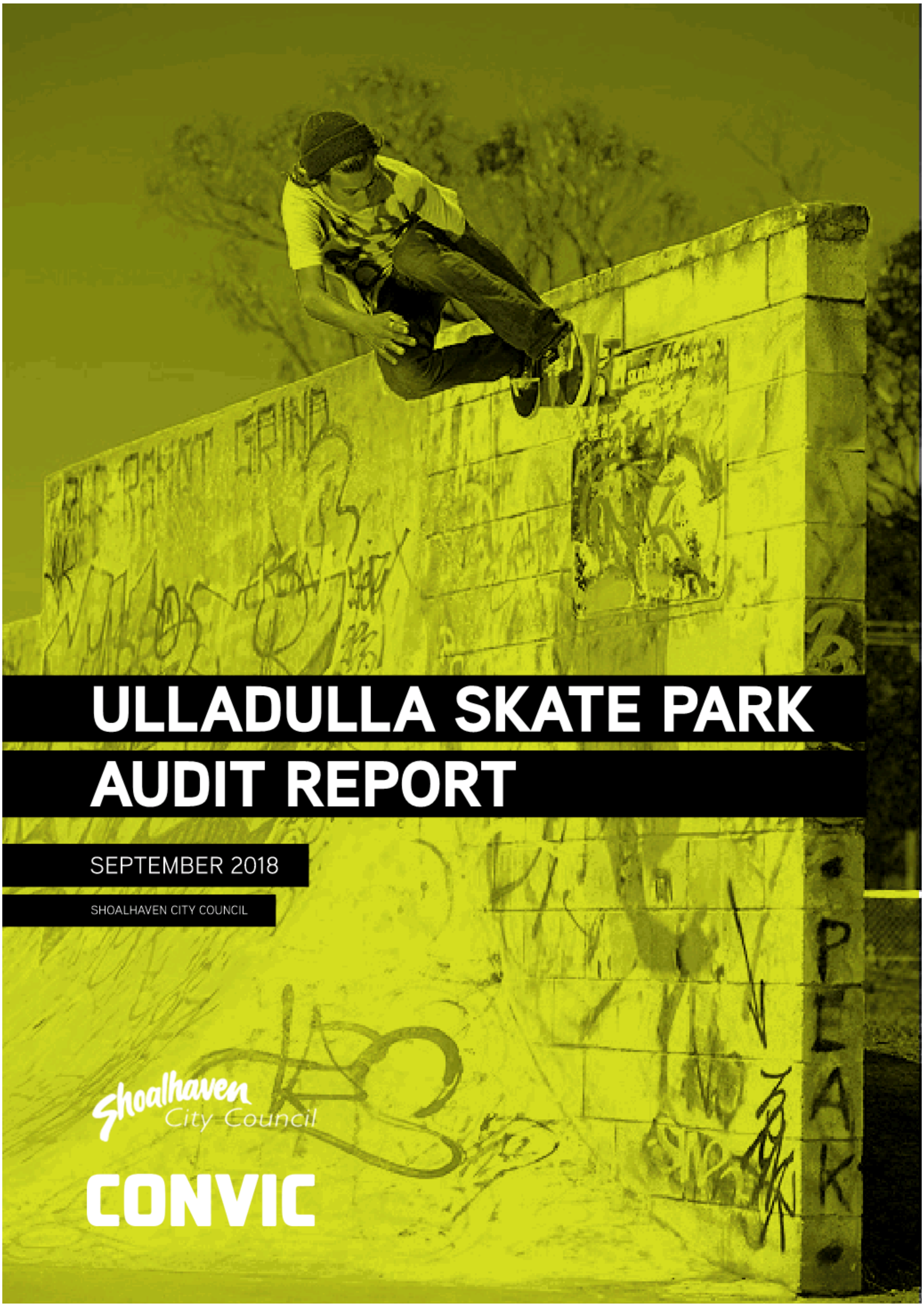
Strategy and Assets Committee

Meeting Date: Tuesday, 16 October, 2018
Location: Council Chambers, City Administrative Centre, Bridge Road, Nowra

Attachments (Under Separate Cover)

Index



SA18.238 - Attachment 1

QUALITY INFORMATION

DOCUMENT: ULLADULLA SKATE PARK AUDIT REPORT

REF: 18042

PREPARED BY: ALEX BOYD

REVIEWED: JASON GERALIS

REVISION HISTORY

REVISION	REVISION DATE	DETAILS	AUTHORISED	
			NAME / POSITION	SIGNATURE
A	23/08/18	DRAFT ISSUE	JASON GERALIS/ DESIGN MANAGER	[signature]
B	07/09/18	FINAL ISSUE	JASON GERALIS/ DESIGN MANAGER	[signature]

PREPARED BY

CONVIC

FOR

Shoalhaven City Council

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01 INTRODUCTION

OVERVIEW

In August, 2018, CONVIC undertook an assessment of the Ulladulla skate facility for the Shoalhaven City Council. The assessed facility referred to in this report is Ulladulla's district level facility located at Ulladulla Sports Park on Camden St, Ulladulla.

