Catchment Area	55.0 hectares		Spillway Level	25.7m AHD	
Full Supply Level (FSL)	25.7m AHD (water at spillway level)		Spillway Width	5m	
Storage Capacity at FSL	5ML storage on sunny day 33ML storage at dam crest level		Spillway Length	12m	
Imminent Failure Level	27.0m AHD (water at top of dam crest)		Spillway Design Capacity	11545 m³, 25.70m AHD Pond 2 Spillway weir	
Freeboard allowance/Maximum	1.3m (between dam crest 27.0m and spillway crest 25.7m)		Streambed Level	22.0m AHD (crest level 27.0m minus height 5m)	
Warning and Monitoring Systems					
Warning Systems	Currently Significant consequence category, no regulatory requirement for a telemetered pluviometer. Primary warnings are Severe Weather Warnings issued by BoM for Wollongong/Illawarra. Laminated copies of EP flowcharts are kept in Council operational vehicles.				
Monitoring Systems	A telemetered water level system and an on-site visual gauge plate are used for monitoring. If the telemetered system fails, visual on-site monitoring is conducted by a nominated competent Council staff member.				

Notification Protocols	If a White, Amber, or Red Alert is triggered, Shellharbour City Council notifies the Local Emergency Management Officer (LEMO) Melinda Fitzgerald or Donna-Cherie Baxter, who notifies the NSW SES State Operations Centre / SEOC. NSW SES then coordinates downstream evacuation warning and procedures.		
Warnings and Stream Gauges	Bureau Forecast Locations (Warning Gauges) No on-site BoM warning gauges. Severe Weather Warnings are monitored for Wollongong/Illawarra. Blackbutt pluviometer is referenced for local high-intensity rainfall.	River Data Locations (Stream Gauges) No direct river gauges on site; monitoring is conducted via the on-site basin gauge plate or the telemetered water level meter.	
NSW SES Local Flood Emergency Sub Plan Name	Illawarra flood emergency sub plan		
Additional Information			
<i>[Description of any other information that has not been covered, or may be relevant]</i>			
References			
Shell Cove Detention Basin Emergency Plan, Molino Stewart Pty Ltd (September 2026); Operations and Maintenance Plan, Molino Stewart (2021); Shell Cove Major Detention Basin 1 - Dam Break Study, Cardno (2013).			
Prepared By	<i>Zain Riaz</i>	Approved By	<i>Matthew Apolo</i>
Position	<i>Shellharbour City Council, Flood and Stormwater Manager</i>	Position	<i>Shellharbour City Council, Executive Manager Technical and Recreation Services</i>
Version Control	<i>Version 1, Shellcove Estate Detention Basin 1 Data Summary Sheet, 08 September 2026</i>		

Shell Cove Detention Basin Emergency Plan

Final

Client: Shellharbour City Council

Prepared by:

Molino Stewart Pty Ltd

Suite 3, Level 1, 20 Wentworth Street, Parramatta NSW 2150, Australia

PO Box 614, Parramatta CBD BC, Parramatta NSW 2124

T +61 2 9354 0300 www.molinostewart.com.au

ABN 95 571 253 092

ACN 067 774 332

September 2026

© Molino Stewart Pty Ltd. All rights reserved

Molino Stewart has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of Molino Stewart. Molino Stewart undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and Molino Stewart's experience, having regard to assumptions that Molino Stewart can reasonably be expected to make in accordance with sound professional principles. Molino Stewart may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

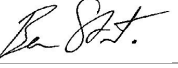
Document Control

Document Reference	1300 Shell Cove Detention Basin EP_V5_Final.Docx
Project	Shell Cove Detention Basin
Document Type	Emergency Plan
Author	Filippo Dall'osso, Steven Molino

Version History*

Date	Version	Name	Comments
08/09/2026	5	Zain Riaz	Review as part of Clause 10(5) Dam Safety Regulation 2019

Document Approval

For Molino Stewart	
Name	Steven Molino
Position	Principal
For Shellharbour City Council	
Name	Ben Stewart
Position	Executive Director Infrastructure Services

*Earlier versions are retained in Council's document management system.

Contents

1300 Shell Cove Detention Basin EP_v5_Final.docx | 8/09/2026

Emergency Response at a Glance	1
1 Preliminary Information	9
1.1 Regulatory Context	9
1.2 Scope of this Report	10
1.3 Consultation with the NSWSES	12
1.4 Endorsement Statement	12
2 Summary Information Sheet	13
3 Alert Levels and Notification Flowcharts	15
3.1 General	15
3.2 Alert Levels	16
3.3 Notification Flowcharts	17
3.3.1 NSWSES Notification Flowchart	17
3.3.2 Supplementary Notes	19
4 Emergency Procedures, Responsibilities and Contact Details	22
4.1 Protection Mode (Heavy Rainfall)	22
4.2 White Alert	23
4.3 Amber Alert	23
4.4 Red Alert	24
5 Dam Failure Information	41
6 Emergency Warning and Communication Systems	45
6.1 Warning Systems	45
6.2 Communications Systems	45
6.2.1 Radio Frequency and TV Channels	45
6.2.2 Emergency Communications Directory	45
7 Required Emergency Resources	46
7.1 Human Resources	46
7.2 Emergency Supplies	46
7.2.1 Power Resources	46
7.2.2 Materials, Plant and Equipment	46
8 Organisational Responsibilities	47

9 Emergency Exercises	50
10 Distribution and Update of the EP	51
10.1 Distribution	51
10.2 Update	51

Appendices

Appendix A Basin Location, Layout, and Access Routes
Appendix B Glossary of Terms & Abbreviations
Appendix C Dam Break Assessment Report
Appendix D Standard Forms
Appendix E Dam Failure Indicators
Appendix F Emergency Remedial Measures
Appendix G Document Control
Appendix H Maps of the Population at Risk

List of Tables

Table 1: Alert Levels and Corresponding Alerts for Shell Cove Detention Basin	16
Table 2: Shell Cove Detention Basin -Emergency Procedures – Flood Evaluation – Protection Mode	26
Table 3: Shell Cove Detention Basin - Emergency Procedures – Flood Evaluation - White Alert	28
Table 4: Shell Cove Detention Basin - Emergency Procedures – Flood Evaluation - Amber Alert	31
Table 5: Shell Cove Detention Basin - Action & Communication Directory – Flood Evaluation - Red Alert	34
Table 6: Emergency Communications Directory – Shell Cove Detention Basin	37
Table 7. Peak water levels for various design storms (Cardno, 2013).	42
Table 8. Population At Risk of dam break (Cardno, 2013)	43
Table 9. Dam break flood wave arrival time, depth and velocities (Cardno. 2013)	44
Table 10: Organisational Responsibilities within Shellharbour City Council	48

List of Figures

Figure 1. Incremental impacts of the Dam Crest Flood and approximate location of the newly developed areas (Cardno, 2013, modified)	11
Figure 2: NSWSES Notification Flowchart	20
Figure 3: SCC Overall Notification Flow Chart. Refer to Appendix B for abbreviations and acronyms	21
Figure 4. Section diagram of Shell Cove Detention Basin (Cardno, 2003)	41

Emergency Response at a Glance

This Section includes a summary of the triggers, actions and responsibilities during an emergency response at the Shell Cove Detention Basin. Shellharbour City Council requested to have this summary section at the beginning of the document to help emergency responders quickly determine what to do during an emergency situation. A table summarising triggers, actions, responsibilities and main contact details is provided below for each alert level (Protection Mode, White Alert, Amber Alert, Red Alert). The information included in this section duplicates part of Section 4 of this Emergency Plan and should be interpreted in the context of the document in its entirety.

Trigger	Alert Level	Organisation	Actions	Responsible Position	Name	Phone / E-mail *
A Severe Weather Warning for Wollongong /Illawarra OR 50mm/h rainfall detected at the Blackbutt pluviometer	Protection Mode	Shellharbour City Council	1. Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecast updates relevant to the catchment; 2. Notify the LEMO of any changes in alert levels or possibly upcoming alerts; 3. Inform the LEMO if weather data indicates a possible escalation of alert status to White Alert Level, as per the notification chart in Figure 3; 4. Contact the on-call Civil Coordinator to issue a preliminary mobilisation alert to the relevant work gang and machinery operators to go onto standby for possible preventative / remedial action at the basin.	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111
			1. Inform the NSWSES if weather data indicates a possible escalation of alert status to White Alert Level, as per the notification chart in Figure 2.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308

Storage (RL m)	Alert Level	Organisation	Actions	Responsible Position	Name	Phone / E-mail *
25.7m AHD (water at the spillway level) OR Serious structural damage without imminent flow through embankm ent	WHITE	Shellharbour City Council	1. Inform the LEMO that a White Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3; 2. Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment; 3. Nominate a trusted staff member to immediately begin onsite monitoring of the condition and the storage level of the basin. Onsite monitoring is required in case of failure of the telemetered water level system, and to timely detect and respond to any structural failure/incidents. The staff member should keep a record of the water rate of rise within the basin and immediately inform the Executive Manager Works and Services if the triggers for the Amber Alert are reached; 4. Notify the LEMO of any further changes in alert levels or possibly escalating alerts; 5. Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111

			logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3; 6. In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions.			
			1. Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3. The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2; 2. Provide assistance to the NSWSES as required.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308
		NSWSES	Activate procedures for flood warnings evacuation etc. as per Figure 2.	NSWSES State Operations Centre (OC)	NSWSES State Operations Centre Duty Officer	1300 737 326 (24 Hours)
		SEOC If NSWSES unavailable		NSW SEOC	SEOC Duty Officer	1300 677 677 (24 hours)
		Additional NSWSES local contacts		NSWSES South Eastern Zone	Zone On-Call Officer (ZOCO)	02 4247 8094

				NSWSES Shellharbour Unit	Duty Officer	0428 470 360
--	--	--	--	-----------------------------	--------------	--------------

<i>Triggers</i>	<i>Alert Level</i>	<i>Organisation</i>	<i>Actions</i>	<i>Responsible Position</i>	<i>Name</i>	<i>Phone / E-mail *</i>
26.5m AHD (water 0.5m below the embankment crest) OR Serious structural damage with imminent flow through embankment	AMBER	Shellharbour City Council	1. Inform the LEMO that an Amber Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3; 2. Ensure that the nominated SCC staff member keeps monitoring the basin's condition, storage level and rate of rise closely until the end of the emergency; 3. Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3; 4. In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions; 5. Inform DSNSW that an Amber Alert has been triggered and report any other incidents observed at the basin;	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111

			6. Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment; 7. Inform the LEMO and Council's Dam Safety Specialist consultant if weather data indicates a possible escalation of alert status to Red Alert. The DSNSW Executive Engineer may also be included in this advice.			
			1. Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3. The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2; 2. Keep the NSWSES updated on the basin condition, storage levels and rate of rise; 3. Provide assistance to the NSWSES as required.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308
		NSWSES	Consider issuing an evacuation warning to the population at risk, or in case of an unusually high rate of rise, an evacuation order may be issued at this point.	NSWSES State Operations Centre (OC)	NSWSES OC Duty Officer	1300 737 326 (24 Hours)
		SEOC (If NSWSES unavailable)	Activate notification procedures as per Figure 2	NSW SEOC	SEOC Duty Officer	1300 677 677 (24 hours)
		DSNSW	Stays informed.	Executive Engineer	Chris Salkovic	(02) 9842 8070 BH 0403 681 645 Mob chris.salkovic@damsafety.nsw.gov.au

		Additional local NSWSES contacts	Are available to provide support and facilitate effective communication during the emergency	NSWSES South Eastern Zone	Zone On-Call Officer (ZOCO)	02 4247 8094
				NSWSES Shellharbour Unit	Duty Officer	0428 470 360

Triggers	Alert Level	Organisation	Actions	Responsible Position	Name	Phone / E-mail *
27.0m AHD (water at the embankment crest) OR Serious structural damage causing flow through embankment	RED	Shellharbour City Council	1. Inform the LEMO that a Red Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3; 2. Ensure that the nominated SCC staff member keeps monitoring the basin's condition, storage level and rate of rise closely until the end of the emergency, if safe to do so; 3. Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3; 4. In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions;	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111

			5. Inform DSNSW that a Red Alert has been triggered and report any other incidents observed at the basin; 6. Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment; 7. Inform the LEMO and Council's Dam Safety Specialist consultant if weather data indicates a possible escalation of alert status to Red Alert. The DSNSW Executive Engineer may also be included in this advice.			
			1. Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3. The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2; 2. Keep the NSWSES updated on the basin condition, storage levels and rate of rise; 3. Provide assistance to the NSWSES as required.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308
		NSWSES	Consider issuing an evacuation order to the population at risk	NSWSES State Operations Centre (OC)	NSWSES OC Duty Officer	1300 737 326 (24 Hours)
		SEOC If NSWSES unavailable	Activate notification procedures evacuation etc. as per Figure 2	NSW SEOC	SEOC Duty Officer	1300 677 677 (24 hours)

		DSNSW	Advise DSNSW Minister	Executive Engineer	Chris Salkovic	(02) 9842 8070 BH 0403 681 645 Mob chris.salkovic@damsafety.nsw.gov.au
		Additional local NSWSES contacts	Are available to provide support and facilitate effective communication during the emergency	NSWSES South Eastern Zone	Zone On-Call Officer (ZOCO)	02 4247 8094
				NSWSES Shellharbour Unit	Duty Officer	0428 470 360

1 | Preliminary Information

1.1 Regulatory Context

From 1 November 2019, the NSW legislation around dam safety has been updated with the commencement of the Dams Safety Act 2015 (the Act). The Act superseded the Dams Safety Act 1978 and introduced the new Dams Safety Regulation 2019 (the Regulation). The regulation sets out operational details and safety standards that declared dam owners must comply with to satisfy the provisions of the 2015 Act.

A new body, Dams Safety NSW (DSNSW), was created under the new Act. DSNSW replaces the Dam Safety Committee and is tasked with regulating the safety of dams in NSW.

DSNSW ensures that all dams in NSW are designed, constructed, maintained and operated to a standard to minimise the risks to the community. The Act and the Regulation require that the owner of a “declared” basin prepares an Emergency Plan (EP), formerly known as Dam Safety Emergency Plans (DSEP). Clause 10 of the Regulation stipulates that an EP, under Section 17(10) of the Act, must set out the following:

- (a) the consequence category of the dam,*
- (b) details of the material contained by the dam,*
- (c) a description of the circumstances that could cause a failure of the dam and the likely consequences of the failure including, for a dam categorised as extreme or high consequence—*
 - (i) details of all credible modes of dam failure, and*
 - (ii) details of the persons, property and infrastructure that are likely to be impacted in each scenario and the environmental damage that is likely to occur,*
- (d) the procedures to be followed by the owner of the dam and staff in the event of an emergency that may cause a failure of the dam, including the following—*
 - (i) a description of the emergency warning systems and how they operate,*
 - (ii) the different levels of emergency alerts (being levels that are consistent with those used by the State Emergency Service), the triggers for those alerts and the responses that are to occur when those alerts are triggered,*
 - (iii) the procedures for alerting emergency services organisations of the emergency,*
 - (iv) the persons who may be at risk if there is a failure of the dam,*
 - (v) the persons responsible for exercising functions in the event of an emergency and the contact details for those persons,*
- (e) details of the emergency exercises to be undertaken.*

In addition to the above, Clause 10 states that:

- (2) The emergency plan may include any other matter that the dam owner considers to be relevant to emergencies at the dam.*
- (3) For the purposes of section 17(3) of the Act, the emergency plan must be updated at least once every 5 years subject to subclauses (4) and (5).*
- (4) The emergency plan must be updated to take account of the following changes within 30 days after the change occurs—*

- (a) a change to the consequence category of the dam,*
- (b) a significant change, since the consequence category of the dam was last determined, to the number of persons who would be put at risk if there were to be a failure of the dam,*
- (c) a change to the emergency management arrangements.*
- (5) The emergency plan must be routinely reviewed, at least annually, to ensure that a change to the contact details of a person responsible for exercising functions in the event of an emergency is updated as soon as practicable after the change.*
- (6) Dams Safety NSW may direct the owner of a declared dam to update the emergency plan for the dam within a time specified in the direction.*
- (7) The owner of a declared dam must not fail to comply with a direction under this clause.*

Maximum penalty—50 penalty units.