This report provides a condition and function assessment of the existing Ulladulla skate park facility. It details and documents the review process for the existing facility and its landscape context, setting and amenities. It serves to inform decisions with regards to the Shoalhaven City Council's future development and ongoing maintenance.

The purpose of this report is to consider the quality of the assets at the facility and make recommendations in regards to rectification and redevelopment works.

This report can be used as a precursor to the development of an operational and budgeting plan for the Shoalhaven City Council to secure funds for maintenance, repairs, and redevelopments. At a broader level, this report will address the immediate and future demand for ongoing regular maintenance and associated budgeting.

EXECUTIVE SUMMARY

The Ulladulla facility is the lone skatepark in the greater Ulladulla area, with the closest other skateparks being Manyana and Durras.

While current usage statistics are unknown, it is understood that the facility remains popular, and is regularly utilised by both the local and broader community of Ulladulla, while also attracting users from further afar. There are a number of iconic elements that have featured in several well known skate films, though none more so than the large vert wall at the southern end of the facility.

The facility caters to intermediate and advanced users of all disciplines of wheeled sports, however there is no provision for beginner level users. The flow lines around the facility are restrictive, and as such the capacity for users is limited.

The facility is fenced in and set back from the carpark, obstructing natural and passive views into the area while giving the facility a "back of house" feel. Access to the facility is limited due to the fencing, particularly the staggered fence treatment at the path entrance. There are limited amenities in the facility, with two bins and a drinking fountain. There is limited shade provision, and little to no seating.

Due to weathering, antiquated building techniques, general wear and insufficient maintenance, the quality of the facility has deteriorated, resulting in a number of safety issues. A number of these issues have been previously repaired to an unacceptable standard, however urgent and major repairs are required across the facility. There are a number of high risk safety items that need to be addressed immediately to alleviate any risk of harm to users.

The presence of concrete cancer was raised as a concern, however on inspection there were no obvious signs of concrete cancer.

The facility contains some obstacles and features that cater to modern skate styles. There are however some elements which are now out dated and do not adequately provide riders with rudimentary skill progression.

SA18.238 - Attachment 1

ULLADULLA SKATE PARK AUDIT REPORT

01 INTRODUCTION

LOCATION

The Ulladulla Skate Park is a district sized facility, located adjacent to the Ulladulla Sports Complex in Ulladulla, New South Wales. The facility is located at the end of Camden St, in a 'back of house' setting away from the carpark.

HISTORY

Recent research indicates that youth participation in action wheeled sports activities such as skate boarding, roller blading, BMX and scootering now out numbers participation in traditional sport, with more than 21% of Australian youth estimated to engage in these activities. With skate boarding now being included in the 2020 Olympic Games, it is expected there will be a significant rise in the interest of skating, as well as other action wheeled sports.

This information highlights the importance of providing functional facility for youth, as well as the importance of maintenance and upkeep to ensure it is used to its maximum capability and potential, and is safe for all users.

CONTEXT PLAN

02 ASSESSMENT CRITERIA

OVERVIEW

The facility has been assessed and rated based on the two key criteria of; CONDITION and FUNCTION. Both of these identified criteria assess the usability and quality of a facility. These criteria are co-dependent and as such make up a 50/50 split with respect to the final assessment evaluation and score.

A facility's function and condition are intrinsically related. If the facility's condition is poor this inherently impacts on function. Alternatively, a facility can be in excellent condition, however, the overall layout and design may be poor or outdated and may not actually meet the needs of users.

FACILITY RANKING SYSTEM

The facility is rated to describe its current CONDITION and FUNCTION in accordance with the following ranking system;

CONDITION

RATING 1 - EXCELLENT (SCORE 5/5)
An asset in excellent overall condition with no visible signs of deterioration. (approximately 100% of life remaining)

RATING 2 - GOOD (SCORE 4/5)
An asset in good overall condition but with some early stages of deterioration evident, but the deterioration is still minor in nature and causing no serviceability problems. (approximately 75% of life remaining)

RATING 3 - FAIR (SCORE 3/5)
An asset in fair overall condition where deterioration would be obvious and there would be some serviceability loss. (approximately 50% of life remaining)

RATING 4 - POOR (SCORE 2/5)
An asset in poor condition with severe serviceability problems and needing rehabilitation immediately. There is a risk to the community if the facility is to remain un-repaired and in service. (approximately 25% of life remaining)

RATING 5 - FAILED (SCORE 1/5)
An asset that has failed, is no longer serviceable and should not remain in service. There is an extreme risk in leaving the asset in service. (0% life remaining)

FUNCTION

RATING 1 - EXCELLENT (SCORE 5/5)
Design and layout suitable for intended use, with adequate on-site amenities.