- (8) The owner of a declared dam must provide a copy of the emergency plan to Dams Safety NSW and the State Emergency Service in a form approved by Dams Safety NSW as soon as reasonably practicable after the plan is prepared or updated.*

Maximum penalty—10 penalty units.

To help dam owners prepare suitable EPs, DSNSW has recently released guidelines. These are available at the following link: <https://www.damsafety.nsw.gov.au/wp-content/uploads/Emergency-Plans-Guideline-publication-September-2020.pdf>

The present report was prepared in line with the requirements of the Dams Safety Act 2015, the Dams Safety Regulation 2019 and the above mentioned DSNSW guidelines.

1.2 Scope of this Report

This document covers preparedness in relation to the occurrence of an emergency condition at Shell Cove Detention Basin, in Shellharbour LGA. It provides information necessary for emergency agencies to manage a downstream evacuation in the unlikely event of a potential dam failure.

Shell Cove Detention Basin is Declared by DSNSW. Its location and layout are shown in Appendix A.

The dam consists of two water quality ponds with flood detention capacity above the permanent water level. Water level control devices operate on each pond with a 150mm pipe discharging from Pond 1 to Pond 2 and a 225mm pipe discharging from Pond 2 to the downstream creek. Flow in excess of these pipes spills from Pond 1 to Pond 2 and from Pond 2 to the downstream creek via a 900mm pipe and spillway.

The dam embankment is 40m long and is constructed from earth fill. The embankment is 5m wide at the top and 5m high with side slopes of 1 in 4. The spillway is 17.5m wide and 12m long. A channel conveys flow from the spillway to the creek and contains two rock drop structures.

The dam detains runoff from an urbanised catchment, which generally slopes from west to east before discharging into Shellharbour swamp and the Tasman Sea at the southern end of Shellharbour beach, located about 2km downstream of the basin.

The basin is located at the confluence of two water courses and is located within a public reserve. The catchment consists of residential lots, roads, and public recreation areas. The catchment downstream of the basin is a mixture of residential development and open space, and has undergone significant new development after the dam break assessment study for this basin was undertaken in 2013 (Cardno, 2013). This new development has placed a number of residential and commercial units downstream of Shallows Road, in an area that, according to the 2013 flood modelling exercise, is likely

to be affected by a dam break (Figure 1). However, Council has notified that as part of the development, the topography downstream of Shallows Road has also been modified, and that it cannot be simplistically assumed that the 2013 dam break model would still apply at this location.

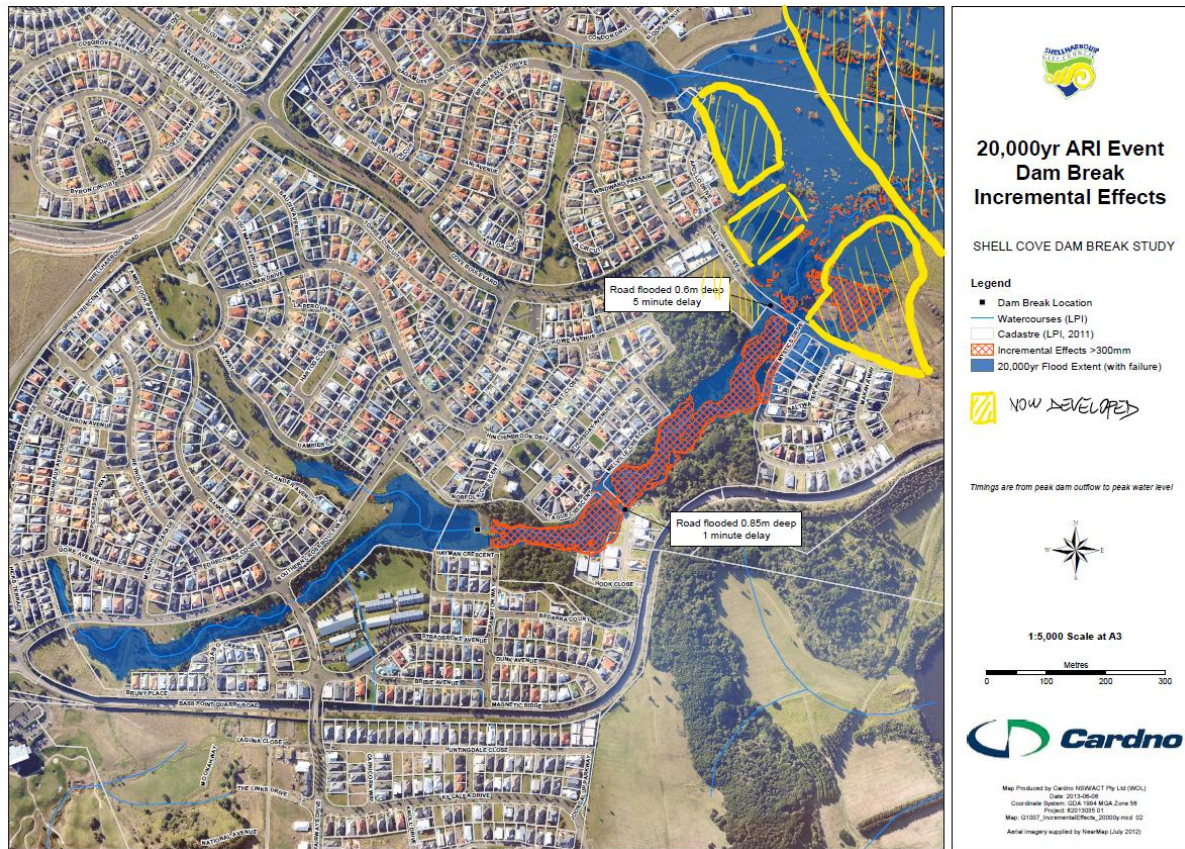


Figure 1. Incremental impacts of the Dam Crest Flood and approximate location of the newly developed areas (Cardno, 2013, modified)

While Council recognises that the dam break model must be updated, this is not within the scope of this Emergency Plan, nor is it to validate the consequence category of the basin to account for the potentially higher number of properties affected by a dam break. Council has confirmed that the dam break model will be updated as a matter of urgency. As soon as the new modelling becomes available, Council will update this Emergency Plan accordingly.

The scope of this document is to detail:

- The type, size, location and consequence category of the basin;
- The Population at Risk (PAR) and downstream areas affected by various flood events, as per the 2013 dambreak model results (Cardno, 2013);
- The Potential Loss of Life (PLL), Societal Risk Rating and Individual Risk Rating of the basin, as per the 2013 dambreak model results (Cardno, 2013);
- The responsibilities of persons and organisations involved in the operation of the dam under emergency conditions, and the persons/organisations responsible for activating the Plan;
- The persons and organisations to be notified in the event of an emergency situation;
- The procedure for identification, evaluation, and classification of potential emergency conditions;
- Local area communications network and alternative communications procedures to be used if the local area network fails;
- Local area alarm systems to alert the basin owner and initiate the EP to provide maximum warning to the Population at Risk (PAR);

- Available access to the dam under normal and varying emergency conditions;
- Other necessary information to protect the Population At Risk (PAR) and mitigate flood damage;
- Actions, Responsibilities and Communications protocols;
- Location of materials to be readily available during an emergency; and
- Temporary and permanent emergency remedial measures to be taken to maintain/return the structures to a safe operational condition.

This EP is to be used to activate the NSWSES Shellharbour Local Flood Plan or the Shellharbour Local Disaster Plan as prepared by the Shellharbour Local Emergency Management Committee as circumstances require. It is not intended as a replacement for the Shellharbour Local Disaster Plan. Instead, it presents a plan of procedures to complement the needs of the Shellharbour Local Disaster Plan.

Appendix B provides a glossary of the technical terms and abbreviations used in this report.

1.3 Consultation with the NSWSES

This report was prepared in consultation with the NSWSES, as per the DSNOW guidelines.

A meeting with the NSWSES was held at the beginning of the project, on 17/06/2021, to discuss the proposed EP content and the general approach.

The recommendations and comments from the NSWSES were then integrated in the draft EP.

The final version of the EP, this document, was then sent to the NSWSES for a final check. A hard copy version was also provided to the NSWSES and DSNOW.

1.4 Endorsement Statement

Shellharbour City Council endorses that the notification and responsibility details contained within this document are in accordance with the agreed protocols established for an Emergency Plan.

.....
Ben Stewart
Executive Director Infrastructure Services
Shellharbour City Council

Dated

2 | Summary Information Sheet

General Information	
Dam Name	Shell Cove Detention Basin
Dam Owner	Shellharbour City Council
Location	Between Hayman Cres and Norfolk Cres, Shell Cove, NSW MGA zone 56, 303450 East 6169850 North
Engineered by	BMD Consulting
Constructed by	Australand, 2005
Purpose	Flood detention for 55ha catchment
Consequence Category	Sunny Day – N/A Flood - Significant
Availability of Dam data	By visual observation only
Dam Data	
Capacity	5ML storage on sunny day 33ML storage at dam crest level
Dam Type	Homogenous Earth Fill
Height	5m
Crest Length	40m
Crest Width	5m
Crest Level	27.0m AHD
Spillway	
Type	Uncontrolled Weir – Homogenous Earth Fill
Crest Length	12m
Crest Width	5m
Crest Level	25.7m AHD
Outlet	
Type	900mm concrete pipe
Upstream Invert Level	23.90m AHD
Downstream Invert Level	23.64m AHD
Consequence of Dam Failure (PMF)	
Number of Houses Affected - Total	4
Population at Risk (PAR) - Total	13.2
Hydrological Information	
Catchment Area	55ha
Dam Crest Flood (Credible Failure Flood)	20,000 Year ARI, Water at dam crest level (27.0m)
PMF peak inflow	58.2 m ³ /s
PMF peak outflow	56.3 m ³ /s
PMF peak water level	27.3m
PMF time to peak	30 minutes
Alert Levels for Flooding	
Red Alert	27.0m AHD (Water at Dam Crest)
Amber Alert	26.5m AHD (Water 0.5m below Dam Crest)
White Alert	25.7m AHD (Water at Spillway Level)
Notification Protocols	
Emergency Authority	NSWSES
Local Flood Plan	
Name	Kiama / Shellharbour City Local Flood Plan

Alert Levels	
<i>Red Alert</i>	Flood RL 27.0m AHD (water at dam crest) OR Serious structural damage causing flow through embankment
<i>Amber Alert</i>	Flood RL 26.5m AHD (water 0.5 below dam crest) OR Serious structural damage with imminent flow through embankment
<i>White Alert</i>	Flood RL 25.7m AHD (water at spillway level) OR Serious structural damage without imminent flow through embankment
<i>Protection Mode</i>	A Severe Weather Warning is issued by the Bureau of Meteorology
Notification Protocols	
<i>Council to notify in the order as shown:</i>	NSWSES / DSNSW
<i>Local Flood Plan</i>	Shellharbour Local Flood Plan

* Freeboard = dam crest level – spillway crest level.

3 | Alert Levels and Notification Flowcharts

3.1 General

The main scope of this EP is to provide guidance to Council on how to manage an emergency at the Shell Cove detention basin. A set of suitable alert levels and corresponding triggers have been identified to define when the basin will enter a state of emergency and which actions are to be undertaken as floodwaters rise within the basin. These actions include specific notification procedures.

The main purpose of establishing specific notification procedures is to ensure that timely warning is provided to the responsible persons in the event of a potential basin failure or incident, and to provide information that is relevant to the emergency response. A secondary purpose is to provide communication pathways for emergencies generally and to ensure proper reporting of all emergencies.

The primary means of preventing the development of a potential emergency condition is through regular inspection of the basins by relevant SCC Staff. Routine inspections and extraordinary inspections (i.e. after flood events) are outlined in the basin Operations and Maintenance Plan.

In general, the two major possible causes of basin failure are:

- Failure due to extreme flood levels overtopping the basin or inducing a failure in the embankment; and
- Failure due to a rapidly deteriorating structural deficiency induced by, for example, an earthquake (Sunny Day Failure)

A Sunny Day failure was investigated by Cardno (2003), but was not considered a significant event and was therefore excluded from the analysis (see Section 5).

Although the basin has been constructed to the required standards, an unsafe or emergency condition could occur at any time due to an extreme flood event.

Careful judgement is needed in reacting to emergencies. Whenever time permits, the communication pathways given in this section are to be followed. These ensure that decisions will be made by senior, responsible persons and will be based on the best available specialist advice.

The procedures are designed to avoid unnecessary warnings to the public. In most instances, notification of a basin safety emergency to the public will cause alarm, anxiety, resentment, and disruption to normal activities and expense. Evacuation greatly heightens these effects.

In case an emergency situation is developing so rapidly that to follow the alert protocols would endanger the public, operational personnel should immediately contact the NSWSES who should direct any action considered appropriate, such as alerting the Population at Risk (PAR) directly.

The Council and Operational Personnel must at all times consider public safety as paramount.

3.2 Alert Levels

The alert levels used in this Plan (Table 1) utilise a heavy rainfall warning from the Bureau of Meteorology and progressively higher storage levels within the basin.

In addition to triggers based on storage level, alternate triggers were included to account for serious structural damage to the embankment occurring before or concurrently with a flood. Serious structural damage is an unusual occurrence which could threaten the stability of the basin. These occurrences are defined as *incidents* and may include instances of severe erosion, cracking, seepage, or piping in the embankment or storage area. Typical incidents for this basin are described in the Operations and Maintenance Plan, Section 3 (Molino Stewart, 2021). In addition, Appendix E of this report provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents.

Table 1: Alert Levels and Corresponding Alerts for Shell Cove Detention Basin

Alert	Trigger	Annual Exceedance Probability	Time from beginning of rainfall in a PMF
PROTECTION	A Severe Weather Warning is issued by the Bureau of Meteorology, OR intense rainfall is detected at the Blackbutt pluviometer (50mm/h)	Several times per year	NA
WHITE	25.7m AHD (water at the spillway level) OR Serious structural damage without imminent flow through embankment	50%	14 mins
AMBER	26.5m AHD (water 0.5m below the embankment crest) OR Serious structural damage with imminent flow through embankment	0.2%	16.5 mins
RED	27.0m AHD (water at the embankment crest) OR Serious structural damage causing flow through embankment	0.005%	19 mins

The alert levels should be activated in sequence as the storage level rises during the course of a major flood event. Timely implementation of the alert level responses is crucial for the effectiveness of the EP and the effectiveness of warning systems which are imperative for minimising loss of life and property damage.

During a flood emergency, the water level within the basin is to be monitored by a member of SCC. At the time this report was prepared, the basin did not have a system to measure the storage level, however Council committed to install a gauge plate and a telemetered water level meter within 6 months from the adoption of this report.

NOTE ABOUT TIMING: In a flood rising as fast as a PMF (worst case scenario), a red alert will be triggered within 19 minutes from the beginning of the rainfall event, and only 2.5 minutes after an amber alert. This corresponds to an average rate of rise of about 0.2 m per minute.

In this situation, the timing between alert levels may be too short to follow the alert protocols. Should this occur, SCC operational personnel should immediately contact Council's Executive Manager Works and Services who will collaborate with the LEMO and the NSWSES in undertaken any action considered appropriate. Any doubts should be resolved in favour of protecting public safety.

The Council and Operational Personnel must at all times consider public safety as paramount.

3.3 Notification Flowcharts

The notification pathway and procedures to be followed for each alert level are summarised in the notification flow charts (Figure 2 and Figure 3 following). For a descriptive outline of the procedures and responsibilities, refer to Section 4.

The flow charts summarise the persons/organisations to be notified and the prioritised order of notification in the event of an emergency, as required by the NSWSES. The following two notification flowcharts are provided:

- The NSWSES notification flowchart (Figure 2). This chart shows how SCC should notify a change in alert mode to the NSWSES and provides an alternate notification pathway in case the NSWSES could not be contacted. In the following notification steps, the chart shows how the emergency notification is escalated within the relevant emergency services agency. This chart is generated by the NSWSES and it is further described in the remainder of this section.
- SCC overall notification flowchart (Figure 3). This chart represents the overall emergency notification procedure for SCC and integrates the protocols for notifying the NSWSES as per the NSWSES notification flowchart (Figure 2). A more detailed description of the emergency procedures within SCC, for each alert level, is provided in Section 4 of this report.

Although each emergency condition will be evaluated and responded to individually, the actions for most emergencies will be similar. In addition to the reporting procedures indicated in the notification flow charts, those involved may make any contacts they judge to be appropriate within their normal authority.

3.3.1 NSWSES Notification Flowchart

The NSWSES notification flowchart depicted in Figure 2 has been adopted from the DSNSW guidelines for Emergency Plans. This flow chart provides guidance for SCC on notifying the NSWSES when a White, Amber or Red Alert is triggered, and shows how this notification is further escalated within the NSWSES.

The primary NSWSES contact for SCC is the NSWSES State Operations Centre, available 24/7 at the telephone number 1300 737 326. Alternatively, only in case the NSWSES State Operations Centre cannot be contacted, SCC should notify the change in alert level to the NSW Duty Officer, State Emergency Operations Centre (SEOC) on the 24 hour phone number (1300 677 677).

In addition to the two notification options above, the following NSWSES local contact numbers were provided by the NSWSES as part of the consultation exercise undertaken when preparing this Emergency Plan. These may be required to facilitate effective communication during and emergency:

- NSWSES South Eastern Zone, On-call Officer: 02 4247 8094
- NSWSES Shellharbour Unit, Duty Officer: 0428 470 360

SCC personnel should make every attempt to call the NSWSES in the first instance. Use of the protocols in the Flow Chart must be followed if the NSWSES cannot be contacted. The NSWSES/Duty Officer SEOC is responsible for notifying the other emergency response agencies as per the Flow Chart.

The NSWSES is the designated Combat Agency for floods in NSW and in all local government areas where a significant riverine or flash flood threat exists; the Service has produced flood plans which are sub-plans of their respective local emergency plans (EMPLANs). Potential dam failure can best be managed through the activation of the local flood plan(s). In some cases, where dams are particularly at risk of failure (i.e., deficient flood capacity or known structural problem), special additional planning may be incorporated into the local flood plan to account for potential dam failure.

A more detailed description of NSWSES responsibilities as combat agency for floods can be found in the NSW State Flood Plan (2018), Section 1. 7. These responsibilities include coordinating the rescue, evacuation, and welfare of affected communities (EMPLAN, 2012 and SES Act 1989) through prevention, preparedness, response, and recovery.

It is recommended that laminated copies of **EP** Flow Charts be carried in the vehicles of SCC Operational Personnel.

(a) Alert Status – How to Advise Emergency Services

When a member of SCC staff is advising the emergency agencies by phone/radio/email in relation to the Alert status, the following communication protocol **MUST** be followed in the order listed:

1. This is Name & Title of Caller from SCC
2. This is to advise that there is an emergency at Shell Cove Detention Basin, Shell Cove
3. This is to inform you that the current ALERT status at that basin is Code “Heavy Rain / White / Amber / Red”

A “Communications Log” is included in Appendix D. The caller should log in the Communications Log the following:

- the name of the agency;
- the message recipient; and
- the date and time of the message.

3.3.2 Supplementary Notes

General

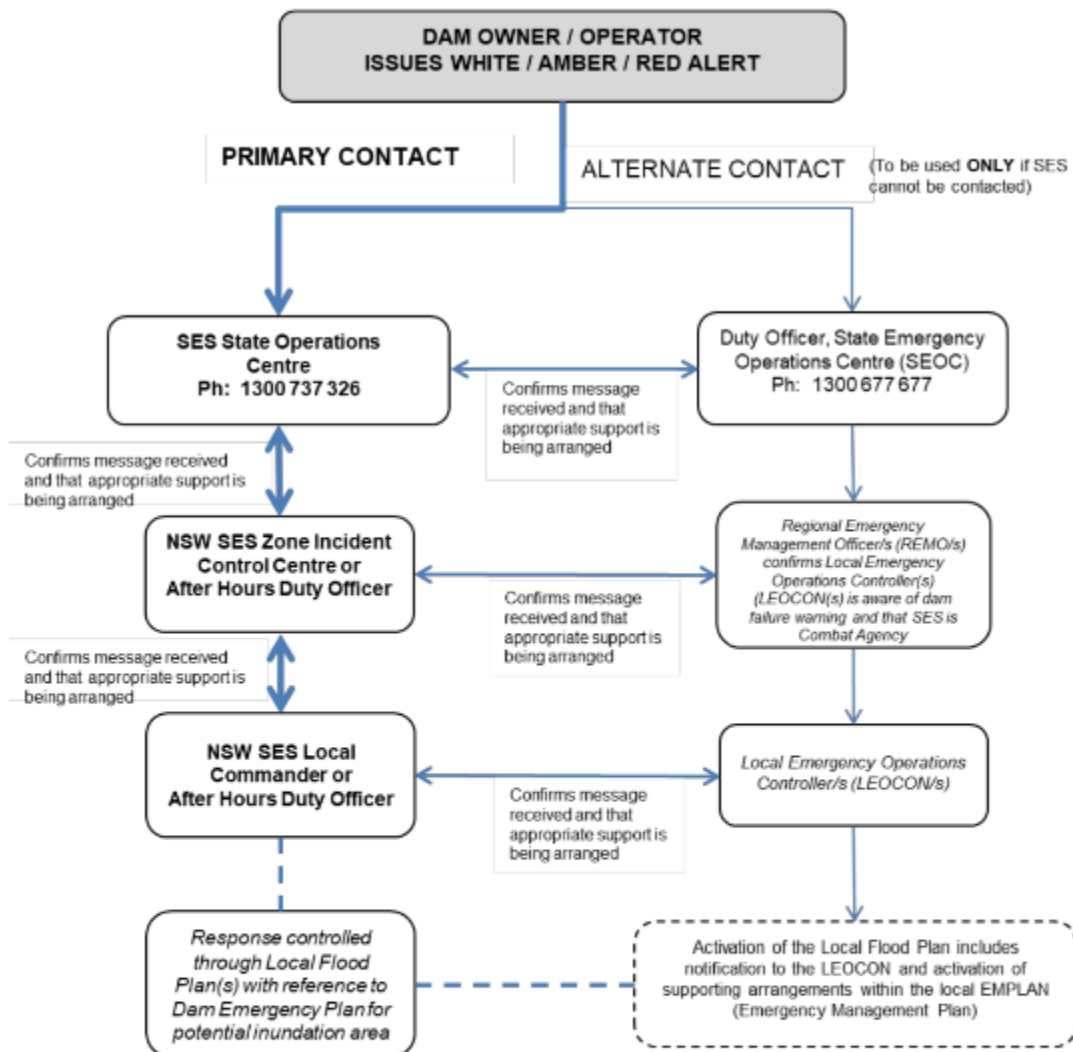
During an emergency, SCC must consult with consultants/designers regarding any temporary repairs to the dam and appurtenant works or the requirements for additional inspections and/or monitoring.

Flood Emergency “All Clear”

The flood emergency ‘all clear’ to the NSWSES & DSNSW should not be issued until the rain has stopped, the flood is receding and the storage level has fallen below the **White Alert level**.

NSWSES Responsibility

The NSWSES is responsible for the warning and evacuation of the downstream populations at risk and notifying the other emergency response agencies as per the Flow Chart at Figure 2.



Notes:

1. Dam owners should only contact the SEOC if the SES State Operations Centre (SOC) cannot be contacted.
2. The first priority for notification is to contact the NSW SES State Operations Centre. If unavailable, contact the SEOC. At each level, the contact agency should notify the alternate contact at the same level before making contact further down the line.
3. The triple zero (000) number for emergency services should not be used unless contact cannot be made with SES or the SEOC as it is likely the triple zero (000) operators will have difficulty dealing with the very unusual case of potential or actual dam failure.
4. Dam owners should send their draft Emergency Plan to the SES for review of the emergency management arrangements (see section 3.1 of this guideline).

Figure 2: NSWSES Notification Flowchart

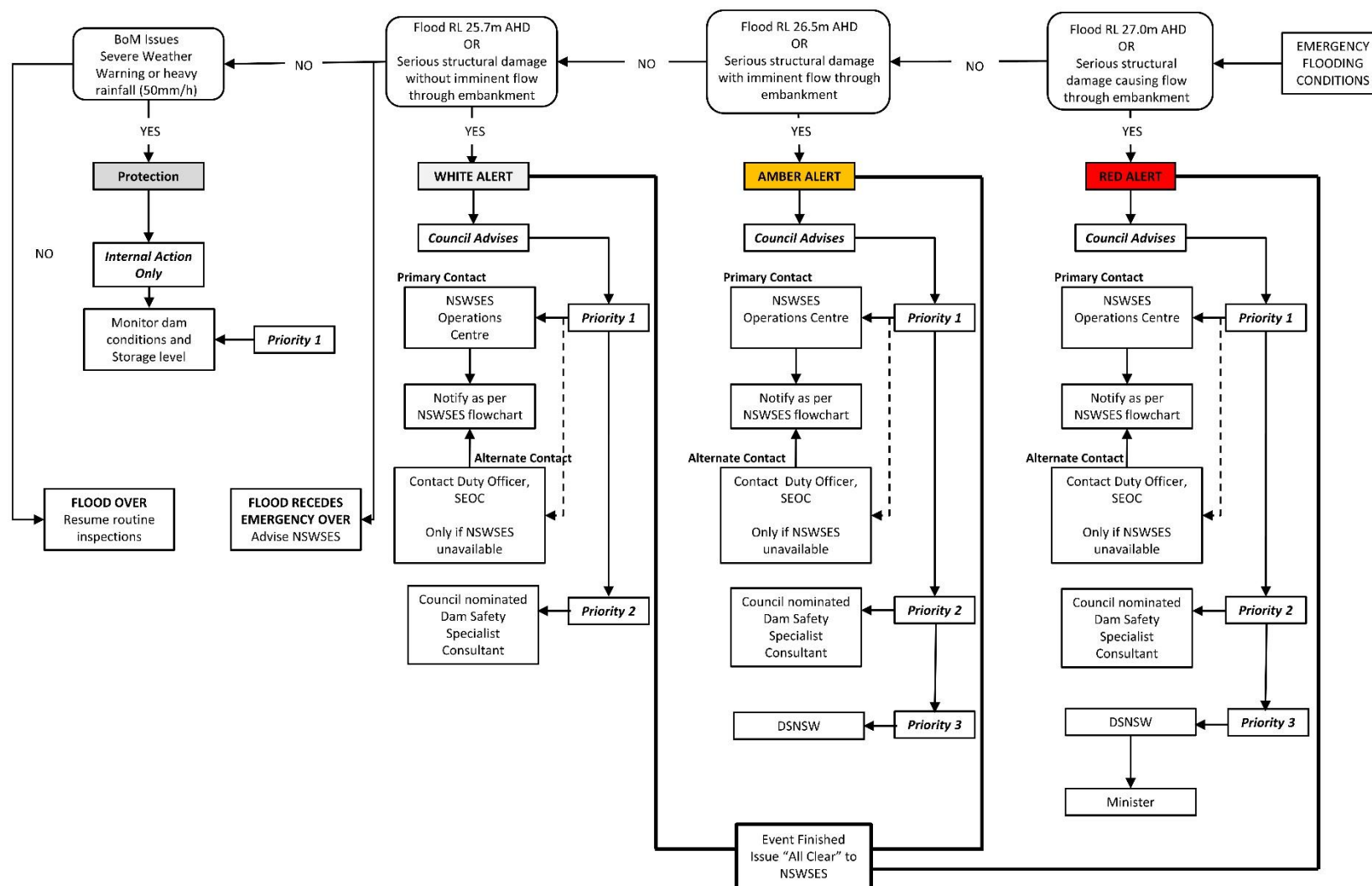


Figure 3: SCC Overall Notification Flow Chart. Refer to Appendix B for abbreviations and acronyms

4 | Emergency Procedures, Responsibilities and Contact Details

The procedures and responsibilities relevant to each alert level are summarised in the **Emergency Procedure Tables** (Table 2 to Table 5). These tables provide communication pathways and contact details to ensure proper reporting of all emergencies to authorities. The Emergency Procedure Tables include:

- Table 2, which refers to heavy rainfall triggering a Protection Mode. This is further discussed in Section 4.1;
- Table 3, which refers to a White Alert. This is outlined in Section 4.2;
- Table 4, which refers to a Amber Alert (Section 4.3);
- Table 5, which refers to a Red Alert (Section 4.4).

Adherence to these procedures will ensure that all relevant sources of specialist knowledge are available to deal with the situation, and that both risk and nuisance to the public is minimised. However, as indicated previously, if the situation is assessed as critical and adherence to the Notification Procedure may place lives at risk, the notifying staff member should act in accordance with the Red Alert requirements and evacuate, to the best of their ability, the population at risk at the earliest possible time.

The Owners and Operational Personnel must at all times consider public safety as paramount.

The **Emergency Communication Directory** (Table 6) summarises all the contact details of the responsible personnel.

4.1 Protection Mode (Heavy Rainfall)

If the BoM issues a Severe Weather Warning for Wollongong/Illawarra or intense rainfall is recorded at the Blackbutt pluviometer (e.g. >50mm per hour), then a Protection Mode is activated. The telemetry of the pluviometer will be updated within 6 months of this report so that upon reaching this rainfall rate, Protection Mode alerts are sent via text message to Council's Group Management Services and LEMO.

The activation of the Protection Mode should be reported to Executive Manager Works and Services.

The Executive Manager Works and Services will:

- Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecast updates relevant to the catchment;
- Notify the LEMO of any changes in alert levels or possibly upcoming alerts;
- Inform the LEMO if weather data indicates a possible escalation of alert status to White Alert Level, as per the notification chart in Figure 3;
- Contact the on-call Civil Coordinator to issue a preliminary mobilisation alert to the relevant work gang and machinery operators to go onto standby for possible preventative / remedial action at the basin.
- In consultation with Dam Safety Specialist consultant, determine the requirements for remedial action, as necessary. Appendix F provides examples of typical emergency remedial actions. These are unlikely to be required in Protection Mode however they might be necessary if, for instance, the basin has serious structural defects (e.g. from a previous flood event).

The LEMO will inform the NSWSES if weather data indicates a possible escalation of alert status to White Alert Level, as per the notification chart in Figure 2.

4.2 White Alert

When any of the White Alert triggers are activated, the nominated SCC staff member assigned to monitoring the basin should report this to the Executive Manager Works and Services. If any incidents which could threaten the stability of the basin are observed, these should be logged and reported using the forms in Appendix D.

The Executive Manager Works and Services should then:

- Inform the LEMO that a White Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3;
- Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment;
- Nominate a trusted staff member, either the on-call Civil Coordinator or another competent on-call employee, to immediately begin onsite monitoring of the condition and the storage level of the basin. Onsite monitoring is required in case of failure of the telemetered water level system, and to timely detect and respond to any structural failure/incidents. The staff member should keep a record of the water rate of rise within the basin and immediately inform the Executive Manager Works and Services if the triggers for the Amber Alert are reached;
- Notify the LEMO of any further changes in alert levels or possibly escalating alerts;
- Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3;
- In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions.