RATING 2 - GOOD (SCORE 4/5)
Majority of design and layout suitable, however minor improvements necessary. Moderate on-site amenities.

RATING 3 - FAIR (SCORE 3/5)
Some design and layout suitable, however considerable improvements necessary. Minimal on-site amenities.

RATING 4 - POOR (SCORE 2/5)
Extensive design and layout flaws with major improvements necessary. Minimal on-site amenities.

RATING 5 - FAILED (SCORE 1/5)
No function. No on-site amenities

CONDITION ASSESSMENT CRITERIA

The Condition Assessment determines the current state of a facility. This does not consider the design of the facility, only its physical condition.

The condition assessment criteria of the skate facility has been broken down into two categories:

FEATURES AND OBSTACLES
This includes:

- Coping and rail connections and installation.
- Steel including damage, rust and corrosion.
- Skateable surfaces including chips, cracks, and concrete surface quality.
- Sharp or extruding edges.
- Concrete joints, saw cuts, and connections
- Drainage and pooling issues,
- Graffiti and vandalism to surfaces,

LANDSCAPE
This includes surrounding landscape condition:

- Deteriorating vegetation or leaf litter / seed pods dropping on skateable surface.
- Drainage and pooling issues.
- Amenity condition: seats, rubbish bins and shelter etc.
- Litter and debris, graffiti and vandalism.
- Soil erosion and spillage.

FUNCTION ASSESSMENT CRITERIA

The Function Assessment determines how the facility is used by participants and observers.

The function assessment criteria of the skate facility has been broken down into three categories:

SKATE FUNCTION
This includes:

- Flow and general layout
- Distance between features
- Features and obstacles

OVERALL DESIGN & LAYOUT
This includes:

- Provision for skill levels.
- Style of facility (street, transition, combination).
- Acceptable waiting areas.
- Variety.
- Comparison with current skate trends.
- Fall heights and safety standards.

LANDSCAPE & AMENITY
This includes:

- Access, footpaths, car parking etc.
- Surveillance.
- Amenities e.g.. bins, shade, drinking fountains, toilets.
- Lighting
- Recreational provision
- Local youth context, theming and vibrancy.

CONDITION ASSESSMENT ITEMS LEGEND

MINOR CRACKING
Concrete surface cracks that require crack injection.

MAJOR CRACKING
Concrete surface cracks that require chasing and filling.

SURFACE CHIPPING
Concrete surface chips that require chasing and filling.

DIFFERENTIAL SETTLEMENT
Concrete slabs have shifted vertically resulting in edges.

STRUCTURAL DISPLACEMENT
Groundwater forces have displaced structural elements.

CONCRETE TO COPING JOIN (CHS)
Deterioration of concrete around CHS coping.

COPING TOLERANCE
Coping to concrete offsets incorrect on platform and transition face