The LEMO should:

- Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3, as well as the rate of rise of the basin water level;
- Provide assistance to the NSWSES as required.

The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2. The NSWSES will consider the information on the rate of rise when assessing the best response options on a White Alert. It is reiterated that, in the worst case scenario of a flood rising as fast as a PMF, a rate of rise of 0.21m per minute may be observed at this basin. In this scenario, there would be as little as 19 minutes between the beginning of the rainfall event and a Red Alert, and only 2.5 minutes between a White and Amber alert, or an Amber and Red Alert.

4.3 Amber Alert

When any of the Amber Alert triggers are activated, the nominated SCC staff member assigned to monitoring the basin should report this to the Executive Manager Works and Services. If any incidents which could threaten the stability of the basin are observed, these should be logged and reported using the forms in Appendix D.

The Executive Manager Works and Services should then:

- Inform the LEMO that an Amber Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3;
- Ensure that the nominated SCC staff member, either the on-call Civil Coordinator or another competent on-call employee, keeps monitoring the basin's condition, storage level and rate of rise closely until the end of the emergency;
- Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3;
- In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions;
- Inform DSNSW that an Amber Alert has been triggered and report any other incidents observed at the basin;
- Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment;
- Inform the LEMO and Council's Dam Safety Specialist consultant if weather data indicates a possible escalation of alert status to Red Alert. The DSNSW Executive Engineer may also be included in this advice.

The LEMO should:

- Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3;
- Keep the NSWSES updated on the basin condition, storage levels and rate of rise;
- Provide assistance to the NSWSES as required.

DSNSW will keep informed.

The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2. The NSWSES may consider issuing an evacuation warning to the population at risk, or in case of an unusually high rate of rise, an evacuation order may be issued at this point. It is reiterated that, in the worst case scenario of a flood rising as fast as a PMF, a rate of rise of 0.21m per minute may be observed at this basin. In this scenario, there would be as little as 19 minutes between the beginning of the rainfall event and a Red Alert, and only 2.5 minutes between a White and Amber alert, or an Amber and Red Alert.

4.4 Red Alert

When any of the Red Alert triggers are activated, the nominated SCC staff member assigned to monitoring the basin should report this to the Executive Manager Works and Services. If any incidents which could threaten the stability of the basin are observed, these should be logged and reported using the forms in Appendix D.

The Executive Manager Works and Services should then:

- Inform the LEMO that a Red Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3;
- Ensure that the nominated SCC staff member, either the on-call Civil Coordinator or another competent on-call employee, keeps monitoring the basin's condition, storage level and rate of rise closely until the end of the emergency, if safe to do so;

- Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3;
- In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions;
- Inform DSNSW that a Red Alert has been triggered and report any other incidents observed at the basin;
- Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment;
- Inform the LEMO and Council's Dam Safety Specialist consultant if weather data indicates a possible escalation of alert status to Red Alert. The DSNSW Executive Engineer may also be included in this advice.

The LEMO should:

- Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3;
- Keep the NSWSES updated on the basin condition, storage levels and rate of rise;
- Provide assistance to the NSWSES as required.

DSNSW will keep informed and notify the responsible Minister that a Red Alert has been triggered.

The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2. The NSWSES will consider issuing an evacuation order to the population at risk. It is reiterated that, in the worst case scenario of a flood rising as fast as a PMF, a rate of rise of 0.21m per minute may be observed at this basin. In this scenario, there would be as little as 19 minutes between the beginning of the rainfall event and a Red Alert, and only 2.5 minutes between a White and Amber alert, or an Amber and Red Alert.

SCC staff will also tune in to a radio station and television to monitor the dissemination of warning messages.

Enquiries from the media about downstream flooding and any evacuation procedures will be directed to the NSWSES. Council will manage media inquiries about the incident at the dam.

Table 2: Shell Cove Detention Basin -Emergency Procedures – Flood Evaluation – Protection Mode

Trigger	Alert Level	Organisation	Actions	Responsible Position	Name	Phone / E-mail *
A Severe Weather Warning for Wollongong /Illawarra OR 50mm/h rainfall detected at the Blackbutt pluviometer	Protection Mode	Shellharbour City Council	5. Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecast updates relevant to the catchment; 6. Notify the LEMO of any changes in alert levels or possibly upcoming alerts; 7. Inform the LEMO if weather data indicates a possible escalation of alert status to White Alert Level, as per the notification chart in Figure 3; 8. Contact the on-call Civil Coordinator to issue a preliminary mobilisation alert to the relevant work gang and machinery operators to go onto standby for possible preventative / remedial action at the basin.	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111
			2. Inform the NSWSES if weather data indicates a possible escalation of alert status to White Alert Level, as per the notification chart in Figure 2.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308

NOTES:

- i. The Owner must carry out an Annual Review of the Emergency Communications Directory and advise All Organisations on the Document distribution list of any changes.
- ii. All Organisations must advise the Owner immediately of any changes to their structure, the names of their personnel and contact details. The Owner must circulate these changes immediately to All Organisations on the Document distribution list.

- iii. The Owner to provide assistance to the NSWSES if requested by the NSWSES.
- iv. The Owner to nominate the Consultant.
- v. The inspection details and the collection of the surveillance and monitoring data to be in accordance with the requirements of the O&M manual or as requested by the DSNSW.

Table 3: Shell Cove Detention Basin - Emergency Procedures – Flood Evaluation - White Alert

Triggers	Alert Level	Organisation	Actions	Responsible Position	Name	Phone / E-mail *
25.7m AHD (water at the spillway level) OR Serious structural damage without imminent flow through embankment	WHITE	Shellharbour City Council	7. Inform the LEMO that a White Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3; 8. Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment; 9. Nominate a trusted staff member to immediately begin onsite monitoring of the condition and the storage level of the basin. Onsite monitoring is required in case of failure of the telemetered water level system, and to timely detect and respond to any structural failure/incidents. The staff member should keep a record of the water rate of rise within the basin and immediately inform the Executive Manager Works and Services if the triggers for the Amber Alert are reached; 10. Notify the LEMO of any further changes in alert levels or possibly escalating alerts; 11. Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111

			description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3; 12. In consultation with Council’s Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions.			
			3. Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3. The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2; 4. Provide assistance to the NSWSES as required.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308
		NSWSES	Activate procedures for flood warnings evacuation etc. as per Figure 2.	NSWSES State Operations Centre (OC)	NSWSES State Operations Centre Duty Officer	1300 737 326 (24 Hours)
		SEOC If NSWSES unavailable		NSW SEOC	SEOC Duty Officer	1300 677 677 (24 hours)
		Additional NSWSES local contacts		NSWSES South Eastern Zone	Zone On-Call Officer (ZOCO)	02 4247 8094
				NSWSES Shellharbour Unit	Duty Officer	0428 470 360

NOTES:

- i. The Owner must carry out an Annual Review of the Emergency Communications Directory and advise All Organisations on the Document distribution list of any changes.
- ii. All Organisations must advise the Owner immediately of any changes to their structure, the names of their personnel and contact details. The Owner must circulate these changes immediately to All Organisations on the Document distribution list.
- iii. The Owner to provide assistance to the NSWSES if requested by the NSWSES.
- iv. The Owner to nominate the Consultant.
- v. The inspection details and the collection of the surveillance and monitoring data to be in accordance with the requirements of the O&M manual.
- vi. The flood emergency 'all clear' to the NSWSES & DSNSW should not be issued until the rain has stopped, the flood is receding and the storage level has fallen below the White Alert level.

Table 4: Shell Cove Detention Basin - Emergency Procedures – Flood Evaluation - Amber Alert

Triggers	Alert Level	Organisation	Actions	Responsible Position	Name	Phone / E-mail *
26.5m AHD (water 0.5m below the embankment crest) OR Serious structural damage with imminent flow through embankment	AMBER	Shellharbour City Council	8. Inform the LEMO that an Amber Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3; 9. Ensure that the nominated SCC staff member keeps monitoring the basin's condition, storage level and rate of rise closely until the end of the emergency; 10. Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3; 11. In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions; 12. Inform DSNSW that an Amber Alert has been triggered and report any other incidents observed at the basin; 13. Monitor the readings and alerts of the telemetered water level meter system and	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111

			interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment; 14. Inform the LEMO and Council's Dam Safety Specialist consultant if weather data indicates a possible escalation of alert status to Red Alert. The DSNSW Executive Engineer may also be included in this advice.			
			4. Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3. The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2; 5. Keep the NSWSES updated on the basin condition, storage levels and rate of rise; 6. Provide assistance to the NSWSES as required.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308
		NSWSES	Consider issuing an evacuation warning to the population at risk, or in case of an unusually high rate of rise, an evacuation order may be issued at this point.	NSWSES State Operations Centre (OC)	NSWSES OC Duty Officer	1300 737 326 (24 Hours)
		SEOC (If NSWSES unavailable)	Activate notification procedures as per Figure 2	NSW SEOC	SEOC Duty Officer	1300 677 677 (24 hours)
		DSNSW	Stays informed.	Executive Engineer	Chris Salkovic	(02) 9842 8070 BH 0403 681 645 Mob chris.salkovic@damsafety.nsw.gov.au
		Additional local NSWSES contacts	Are available to provide support and facilitate effective communication during the emergency	NSWSES South Eastern Zone	Zone On-Call Officer (ZOCO)	02 4247 8094

				NSWSES Shellharbour Unit	Duty Officer	0428 470 360
--	--	--	--	-----------------------------	--------------	--------------

NOTES

- i. The Owner must carry out an Annual Review of the Emergency Communications Directory and advise All Organisations on the Document distribution list of any changes.
- ii. All Organisations must advise the Owner immediately of any changes to their structure, the names of their personnel and contact details. The Owner must circulate these changes immediately to All Organisations on the Document distribution list.
- iii. The Owner to provide assistance to the NSWSES if requested by the NSWSES.
- iv. The Owner to nominate the Consultant.
- v. The inspection details and the collection of the surveillance and monitoring data to be in accordance with the requirements of the O&M manual.
- vi. The flood emergency 'all clear' to the NSWSES & DSNSW should not be issued until the rain has stopped, the flood is receding and the storage level has fallen below the White Alert level

Table 5: Shell Cove Detention Basin - Action & Communication Directory – Flood Evaluation - Red Alert

Triggers	Alert Level	Organisation	Actions	Responsible Position	Name	Phone / E-mail *
27.0m AHD (water at the embankment crest) OR Serious structural damage causing flow through embankment	RED	Shellharbour City Council	8. Inform the LEMO that a Red Alert at the Shell Cove Detention Basin is now active and ensure that the LEMO notifies the NSWSES as per Figure 3; 9. Ensure that the nominated SCC staff member keeps monitoring the basin's condition, storage level and rate of rise closely until the end of the emergency, if safe to do so; 10. Make sure that any observations of incidents which may increase the probability of dam failure are documented. Appendix E provides examples of typical dam failure indicators, while Appendix D provides standard forms for reporting and logging these incidents. For a more detailed description of the most likely incidents which can be observed at this basin please refer to the Operations and Maintenance Plan (Molino Stewart, 2021), Section 3; 11. In consultation with Council's Dam Safety Specialist consultant, determine the requirements for any emergency remedial works/actions, as necessary. Appendix F provides examples of typical emergency remedial actions; 12. Inform DSNSW that a Red Alert has been triggered and report any other incidents observed at the basin;	Executive Manager Works and Services	Tony Fraser	Ph: 02 4221 6111

			13. Monitor the readings and alerts of the telemetered water level meter system and interrogate the Bureau of Meteorology's website for all weather forecasts relevant to the catchment; 14. Inform the LEMO and Council's Dam Safety Specialist consultant if weather data indicates a possible escalation of alert status to Red Alert. The DSNSW Executive Engineer may also be included in this advice.			
			4. Inform the NSWSES Operations Centre (or if unavailable contact SOEC) of the change in alert level, as per Figure 3. The NSWSES/SEOC Duty Officer shall activate procedures as per Figure 2; 5. Keep the NSWSES updated on the basin condition, storage levels and rate of rise; 6. Provide assistance to the NSWSES as required.	LEMO	Primary: Melinda Fitzgerald Secondary: Donna-Cherie Baxter	Ph: (02) 4221 6061 Mobile: 0437 236 246 Ph: (02) 4221 6318 Mobile: 0436 808 308
		NSWSES	Consider issuing an evacuation order to the population at risk	NSWSES State Operations Centre (OC)	NSWSES OC Duty Officer	1300 737 326 (24 Hours)
		SEOC If NSWSES unavailable	Activate notification procedures evacuation etc. as per Figure 2	NSW SEOC	SEOC Duty Officer	1300 677 677 (24 hours)
		DSNSW	Advise DSNSW Minister	Executive Engineer	Chris Salkovic	(02) 9842 8070 BH 0403 681 645 Mob chris.salkovic@damsafety.nsw.gov.au

		Additional local NSWSES contacts	Are available to provide support and facilitate effective communication during the emergency	NSWSES South Eastern Zone	Zone On-Call Officer (ZOCO)	02 4247 8094
				NSWSES Shellharbour Unit	Duty Officer	0428 470 360

NOTES:

- i. The Owner must carry out an Annual Review of the Emergency Communications Directory and advise All Organisations on the Document distribution list of any changes.
- ii. All Organisations must advise the Owner immediately of any changes to their structure, the names of their personnel and contact details. The Owner must circulate these changes immediately to All Organisations on the Document distribution list.
- iii. The Owner to provide assistance to the NSWSES if requested by the NSWSES.
- iv. The Owner to nominate the Consultant.
- v. The flood emergency 'all clear' to the NSWSES & DSNSW should not be issued until the rain has stopped, the flood is receding and the storage level has fallen below the White Alert level

Table 6: Emergency Communications Directory – Shell Cove Detention Basin

Organisation	Person Title	Business Address	Communication Links	After Hours
COUNCIL				
Shellharbour City Council	LEMO	76 Cygnet Ave, Shellharbour City Centre	Primary: Ph: (02) 4221 6061 Mobile: 0437 236 246 Secondary: Ph: (02) 4221 6318 Mobile: 0436 808 308	Primary: Mobile: 0437 236 246 Secondary: Mobile: 0436 808 308
	Executive Manager Works and Services	76 Cygnet Ave, Shellharbour City Centre	Ph: 02 4221 6111	Ph: 02 4221 6111
	On-call Civil Coordinator	76 Cygnet Ave, Shellharbour City Centre	Ph: 02 4221 6111	Ph: 02 4221 6111
	Engineering Works Manager	76 Cygnet Ave, Shellharbour City Centre	Ph: 02 4221 6111	Ph: 02 4221 6111
Council's Dam Safety Specialist consultant				
EMERGENCY SERVICES				
NSWSES State Operations Centre	Duty Officer	6-8 Regent Street Wollongong NSW 2500	Ph: 1300 737 326 (24 Hours)	
NSW Government – State Emergency Operations Centre (SEOC)	Duty Officer		Ph: 1300 677 677 (24 Hours)	
Shellharbour NSWSES Headquarters	Local Controller	127 Tongarra Road Albion Park NSW 2527	Ph: 02 4251 6111	Ph: 132 500 (for emergency assistance)

Organisation	Person Title	Business Address	Communication Links	After Hours
<i>NSWSES Shellharbour Unit</i>	Duty Officer		Ph: 02 4247 8094	Ph: 02 4247 8094
<i>NSWSES South Eastern Zone Headquarters</i>	Duty Officer	56 – 58 Knox Street Goulburn NSW 2580	Ph: 02 4247 9555	Ph: 132 500 (for emergency assistance)
<i>NSWSES South Eastern Zone</i>	Zone On Call Officer (ZOCO)		Ph: 02 4247 8094	Ph: 02 4247 8094
<i>NSW Police – Lake Illawarra Police Station</i>	Superintendent (LAC) Duty Officer	6 Pioneer Drive Oak Flats NSW 2529	Ph: 02 4232 5599 Fax: 02 4232 5511	000 / 106
<i>Ambulance Service of NSW Illawarra & South Western Sydney Sector</i>	Duty Officer	Block S, Unit 1, 391 Park Road Regents Park NSW 2143	Ph: 9782 9888 Fax: 9782 9809	000 / 106
<i>Fire & Rescue NSW Shellharbour Fire Station</i>	Duty Officer	Lot 301 Wattle Road Shellharbour NSW 2529	Ph: 02 4295 1940	000 / 106
<i>Fire & Rescue NSW Zone Office South 1 - Illawarra</i>	Duty Officer	32 Denison Street Wollongong NSW 2500	Ph: 02 4224 2000 Fax: 02 9166 6305	000 / 106
<i>Toll Ambulance Rescue Helicopter Service</i>		15 Boomerang Avenue Albion Park Rail NSW 2527	Ph: 0417 121 545	
LOCAL RADIO FREQUENCIES				
<i>i98 FM (98.1)</i>		Television Avenue Mt St Thomas NSW 2500	Ph: 02 4223 4198	
<i>Wave FM 96.5</i>		Top Floor, 73 King Street Warrawong NSW 2502	Ph: 02 4275 2965	
<i>VOX FM 106.9</i>		11 Tallegalla Street Unanderra NSW 2526	Ph: 02 4227 3436	

Organisation	Person Title	Business Address	Communication Links	After Hours
ABC Illawarra News		13 Victoria Street Wollongong NSW 2500	Ph: 02 4224 5000	
Shoalhaven FM (2UUU)		Shoalhaven City Arts Centre 12 Berry Street Nowra NSW 2541	Ph: 02 4422 1045	
LOCAL TV CHANNELS				
ABC TV		13 Victoria Street Wollongong NSW 2500	Ph: 02 4224 5000	
Channel 7		38-42 Pirrama Road Pyrmont NSW 2009	Ph: 8777 7777	
Network 9		24 Artarmon Road Willoughby NSW 2068	Ph: 9906 9999	
Network 10		1 Saunders Street Pyrmont NSW 2009	Ph: 9650 1010	
MATERIAL SUPPLIERS				
	Contact on call Civil Coordinator			
EQUIPMENT SUPPLIERS				
	Contact on call Civil Coordinator			
OTHER SERVICES				
Bureau of Meteorology (BoM)	Duty Meteorologists Public Weather	16/300 Elizabeth Street SYDNEY NSW 2000	Ph: (02) 9296 1555 http://www.bom.gov.au/nsw/warnings/	
Dams Safety NSW (DSNSW)	Executive Engineer	Level 3, Macquarie Tower 10 Valentine Avenue PARRAMATTA NSW 2150	Ph: (02) 9842 8073 info@damsafety.nsw.gov.au	0403 681 645 Mob chris.salkovic@damsafety.nsw.gov.a

Organisation	Person Title	Business Address	Communication Links	After Hours
		Or Dams Safety NSW, Locked Bag 5123, Parramatta, NSW 2124		

5 | Dam Failure Information

A Dam Break Study for Shell Cove Detention Basin was undertaken by Cardno for Shellharbour Council in 2013 (Cardno, 2013). The study was undertaken to comply with the relevant NSW DSC requirements at the time, namely:

- Dam Safety Committee, 2012. NSW Dam Safety Committee's Consequence Categories for Dams (DSC3A)
- ANCOLD, 2012. Guidelines on the Consequence Categories for Dams
- W.J. Graham, 1999. A Procedure for Estimating loss of Life Caused by Dam Failure (DSO-99-06)

The study developed a hydraulic model to simulate a dam break for a range of scenarios, to identify the potential dam break effects and the extent of flooding. This information has been used to assess the dam in accordance with DSC guidelines and provide information regarding the Population at Risk (PAR) and the Probable Loss of Life (PLL) from which the Consequence Category was determined (Cardno, 2013).

The hydrological model was the 'Watershed Bounded Network Model' WBNM2012 (Boyd et al, 2012). WBNM is an advanced storage-routing model that allows simulation of complex catchment behaviour. This particular model was considered most appropriate for the task of modelling the study area, given its ability to model a wide range of catchment characteristics and its local development (Cardno, 2013).

The storage capacity of the upstream and the downstream basin, Pond 1 and Pond 2 respectively, was obtained from the topography from the construction plans (Figure 4). All rainfall events were simulated under the assumption that both basins have an initial water storage corresponding to their design permanent water level, namely:

- A level of 24.95m AHD for Pond 1 (giving a storage of 2,907m³); and
- A level of 23.00m AHD for Pond 2 (giving a storage of 2,026m³)

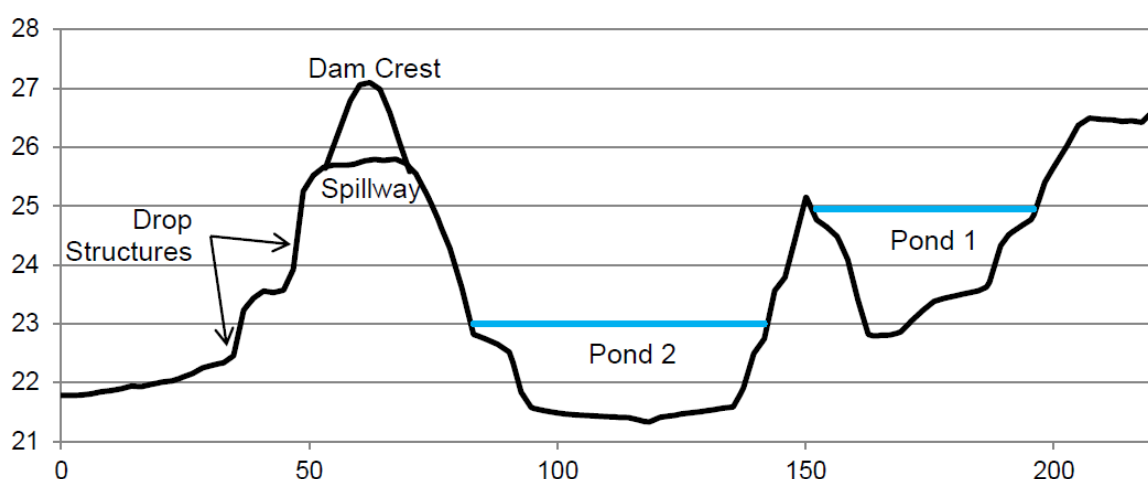


Figure 4. Section diagram of Shell Cove Detention Basin (Cardno, 2003)

The hydrologic model was run for a number of storm events, and the peak level in Pond 2 calculate for each storm (Table 7).

Table 7. Peak water levels for various design storms (Cardno, 2013).

Storm Event (ARI)	Critical Duration (minutes)	Peak Water Level (m)	Comment
1 Year	120	25.606	
2 Year	120	25.842	Spillway weir activated (25.7m)
5 Year	120	26.018	
10 Year	120	26.086	
20 Year	120	26.168	
50 Year	120	26.255	
100 Year	120	26.332	
200 Year	120	26.413	
500 Year	120	26.519	
1,000 Year	60	26.56	
2,000 Year	60	26.647	
5,000 Year	60	26.784	
10,000 Year	60	26.903	
20,000 Year	60	27.02	Dam embankment overtopped (27.0m)
50,000 Year	60	27.101	
100,000 Year	60	27.157	
200,000 Year	45	27.209	
500,000 Year	45	27.271	
PMF*	45	27.307	
*PMF assumed to have an ARI of 1,000,000 Years			

The hydraulic model was undertaken using the TUFLOW 2D modelling software. TUFLOW is able to simulate rapid failure of the basin embankment and predict the resulting flood behavior and flood hazard categories. The following events were modelled:

- 20,000 year ARI (Dam Crest Flood), with and without dam breach
- 100,000 year ARI with and without dam breach
- PMF with and without dam breach

A Sunny Day failure was considered, however it was identified that the level differential between the permanent water level and the toe of dam is only 1m (i.e. the permanent water level is 23.0m AHD and the toe of the dam is 22.0m AHD) and the permanent water volume is only 5ML. For these conditions Sunny Day failure is considered highly unlikely and in the event of a breach the resulting flood wave is expected to be relatively insignificant. Hence detailed hydraulic modelling of the Sunny Day failure was not considered necessary.

Cardno (2013) estimated the basin's flood consequence category to be Significant. This was based on a total PLL (Potential Loss of Life) of 0.132 and a "Medium" loss severity. The incremental Population At Risk (PAR) was found to be maximum in the PMF, and equal to 13.2 PAR (Table 8).

Table 8. Population At Risk of dam break (Cardno, 2013)

Scenario	Time Category	Number of Dwellings Affected		Residents	People in Cars		Total
		Hinchinbrook Drive	Mystics Drive		Hinchinbrook Drive	Shallows Drive	
20,000 Year ARI	Day	1	0	0	2	4	6
	Night			3.3	0	0	3.3
100,000 Year ARI	Day	1	2	0	Already inundated	Already inundated	0
	Night			9.9	0	0	9.9
PMF	Day	1	3	0	Already inundated	Already inundated	0
	Night			13.2	0	0	13.2
						Maximum PAR	13.2

Incremental PAR were defined by Cardno (2013) as the population downstream of the dam who, as a result of a dam break, would experience flood depths greater than 300mm. It is not clear if Cardno (2014) discounted from the incremental PAR the population downstream of the dam exposed to high flood risk without a dam break occurring (as defined by ANCOLD, 2012, i.e. depth > 1.2m, or a velocity > 1.5m/s, or a $d \cdot v > 0.6 \text{ m}^2/\text{s}$). If this was not done, the PAR figures in Cardno (2013) may be overestimated, at least upstream of Shallows Road.

The following key information was extracted from the Cardno (2013) report:

- **Rate of Rise and Time between Alerts.** In a flood rising as fast as a PMF (worst case scenario), a red alert will be triggered within 19 minutes from the beginning of the rainfall event, and only 2.5 minutes after an amber alert. This corresponds to an average rate of rise of about 0.2 m per minute. The minimum time at which each alert levels is reached after the beginning of the rainfall is shown in Table 1.
- **Flood Wave Arrival Time.** After the initial dam break, floodwaters would take 11 minutes and 13-15 minutes to reach the peak depth at Hinchinbrook Drive and Shallows Drive respectively. This is shown in Table 9 and in the maps in Appendix H, noting that the times in the maps must be increased by about 10 minutes as they represent the time of peak depth after the peak outflow is reached at the dam, and this occurs about 10 minutes after the break.

Table 9. Dam break flood wave arrival time, depth and velocities (Cardno. 2013)

Location	Distance d/s (m)	20,000 year ARI (DCF)			100,000 year ARI			PMF		
		Time (min)	Depth (m)	Velocity (m/s)	Time (min)	Depth (m)	Velocity (m/s)	Time (min)	Depth (m)	Velocity (m/s)
Water at Spillway Level		-9			-8			-5		
Dam Breach		0			0			0		
Peak outflow from Dam	0	10			10			10		
Peak water level at Hinchinbrook Drive Bridge	270	11	0.85	2.2	11	0.9	2.3	11	1.0	2.5
Peak water level at Shallows Drive Bridge	700	15	0.6	1.8	15	0.65	2.0	13	0.7	2.2

- **Number of houses affected and depth.** In the PMF with dam break, four buildings are affected by flooding (one in Hinchinbrook Drive and three in Mystics Drive), with depths between 0.2m and 0.5m.
- **Additional dwellings in the newly developed are downstream of Shallows Road may be exposed** to incremental depths greater than 300mm, particularly in the 20,000 year ARI event with dam break (Figure 1). These were not included in the PAR count by Cardno (2013) because that area was not developed when the report was prepared.
- **Road Affection.** The maps in Appendix H show the extent of flooding over local roads. Cardno (2013) states that during and extreme flood, Southern Cross Boulevard may experience flood depths of 200mm west of Bank Drive, while directly upstream of the dam flood depths can reach 400mm.

The full report from Cardno (2013), including inundation mapping, flooding timeline, risk assessment and population at risk, is attached to this report in Appendix C, while the maps of the population at risk from a dam break in the 20,000 year ARI, 100,000 year ARI and PMF are attached in Appendix H.

Until an updated dam break study is available, it is recommended that, in addition to the Population at Risk identified in the Cardno (2013) report (Appendix C), all the newly developed areas downstream of Shallows Road be considered at risk of a dam breach, and evacuated when a decision to do so is made by the NSWSES.

6 | Emergency Warning and Communication Systems

6.1 Warning Systems

The Dams Safety Regulation 2019 requires that all declared dams or detention basins with a consequence category equal to Extreme or High utilise, as a minimum, a telemetered pluviometer nearby the basin to monitor rainfall. The consequence category of the Shell Cove detention basin is currently Significant, hence there is no requirement for a telemetered pluviometer. However, it is reiterated that the Consequence Category of the basin may be revised after the dam break modelling is updated to account for the newly developed areas in the downstream catchment.

The first trigger to go to emergency operations and monitoring is when a Severe Weather Warning is issued for the Shellharbour region by the Bureau of Meteorology.

Should that alarm be triggered, the Executive Manager Works and Services will immediately arrange for the basin to be monitored until the rainfall event ceases and water levels in the basin decrease. The water level is to be monitored using a gauge plate and a telemetered water level system to be installed within the basin within six months from the date of this report. In the meantime, the water level and basin condition during a flood will be monitored using the visual references set for each alert level in Section 3.2, Table 1.

6.2 Communications Systems

A reliable communications system for basins is required both in normal and emergency situations. All information is transferred between the stakeholders/Council staff via mobile/landline phone systems and internet connections. If power supplies and communication systems are interrupted, handheld two-way radios in the networks of SCC will be used.

6.2.1 Radio Frequency and TV Channels

The dissemination of information on the dam emergency will be carried out by the NSWSES as per Figure 2. By a specific agreement between NSWSES and the ABC, that network is the official emergency broadcaster and will interrupt programming as required. In addition, local media outlets, including ethnic radio (Vietnamese, Khmer, Arabic and standardised Chinese) and community radio stations, as identified in Table 6 shall receive flood bulletins from the NSWSES Division Headquarters and the NSWSES HQ Media Unit.

6.2.2 Emergency Communications Directory

For contact names and phone numbers refer to Table 6 - Emergency Communications Directory. A draft "Communications Log" is included in Appendix D. It should be used to record all discussions that take place regarding the emergency. It should include all phone calls, radio and person to person conversations with reference to the current emergency situation. Rule a line to indicate the end of the discussion after every entry.

7 | Required Emergency Resources

7.1 Human Resources

When a “Heavy Rain Alert” (i.e. Protection Mode) is triggered, the Executive Manager Works and Services will contact the on-call Civil Coordinator of SCC to issue a preliminary mobilisation alert to the relevant work gang and machinery operators to go onto standby for preventative / remedial action at the basin.

Should the situation move on to a White, Amber or Red Alert, the work gang and operators will undertake any preventative / remedial actions as directed by the Executive Manager Works and Services and Council Dam Safety Specialist consultant. Appendix E and F provide examples of typical dam failure indicators and emergency remedial actions.

It is important that the likely participants in this procedure have suitable prior training and exercise the mobilisation on a regular basis. Any works under emergency conditions should be subject to appropriate risk assessment in accordance with SCC WHS procedures and the use of appropriate SWM.

In addition to the above, the NSWSES Local Controller can source emergency labour from within the NSWSES and other emergency management agencies deemed necessary in a flood incident. The NSWSES can also request the assistance of SCC personnel in liaison with the LEMO.

7.2 Emergency Supplies

7.2.1 Power Resources

During emergencies, battery powered lighting or portable generators would be required although power could also be sourced from nearby residences. Provision of power should be considered as part of both this plan and the overall Local Emergency Plan.

7.2.2 Materials, Plant and Equipment

Given the nature of most likely failure scenarios, the requirement for emergency supplies and equipment will revolve around the transport to the site of a back-hoe and the ability to find, excavate and place the materials to prevent failure as outlined in Appendix F.

SCC Works Depot is located at 132-134 Industrial Road, Oak Flats. It will take some time to drive a back-hoe from the depot to the basin, especially if the rainfall event causing the concern has been or remains significant across the Shellharbour LGA.

The Executive Manager Works and Services is responsible for the acquisition of materials and plant during emergency incidents. Obtaining the material to undertake any emergency remedial measures may be difficult, especially as a greater the level of development occurs around a basin. Given that an emergency situation is likely to develop while rain continues, there may be access issues for major construction equipment, as well as accessing earth-fill for emergency blocking of flows. Options such as flood sacs or temporary flood walls should be investigated and incorporated into the overall emergency management plan. The majority of this activity will fall within the control of the Executive Manager Works and Services.

8 | Organisational Responsibilities

The responsibilities of persons and organisations involved with this emergency management are Shellharbour City Council (SCC) as the dam owner, NSW State Emergency Service (NSWSES), NSW State Emergency Operations Centre (SEOC) and the DSNSW.

The responsibilities of persons and organisations involved with this emergency management are detailed further in Table 10 below. **It is essential that the lead contact officer and their nominated deputies be provided with the delegated authority to act as necessary to ensure that the Emergency Plan is activated and implemented at the earliest, most appropriate time should an emergency develop.**

Table 10: Organisational Responsibilities within Shellharbour City Council

Responsible Positions in Shellharbour City Council	General Responsibilities	Emergency Responsibilities
Executive Manager Works and Services	- Management of Council resources to ensure readiness - Plan for and requisition materials and plant required to combat floods and flood related dam incidents.	- Activate emergency alerts and advise/liaise with LEMO. - Arrange onsite monitoring of the basin upon activation of a White Alert. - During an emergency, monitor any alerts from the telemetered water level meter and BoM - Engage and liaise with Council's Dam Safety Specialist consultant. - In consultation with Dam Safety Specialist consultant, determine the requirements for remedial action, as necessary. - Monitor and document the progress and decisions made during the incident response, including any incidents detected at the basin. - Liaise with LEMO, Council's Dam Safety Specialist consultant, NSW SES and DSNSW during emergency. - Direct any media enquiries to the NSWSES. - Provide assistance to the NSWSES if requested to do so. - Planning for and leading the emergency exercises, including yearly seminars.
LEMO	Facilitating and collating Local EMPLANS for endorsement.	- Liaise with the NSWSES - Provide assistance to the NSWSES if requested to do so
Engineering Works Manager		- Manages on-call Civil Coordinator - React to the advice from Dam Safety Specialist consultant in consultation with Executive Manager Works and Services regarding temporary repairs to the dam and appurtenant works and any additional monitoring requirements. - Carry out temporary or permanent repairs recommended by the Dam Safety Specialist consultant in consultation with Executive Manager Works and Services to return basins to a safe operational condition.
Infrastructure Planning Manager	Identify & scope corrective maintenance work necessary to keep basins in a safe operational condition.	
Flood and Stormwater Manager	Production of O&M Plans	
Infrastructure Planning Manager / Infrastructure Officer Strategy	Collection of routine inspection & monitoring data and undertake preventative maintenance of basins in accordance with the O&M Plan.	

Executive Manager Technical and Recreation Services	• Nomination of Council's Dam Safety Specialist consultant. • Production of the EP. • Annual review and distribution of all revisions, amendments, contact details etc. to EP.	
--	--	--

9 | Emergency Exercises

The emergency plan needs to include the details of emergency exercises to be undertaken to test the emergency plan for the declared dam.

Guidelines on how to conduct an exercise can be found on the Australian Institute for Disaster Resilience (AIDR) website at:

<https://knowledge.aidr.org.au/resources/handbook-3-managingexercises/>

The regulation requires exercises to be undertaken every three years (and a practical exercise for high and extreme consequence dams every five years).

As the consequence category of the basin is currently Significant, Council will undertake emergency exercises with the following requirements:

- An emergency exercise will be undertaken every three years;
- Every second emergency exercise (i.e. every six years) will be a practical exercise;
- The exercises will be undertaken taking direction from the Australian Disaster Resilience Handbook 3: Managing Exercises, 2012, Australian Institute for Disaster Resilience;
- Executive Manager Works and Services in collaboration with LEMO and Manager Floodplain and Transport is responsible for planning, undertaking the exercise and ensuring corrective actions have been recorded and undertaken;
- Minutes and all records produced as part of the exercise are to be kept as part of Councils Dam Safety Management System.

Good practice would also include an annual seminar, or 'run-through' of emergency procedures, with key onsite staff, to help familiarise them with emergency systems and procedures and measures for emergency preparedness. An annual seminar would also assist in identifying the equipment, resources and materials required to respond in an emergency. The Executive Manager Works and Services will arrange these yearly seminars.

4.7.1. Three yearly exercise

This exercise may be in the form of a classroom exercise where an actual physical response to the simulated emergency is not required.

The exercise needs to involve staff who are involved in the operation of the dam and who would be involved in an emergency response. The AIDR handbook describes these exercises as 'discussion' or 'hypothetical' exercises.

4.7.2. Six yearly practical exercise

This exercise may involve staff who are involved in the operation of the dam and (as far as practicable) the range of emergency agencies that are identified in the emergency plan (usually the NSWSES). This exercise should be planned as early as possible to allow time for all relevant emergency agencies to schedule their attendance. The AIDR handbook 3 may be useful as a guide to plan and execute the emergency exercise.

4.7.3. Records

Dam owners need to keep records of emergency exercises. Records include the exercise participants, scenario, exercise results and any required corrective actions to the emergency plan. This may be best included in an emergency exercise evaluation report (see AIDR handbook 3 for a suggested evaluation report template). The report should be made available to all agencies involved in the exercise.

10 | Distribution and Update of the EP

10.1 Distribution

It is a responsibility of SCC to distribute this EP and any amendments/updates to all the relevant organisations as per the EP distribution list in Appendix D. These include DSNSW and the NSWSES. The EP is to be distributed in PDF format, and additional GIS layers representing the outputs of the dam break modelling (e.g. flood extents) should be attached in GIS format.

The NSWSES has established a flood data portal to store flood information, including declared dam emergency plans (<https://floodddata.ses.nsw.gov.au/>). The portal provides a single location for important emergency information and includes security features to protect sensitive information. The NSWSES should be contacted for information on how to submit the EP for inclusion on the portal.

10.2 Update

In terms of reviews and updates of this EP, Clause 10 of the regulation requires the following:

(3) For the purposes of section 17(3) of the Act, the emergency plan must be updated at least once every 5 years subject to subclauses (4) and (5).

(4) The emergency plan must be updated to take account of the following changes within 30 days after the change occurs—

(a) a change to the consequence category of the dam,

(b) a significant change, since the consequence category of the dam was last determined, to the number of persons who would be put at risk if there were to be a failure of the dam,

(c) a change to the emergency management arrangements.

(5) The emergency plan must be routinely reviewed, at least annually, to ensure that a change to the contact details of a person responsible for exercising functions in the event of an emergency is updated as soon as practicable after the change.

Appendix G provides a Document Control summary with information on the current version of this EP, authors, ID and Approver.

As per the regulation, interim updates must be arranged (within 30 days) if the consequence category of the basin is modified, if there has been a significant change to the number of persons at risk, or if emergency arrangements change. Additional updates may be undertaken after an emergency exercise to incorporate any lessons learnt.

Further, a review of the EP needs to be carried out every year to ensure that a change to the contact details of a person responsible for exercising functions in the event of an emergency is updated as soon as practicable after the change.

Appendix D provides standard forms that may be used by SCC to record amendments to the EP content (text, figures, maps) or contact details. As new persons take office, or positions change title, it is essential that the EP contact details be immediately updated for phone numbers or addresses change (amongst other information) and circulated to all the holders.

Any amendments to the contact details should be reflected in the Emergency Communications Directory (Section 4, Table 6), and in the emergency procedures tables (Section 4, Table 2 to Table 5).

Following any amendments to the contact details, SCC must advise all organisations on the documentation distribution list. All organisations must advise SCC immediately of any changes to their structure, the names of their personnel and contact details. It is the responsibility of SCC to circulate these changes immediately to all organisations on the document distribution list.

References

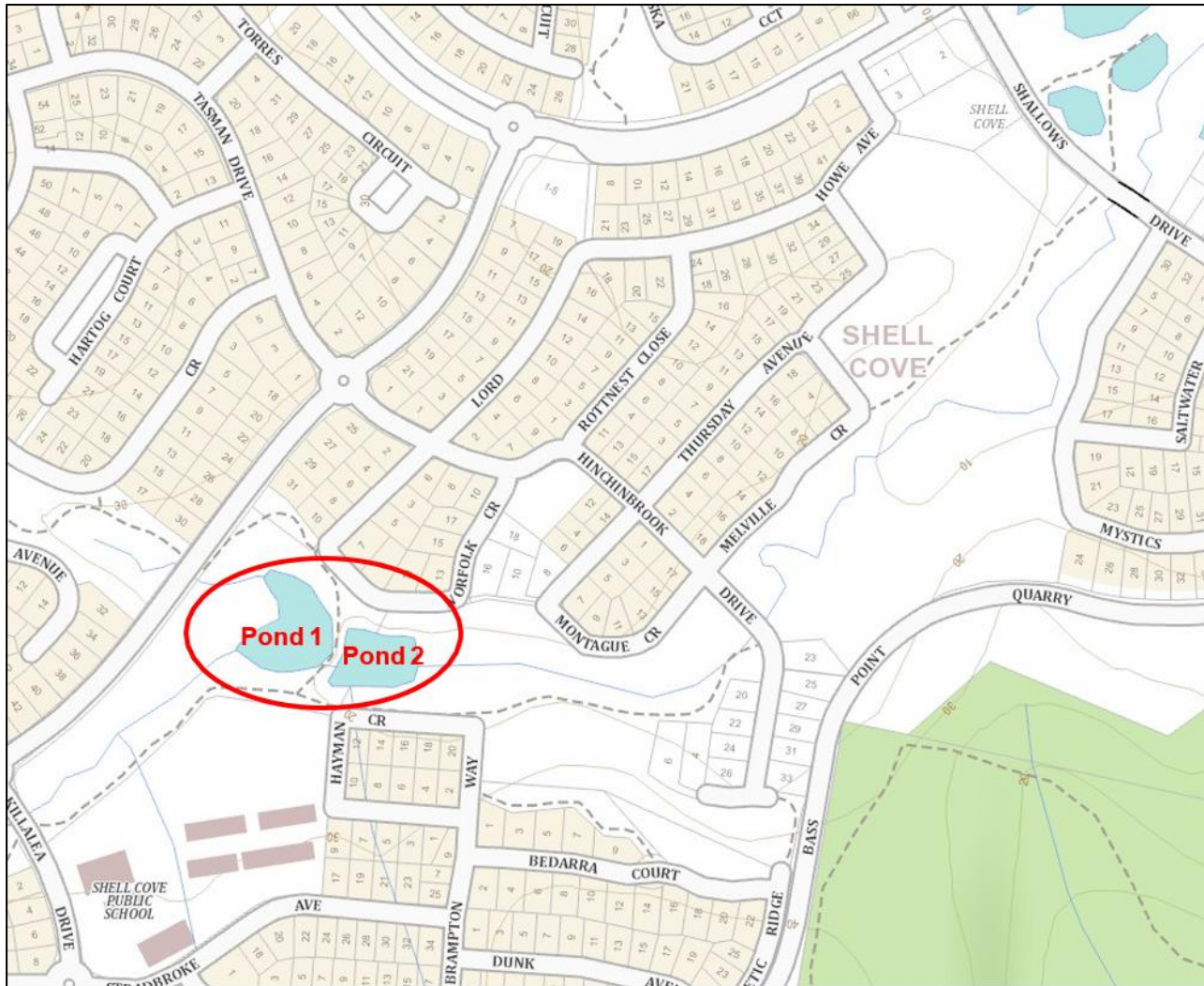
Australian National Committee on Large Dams (ANCOLD), 2003: Guidelines on Risk Assessment

Australian National Committee on Large Dams (ANCOLD), 2012: Guidelines on Consequence Categories for Dams.

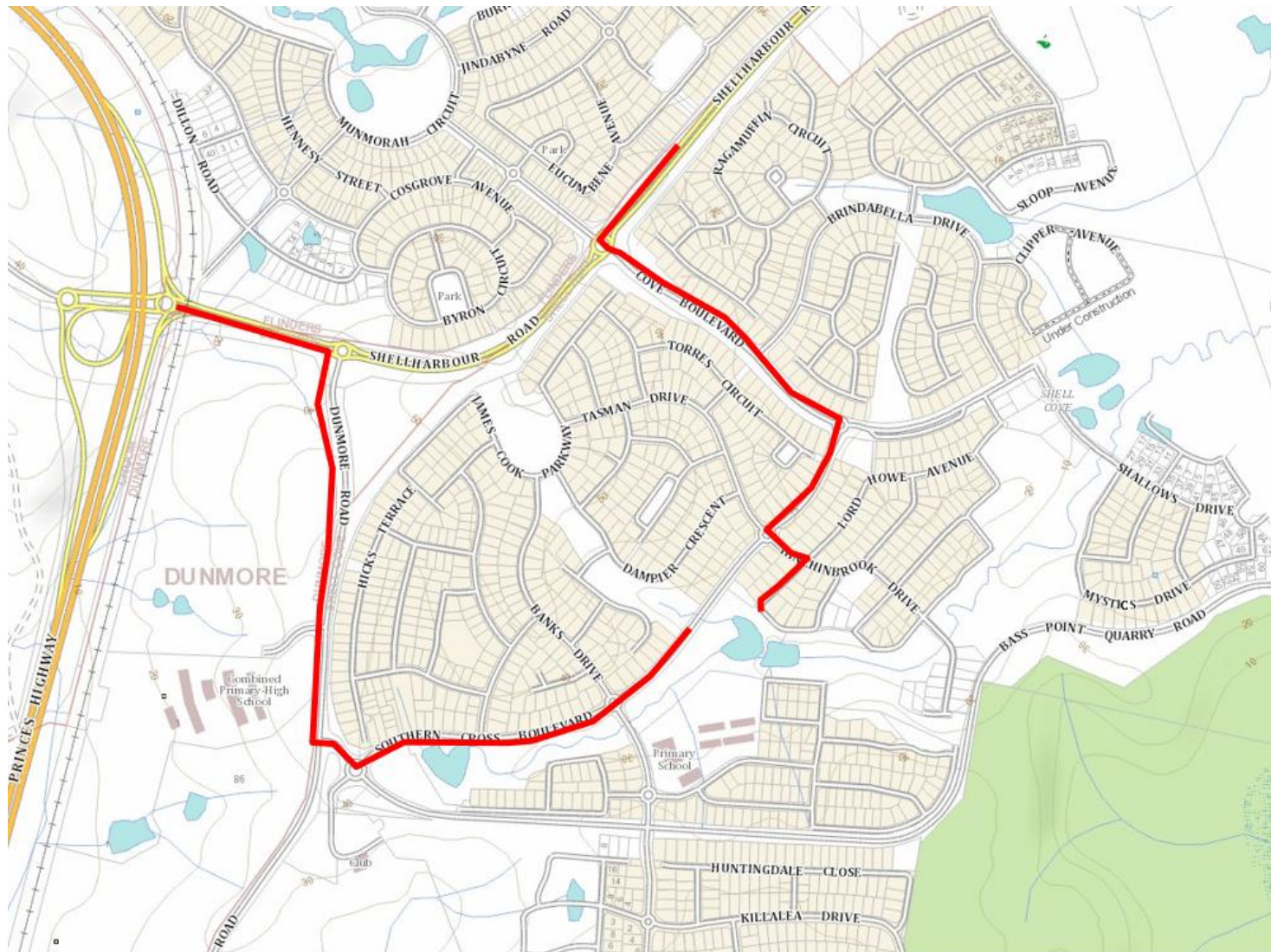
Cardno, Shell Cove Major Detention Basin 1 - Dam Break Study, 2013

Cardno, Shell Cove Dam Safety Emergency Plan, 2014

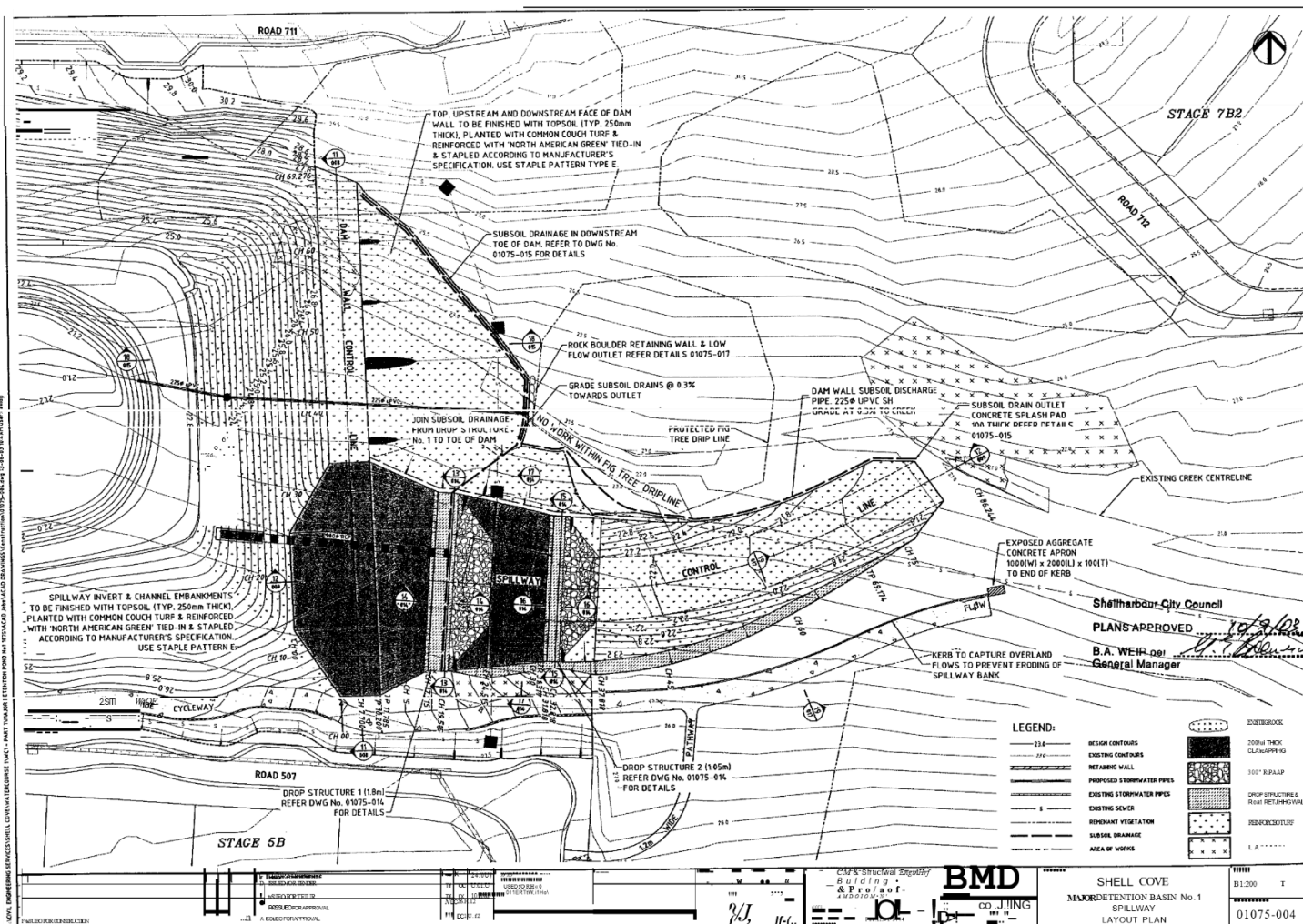
Appendix A | Basin Location, Layout, and Access Routes



Location of the basin (from Cardno, 2014)



Access to the basin (from Cardno, 2014). The route via Southern Cross Boulevard is subject to shallow flooding (up to 400mm in the PMF)



Spillway

Appendix B | Glossary of Terms & Abbreviations

Glossary of Terms

<i>Abutment</i>	That part of the valley wall against which the basin/dam is constructed.
<i>Australian Height Datum (AHD)</i>	A system of control points for height based on a network of levelling measurements which covered the whole of Australia and which was fitted to mean sea level as measured at tide gauges distributed around the Australian coast, over the period 1968-1970.
<i>ANCOLD</i>	Australian National Committee on Large Dams Inc.
<i>Annual Exceedance Probability (AEP)</i>	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m ³ /s has an AEP of 5%, it means that there is a 5% chance (i.e., a one-in-20 chance) of a 500 m ³ /s or larger events occurring in any one year (see ARI).
<i>Appurtenant Works</i>	All ancillary structures of a basin/dam including, but not limited to, spillways, inlet and outlet works, tunnels, pipelines, etc.
<i>Base of Dam / Basin</i>	The general foundation area of the lowest portion of the main body of the dam.
<i>Catchment</i>	The land surface area which drains to a specific point, such as a reservoir.
<i>Collapse</i>	The physical deformation of a structure to the point where it no longer fulfils its intended purpose.
<i>Consultant</i>	A Company Department or Organisation, with qualified professional engineers, capable of providing advice on the design, construction, maintenance and operation of large dams.
<i>Dam/Basin</i>	Any man made barrier, temporary or permanent, including appurtenant works which does or could impound, divert or control water, other liquids, silts, debris or other liquid-borne material.
<i>Dam Crest</i>	Frequently used to denote top of dam. However, the term Crest is usually applied to the level at which water may overflow the spillway section of the dam. The term "Top of Dam" is preferred to denote uppermost surface of the dam proper, excluding parapets, handrails, etc. – See Spillway Crest
<i>Dam Crest Flood (DCF)</i>	The flood event which, when routed through the reservoir, results in a still water level, excluding

	wave effects, which for an embankment is the lowest point of the embankment crest.
Dam Owner	Any person, organisation or legal entity who owns a dam. Legal opinion indicates that the dam owner is that person, authority or legal entity that owns the land on which the dam structure is situated.
Dams Safety New South Wales (DSNSW)	DSNSW is a statutory corporation of the New South Wales Government in Australia. It was created under the Dam Safety Act 2015.. Its main function is to ensure the safety of dams within the State.
Emergency Plan (EP)	A continually updated document incorporating instructions and maps that, together with ongoing public education, outlines the actions to be taken by a dam owner to deal with the emergency situation or unusual occurrence at a given dam or reservoir.
Regional Emergency Management Officer (REMO)	Local controller of an emergency under the control of the State Emergency Operations Controller (SECON).
Failure (Dam)	The uncontrolled release of the contents of a dam. The failure may consist of the collapse of the dam or some part of it, or excessive seepage or discharges in cases where hazardous substances are being stored.
Emergency	An emergency in terms of dam operation is any condition which develops unexpectedly, endangers the integrity of the dam or downstream property and life and requires immediate action.
Failure	The uncontrolled release of the contents of a reservoir through collapse of the dam or some part of it, or the inability of a dam to perform functions such as water supply, prevention of excessive seepage or containment of hazardous substances.
Foundation	The undisturbed material on which the dam structure is placed.
Freeboard	The vertical distance between the surface of the stored water and the top of the dam. Examples of freeboards are the distances from the top of the dam to the normal full supply level (normal freeboard), and the design flood level (flood freeboard).
Full Supply Level (FSL)	The level of water surface when the reservoir is at maximum operating level, excluding periods of flood discharge.

<i>H & V</i>	Horizontal and Vertical e.g. 3H:1.5V describes the steepness of slope.
<i>Hazard</i>	That which has the potential for creating adverse consequences such as loss of life, property and services damages and environmental effects (also see Risk).
<i>Height of Dam</i>	Normally this is the difference in level between the natural bed of the stream or watercourse at the downstream toe of the dam or, if it is not across a stream, channel or watercourse, between the lowest elevation of the outside limit of the dam, and the top of the dam. (See definition "Top of Dam".)
<i>Imminent Failure Flood (IFF)</i>	The flood event which, when routed through the reservoir just threatens failure of a dam. The reservoir is assumed to be initially at FSL.
<i>Incident</i>	An event which could deteriorate to a very serious situation or endanger the dam.
<i>Inspection (Dam)</i>	A careful/critical viewing and examination of all visible aspects of a dam.
<i>Local Flood Plan (LFP)</i>	Plans prepared by NSWSES for the management of flood mitigation measures and to cover the evacuation of the population in the flood zone.
<i>Maintenance</i>	The routine work required to maintain existing works and systems (civil, hydraulic, mechanical and electrical) in a safe and functional condition.
<i>Monitoring</i>	The observing of measuring devices that provide data from which can be deduced the performance and behavioural trends of a dam and appurtenant structures, and the recording and review of such data.
<i>Operator</i>	The person, organisation, or legal entity, which is responsible for the control, operation and maintenance of the dam and/or reservoir and the appurtenant works. In this case, the owner/operator is Shellharbour City Council (SCC).
<i>Outlet Works</i>	The combination of intake structure, screens, conduits, tunnels and valves that permit water to be discharged under control from the reservoir.
<i>O&M Manual Operations and Maintenance Manual</i>	The collection in One Document the complete accurate and current operating and maintenance instructions for the dam and its appurtenant works. Prescribed Dam A dam is PRESCRIBED under the NSW DAMS SAFETY ACT 1978 on the

	recommendation of the Dams Safety Committee and is usually based on size and hazard ratings.
<i>Population at Risk (PAR)</i>	All those persons who would be directly exposed to flood waters within the dambreak affected zone if they took no action to evacuate. Note: The PAR may be much greater than the potential loss of life as PAR is determined by the floodwater inundation area in the dambreak affected zone. The floodwater may be as little as 100mm deep. However loss of life would generally not be expected unless the floodwater is greater than about 300mm deep with a velocity of flow greater than about 1m/s.
<i>Probable Maximum Flood (PMF)</i>	The flood resulting from PMP and, where applicable, snow melt, coupled with the worst flood-producing catchment conditions that can be realistically expected in the prevailing meteorological conditions.
<i>Probable Maximum Precipitation (PMP)</i>	The theoretical greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin.
<i>Recommended Design Flood (RDF)</i>	The flood event which has the recommended annual exceedance probability or magnitude and which produces the highest flood surcharge for the dam. In the ANCOLD (2003) guidelines the RDF is selected for the appropriate IFCC.
<i>Reservoir Capacity</i>	The total or gross storage capacity of the reservoir up to FSL excluding flood surcharge.
<i>Risk</i>	A measure of the probability and severity of an adverse event as either the product of probability and consequences, or in a non product form.
<i>Safety Check Flood</i>	The "limit state" overall safety flood relating to potential extraordinary flood events in the safe limit of dam integrity (previously called Imminent Failure Flood).
<i>Spillway</i>	A weir, conduit, tunnel or other structure designed to permit discharges from the reservoir when water levels rise above the full supply level (FSL) and to convey flood-waters safely pass a dam.
<i>Spillway Crest</i>	The uppermost portion of the spillway overflow section.
<i>Supervisory Control & Data Acquisition (SCADA)</i>	An electronic system for the automatic collection and transfer of monitoring data to a central control point.
<i>State Emergency Operations Controller (SEOC)</i>	Authority that assumes control of an emergency if it is not under the control of a combat agency.

<i>State of Emergency</i>	As defined by the State Emergency and Rescue Management Act, 1989 - Section 33 (1): If the Premier is satisfied that an emergency constitutes a significant and widespread danger to life or property in New South Wales, the Premier may, by order in writing, declare that a state of emergency exists in the whole, or in any specified part or parts, of New South Wales in relation to that emergency.
<i>SES State Operations Centre (OC)</i>	NSWSES OC is the first point of contact for NSWSES in an emergency.
<i>Tailwater Level</i>	The level of water in the discharge channel immediately downstream of the dam.
<i>Top of Dam</i>	The elevation of the uppermost surface of the dam proper, not taking into account any camber allowed for settlement, kerbs, parapets, guardrails or other structures that are not a part of the main water retaining structure. This elevation may be a roadway, walkway or the non-overflow section of the dam.
<i>Abutment</i>	That part of the valley wall against which the basin/dam is constructed.
<i>Australian Height Datum (AHD)</i>	A system of control points for height based on a network of levelling measurements which covered the whole of Australia and which was fitted to mean sea level as measured at tide gauges distributed around the Australian coast, over the period 1968-1970.

Abbreviations

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ANCOLD	Australian National Committee on Large Dams
ARI	Average Recurrence Interval
D/S	Downstream
DCF	Dam Crest Flood
DFL	Dam Flood Level
DSNSW	Dam Safety New South Wales
EP	Emergency Plan
FSL	Full Supply Level
IFCC	Incremental Flood Consequence Category
IFF	Imminent Failure Flood
LEMO	Local Emergency Management Officer, SCC – NSWSES
LEOCON	Local Emergency Operations Controller, Shellharbour – Police
LFP	Local Flood Plan –NSWSES
LWU	Local Water Utility
MDS	Manager Dam Safety
NSWSES	NSW State Emergency Service
PAR	Population at Risk
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PRM	Probabilistic Rational Method
REMO	District Emergency Management Officer
REOCON	District Emergency Operations Controller
SCADA	Supervisory Control and Data Acquisition
SCC	Shellharbour City Council
SCF	Safety Check Flood
SDCC	Sunny Day Consequence Category
SEOC	State Emergency Operations Centre
U/S	Upstream
UHF	Ultra High Frequency
VHF	Very High Frequency

Appendix C | Dam Break Assessment Report

Appendix D | Standard Forms

Distribution List

Control Document Distribution List

<i>Distribute a Copy to:</i>	Control Copy Number
SCC	001
LEMO	002
<i>Council's Dam Safety Specialist consultant</i>	003
<i>Dams Safety New South Wales (DSNSW), Parramatta</i>	004
<i>NSW State Emergency Service (NSWSES) State Headquarters, Wollongong (For internal distribution to appropriate NSWSES Regions and Units)</i>	005 - 007
<i>State Emergency Operations Centre (SEOC) (For internal distribution in accordance with the number of SEOC District Emergency Management Officers (DEMO) involved)</i>	008

NOTES:-

1. The number and position of each document within SCC is the responsibility of SCC
2. SCC is responsible for circulating any amendments to the EP internally and to the DSNSW, NSWSES.
3. The NSWSES State Operations Centre and State Emergency Operations Centre (SEOC) are then responsible for circulating any amendments internally to any holders of the EP nominated by the NSWSES and SEOC.
4. **It is the responsibility of each Organisation to acknowledge receipt of the amendments and advise SCC that the relevant pages have been replaced and the EP document has been updated accordingly.**

Amendments to Contact Details

All amendments to the EP contact details are to be entered and certified on the table below by SCC then all the relevant pages together with the amended table forwarded to ALL the Organisations on the Document Distribution List.

Amendments to Contact Details

CONTACT DETAILS						ENTERED BY
Date	Organisation	Title	Name	Phone/E-mail	Page Nos	Name (Print Name)

NOTES:-

1. It is the responsibility of SCC to advise each Organisation immediately of any changes to its organisational structure, his personnel and relevant contact numbers.
2. It is the responsibility of each Organisation to advise SCC immediately of any changes to their organisational structure, their personnel and relevant contact numbers.
3. It is the responsibility of SCC to contact each Organisation annually to check that there have been no changes to their organisational structure their personnel or relevant contact numbers.
4. **It is the responsibility of each Organisation to acknowledge receipt of the amendments to the contact details and advise SCC that the relevant pages have been replaced and the EP document has been updated accordingly.**

Amendments to Text Items

Approved amendments or additions to the text of the EP are to be entered and certified in the table below by SCC then all the relevant pages together with the amended table forwarded to **ALL** the Organisations on the Document Distribution List.

Amendments to Flow Charts, Text Items & Drawings

AMENDMENT SECTION						ENTERED BY
Date	Organisation	Title	Name	Phone/E-mail	Page Nos	Name (Print Name)

NOTES:-

1. It is the **responsibility of the basin owner to circulate all proposed amendments** to the flow charts, text pages and drawings of the EP to all affected organisations for approval prior to forwarding the approved amendment(s) to all the organisations on the document distribution list.
2. It is the **responsibility of each organisation to acknowledge receipt of the amendments**, and advise SCC that the relevant pages have been replaced and the EP document has been updated accordingly.
3. The flow charts text pages and drawings of the original document should show the date the document was issued in the footer.
4. Any subsequent amendments to flow charts text pages and drawings should show the date of the amendment in the footer of the affected page.

Communications Log

Communications Log

Date: _____ Sheet ____ of ____

[illegible][illegible]

Signed: _____

Position: _____

Date: _____

Incident Report Form

INCIDENT REPORT FORM		
Date of the Incident:		
Time of the Day:		
Location:		
Incident Type: <i>(of the following incident types set by the Dams Safety Regulation 2019, pick the most relevant)</i>		
failure of the dam without release of water (the dam ceases to perform its functions)	a serious failure or inadequacy in the dam safety management system and associated documentation that could potentially have caused death, serious injury, property damage, or environmental impact	
failure of the dam, with release of water, but without a catastrophic breach	a suspected terrorist attack	
failure of the dam with loss of water due to a catastrophic breach	any change in the dam or its surrounds that is abnormal and could indicate an increased risk of the failure of the dam. This includes incidents which could interfere with correct functioning of the dam (for example, obstruction of spillway or outlet pipes)	
any change observed in the dam or its surrounds which could indicate an increased vulnerability to failure (for example, erosion on the embankment, increase in seepage flow, turbidity in seepage flow, new seeps, appearance of cracking in the dam).	a serious failure or inadequacy in the dam safety management system and associated documentation that could potentially have caused death, serious injury, property damage, or environmental impact	
an incident that results in the death or serious injury of a person or significant damage to property or the environment	breaches of security with implications for dam safety	
Provide details: 		
Was the media involved?	YES	NO

Visual Inspection Reports

Dam Surveillance Inspection Report

Asset Name

Shell Cove Detention Basin

Inspection Details

Date of Inspection:		Weather conditions
Time of Inspection		

Inspecting Organisation:

Inspection completed by (Officer Name):

Phone:

Email:

Safety Status

☐	Dam has Serious Defect.	Urgent repair is necessary as risk of failure under flood conditions is high
☐	Dam has Defect.	Programmed repair recommended as risk of failure under flood conditions is low
☐	Dam has No Defect that needs programmed repair.	

Note: Urgent repair is necessary - repair to commence within two (2) weeks
Programmed repair recommended - repair to commence within one month

Summary of Recommended Actions

Urgent Repair:	Programmed Repair:

e.g. Embankment

Mark observations

	Inspected	Action Needed	Note
Misalignments along crest			
Misalignment along upstream embankment slope			
Misalignment along downstream embankment slope			
Wet areas or lush growth along embankment toe			
Cracks-desiccation			
Cracks-transverse			
Cracks-longitudinal			
Slides/slough-upstream slope			
Slides/slough-downstream slope			
Depressions			
Sinkholes			
Inadequate upstream slope protection (bare areas)			
Inadequate downstream slope protection (bare areas)			
Erosion on upstream face			
Erosion on downstream face			
Vegetation obscuring embankment			
Grass cover dying			
Deep rooted vegetation (trees/bushes/weeds)			
Deep rooted vegetation dying			
Debris			
Animal burrows			
Wear on crest			
Other – see below			

Required actions and notes

[illegible]

e.g. Pit, pipe, headwalls

rule must be “Safety at All Times”.

Required actions and notes

[illegible]

Flow Area Component

e.g. overland flow paths, spillways, earth channel

	Inspected	Action Needed	Note
Erosion of flow area banks			
Erosion of flow area bed			
Undercutting of flow area bank			
Flow area clear/partially/fully blocked with debris (circle one)			
Services exposed			
Slides/slough on flow area banks			
Flow redirected by other works			
Wet areas/seepage			
Dislodged rocks			
Other – see notes			

Required actions and notes

[illegible]

Appurtenant Component

e.g. Fencing, walkways, gauge plates, warning signs, telemetry

	Inspected	Action Needed	Note
Gauge plat or warning signs not securely attached			
Paintwork on gauge plate or warning signs not clear			
Vegetation obscuring view of gauge plate or warning signs			
Walkway damage			
Pedestrian bridge/fence between ponds damaged			
Telemetry system damaged			
Other – see notes			

Required actions and notes

[illegible]

Site Inspection Photos

Appendix E | Dam Failure Indicators

Owners of dams and operating and maintenance personnel must be knowledgeable of the potential problems which can lead to failure of a dam. These people regularly view the structure and, therefore, need to be able to recognize potential problems so that failure can be avoided. If a problem is noted early enough, an engineer experienced in dam design, construction, and inspection can be contacted to recommend corrective measures, and such measures can be implemented. Acting promptly may avoid possible dam failure and the resulting catastrophic effect on downstream areas.

If there is any question as to the seriousness of an observation, an engineer experienced with dams should be contacted.

Since only superficial inspections of a dam can usually be made, it is imperative that owners and maintenance personnel be aware of the prominent types of failure and their tell-tale signs. Earth dam failures can be grouped into three general categories: overtopping failures, seepage failures, and structural failures. A brief discussion of each type follows.

Overtopping Failures

Overtopping failures result from the erosive action of water on the embankment. Erosion is due to uncontrolled flow of water over, around, and adjacent to the dam. Earth embankments are not designed to be overtopped and therefore are particularly susceptible to overtopping erosion. Once erosion has begun during overtopping, it is almost impossible to stop. A well vegetated earth embankment may withstand limited overtopping if its crest is level and water flows over the crest and down the face as an evenly distributed sheet without becoming concentrated. However, as soon as the overtopping flow concentrates, erosion may begin creating a deep, v-shaped scouring on the embankment crest.

The owner should closely monitor the reservoir pool level during severe storms as any sudden increase or decrease in level may indicate the failure of a basin component. After a flood event in which overtopping has occurred, severe overtopping erosion signs would be visible (i.e. deep, v-shaped scouring on the embankment crest).

It is also noted that a basin that cannot discharge floodwaters at the design flow capacity of the outlet or the spillway is more prone to overtopping erosion and failure, all other things equal. Occurrences which could lead to hydraulic deficiencies during a flood include, but are not limited to, significant obstructions of the spillway (e.g. debris, vegetation growth) or blocked pits or pipes (e.g. by siltation).

Seepage Failures

All earth dams have seepage resulting from water permeating slowly through the dam and its foundations. Seepage must be controlled in both velocity and quantity. If uncontrolled, it can progressively erode soil from the embankment or its foundation, resulting in rapid failure of the dam.

Erosion of the soil begins at the downstream side of the embankment, either in the dam proper or the foundation, progressively works toward the reservoir, and eventually develops a direct connection to the reservoir. This phenomenon is known as "piping." Piping action can be recognized by an increased seepage flow rate, the discharge of muddy or discoloured water, sinkholes on or near the embankment, or a whirlpool in the reservoir. Once a whirlpool (eddy) is observed on the reservoir surface, complete failure of the dam will probably follow in a matter of minutes. As with overtopping, fully developed piping is virtually impossible to control and will likely cause failure.

Seepage can cause slope failure by creating high pressures in the soil pores or by saturating the slope. The pressure of seepage within an embankment is difficult to determine without proper instrumentation. A slope which becomes saturated and develops slides may be showing signs of excessive seepage pressure.

Structural Failures

Structural failures can occur in either the embankment or the appurtenances. Structural failure of a spillway, lake drain, or other appurtenance may lead to failure of the embankment. Cracking, settlement, and slides are the more common signs of structural failure of embankments. Cracks may appear in the crest or slopes of the dam. Cracking in an embankment dam falls into the following three principal categories:

- Longitudinal cracking
- Transverse cracking
- Desiccation cracking

Longitudinal Cracking

Longitudinal cracking occurs in a direction roughly parallel to the length of the dam. It is an indication of:

- Uneven settlement between adjacent embankment zones of differing compressibility.
- Tension from excessive settlement and lateral spread of the embankment.
- The beginning scarp of an unstable slope. In this case, the crack may appear arc-shaped.

Longitudinal cracks allow water to enter the embankment. When water enters the embankment the strength of the embankment material adjacent to the crack may be lowered. The lower strength of the embankment material can lead to or accelerate slope stability failure.

Transverse Cracking

Transverse cracking appears in a direction roughly perpendicular to the length of the dam. If these cracks extend into the core below the reservoir level they are especially dangerous because they could create a path for concentrated seepage through the core. Transverse cracks usually appear on the dam crest, near abutments, and in U-shaped or trapezoidal-shaped valleys.

The presence of transverse cracking indicates differential settlement within the embankment or underlying foundation. This type of cracking frequently develops when:

- Compressible embankment material overlies steep or irregular rock abutments.
- There are zones of compressible material in the foundation.

Transverse cracks may provide a path for seepage through the embankment. When the depth of the crack extends below the level of the reservoir, very rapid erosion of the dam may occur, eventually breaching the dam.

Desiccation Cracking

Desiccation cracking is caused by the drying out and shrinking of certain types of embankment soils. Desiccation cracks usually develop in a random, honeycomb pattern. Typically, desiccation cracking occurs in the crest and the downstream slope. The worst desiccation cracking develops when a combination of the following factors is present:

- A hot, dry climate accompanied by long periods in which the reservoir remains empty.
- An embankment that is composed of highly plastic soil, such as clay.

Usually, desiccation cracking is not harmful unless it becomes severe. The major threat of severe desiccation cracking is that this type of cracking can contribute to the formation of gullies. Surface runoff erosion concentrating in the desiccation cracks or gullies can result in eventual damage to the dam. In addition, heavy rains can fill up these cracks and cause portions of the embankment to become

unstable and to slip along crack surfaces where the water has lowered the strength of the embankment material. Deep cracks that extend through the core conceivably can cause a breach of the dam when the water level rises and the cracks fail to swell rapidly enough to reseal the area.

Large cracks in either an appurtenance or the embankment, major settlement, and major slides will require immediate remedial measures to ensure safety, especially if these problems occur suddenly. If this type of situation occurs during a flood emergency, the water level should be lowered (if possible), the appropriate state and local authorities notified, and professional advice sought from Council's Dam Safety Specialist consultant.

Appendix F | Emergency Remedial Measures

This section details remedial measures and preventative actions that may be implemented both prior to and following the development of an emergency situation to reduce the damage to the dam structure(s). It details provisions for surveillance and detection of an emergency situation.

In close consultation with the Council's Dam Safety Specialist consultant and depending on the severity and type of the emergency, it may be possible to implement remedial measures to reduce the damage to the structure(s) by:

- Sealing or draining cracks;
- Modifying operational procedures;
- Buttreassing unstable slopes;
- Dewatering the basin; and
- Other actions

Sealing or Draining Cracks

When cracks in the dam or foundation are leaking to significant leakage or erosion of materials, the cracks maybe sealed to reduce the amount of leakage and to lessen the potential of erosion or piping. Crack sealing with proper crack drainage can reduce detrimental uplift pressures.

It is advisable for drainage of the cracks, so that the leaking water is conducted to a suitable location in the drainage system. Drainage alone also can be used to relieve internal pressures that tend to keep the cracks open and propagate them.

Buttreassing Unstable Slopes

Unstable reservoir slopes or excavations may require buttressing with large, free-draining material. Buttressing can be used to improve stability, control piping and allow internal hydrostatic pressures to dissipate safely.

Dewatering

Failure due to a rapidly deteriorating structural deficiency such as may be induced by an extreme earthquake. This is generally referred to as a "Sunny Day" failure, i.e. not induced by an inflow flood, however there is always the possibility that such a failure can arise after the peak of the event when the basin is full but not overflowing.

If such a scenario arises, lowering the storage level is the single most useful preventative action. However, it is really only useful for Sunny Day failure modes, because flood inflows far exceed the release capacity.

Other Actions

In the event of a rapidly deteriorating structural deficiency which is likely to threaten the security of basins, SCC staff having reported a potential emergency situation, should do the following:

- Ensure that a responsible person with portable communication is left in a safe position at basins to monitor the emergency condition.
- Restrict access to the dam area.
- Liaise with emergency management authorities.
- If possible, document the emergency condition with photographs and/or a video camera.
- Monitor and record weather forecasts, streamflow information and rain gauge information.

- Inform all involved personnel of any change in the emergency condition.

Do not take any unnecessary risks in undertaking the above actions.

Appendix G | Document Control

This Emergency Plan is registered as a controlled document with Shellharbour City Council, which also holds the Master Manual. The details are:

Document Author: Molino Stewart Pty Ltd

Document Objective ID : 2021/32-1 SCDB EP

Document Title: Shell Cove Detention Basin – Emergency Plan

Document Approver: Ben Stewart, Executive Director Infrastructure Services, Shellharbour City Council

Other controlled copies of this document are located as listed in the “EMERGENCY PLAN FOR BASINS, CONTROLLED DISTRIBUTION LIST” which can be found in this document (Appendix D)

The responsible officer for the document is Executive Manager Works and Services, Shellharbour City Council. This officer is responsible for ensuring that:

- the document is reviewed regularly (at least annually) for adequacy and accuracy, especially of the emergency communications directory (Table 6);
- the document is updated after review if required;
- the document is approved by an appropriate senior officer;
- the distribution list and records of amendments are maintained.

Appendix H | Maps of the Population at Risk



20,000yr ARI Event Dam Break Incremental Effects

SHELL COVE DAM BREAK STUDY

Legend

- Dam Break Location
- Watercourses (LPI)
- Cadastre (LPI, 2011)
- ▨ Incremental Effects >300mm
- 20,000yr Flood Extent (with failure)

Timings are from peak dam outflow to peak water level



1:5,000 Scale at A3



Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
 Date: 2013-06-26
 Coordinate System: GDA 1984 MGA Zone 56
 Project: 82013035 01
 Map: G1007_IncrementalEffects_20000yr.mxd 02
 Aerial imagery supplied by NearMap (July 2012)



100,000yr ARI Event Dam Break Incremental Effects

SHELL COVE DAM BREAK STUDY

Legend

- Dam Break Location
- Watercourses (LPI)
- Cadastre (LPI, 2011)
- ▨ Incremental Effects >300mm
- 100,000yr Flood Extent (with failure)

Timings are from peak dam outflow to peak water level



1:5,000 Scale at A3



Map Produced by Cardno NEWACT Pty Ltd (WOL)
Date: 2013-05-15
Coordinate System: GDA 1984 MGA Zone 56
Project: 82013025 01
Map: G1004_IncrementalEffects_100000yr.mxd 04
Aerial imagery supplied by NearMap (July 2012)



PMF Event Dam Break Incremental Effects

SHELL COVE DAM BREAK STUDY

Legend

- Dam Break Location
- Watercourses (LPI)
- Cadastre (LPI, 2011)
- ▨ Incremental Effects >300mm
- PMF Flood Extent (with failure)

Timings are from peak dam outflow to peak water level



1:5,000 Scale at A3



Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2013-05-15
Coordinate System: GDA 1984 MGA Zone 56
Project: 82013035 01
Map: G1005_IncrementalEffects_PMF.mxd 04
Aerial imagery supplied by NearMap (July 2012)