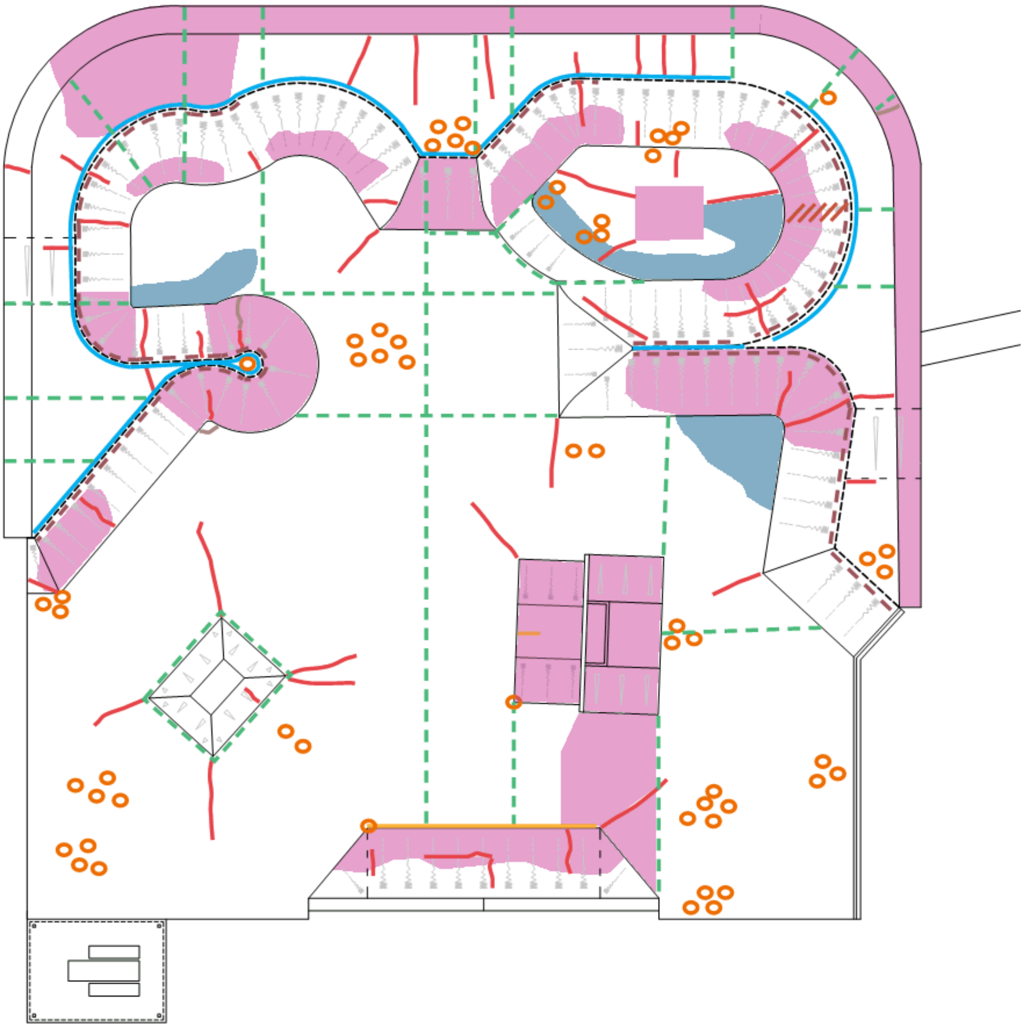
HAZARDOUS CONCRETE JOINT
Deterioration of concrete joints.

ROUGH SKATE SURFACE AREA
Concrete surface has deteriorated from use or weathering over time.

WATER LEAKING / PONDING
Evidence of water ponding on skate surface.

CONDITION ASSESSMENT REFERENCE PLAN

NTS



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03 ASSESSMENT

CONDITION ASSESSMENT - MINOR CRACKING

MINOR CRACKING:

The concrete slabs are showing signs of minor cracking in a number of locations across the facility. This cracking could be due to earth movement, incorrect construction techniques employed during the initial build, or general deterioration due to the age of the concrete.

While currently minor, if left unaddressed the cracking has the potential to develop further, resulting in major cracking, or leading to an uneven skate surface that is prone to chipping.

RISK RATING: LOW

CONDITION ASSESSMENT - MAJOR CRACKING

MAJOR CRACKING:
There are some incidence of major cracking in a number of locations across the facility. Major cracks present a hazard on the skate area where the smaller wheels of scooters and skateboards can become lodged in the cracks while the user is travelling at speed, consequently throwing the rider off their vehicle. Unexpectedly being thrown while travelling at speed has the potential to result in serious harm to the user.

RISK RATING: HIGH

CONDITION ASSESSMENT - SURFACE CHIPPING

SURFACE CHIPPING:
The concrete slabs have a number of areas suffering from surface chipping. Chipping is the result of wear and tear from general use, and is common in parks of this age. Surface chipping presents a hazard on the skate area where the smaller wheels of scooters and skateboards can become lodged while the user is travelling at speed, consequently throwing the rider off their vehicle. Unexpectedly being thrown while travelling at speed has the potential to result in serious harm to the user.

RISK RATING: HIGH

CONDITION ASSESSMENT - DIFFERENTIAL SETTLEMENT

DIFFERENTIAL SETTLEMENT:
Differential settlement occurs where a slab has shifted either horizontally or vertically, independent of the adjacent slabs. This results in an edge at the abutment of the two slabs, and presents an opportunity for scooter or skateboard wheels to catch on the edge. Differential settlement in this case has occurred at the base of the vert wall, and in the transition of the deep bowl. These locations are where users are travelling at speed, and as such the potential for harm to users is high.

RISK RATING: HIGH

CONDITION ASSESSMENT - STRUCTURAL DISPLACEMENT

STRUCTURAL DISPLACEMENT:

Evidence of groundwater forces is prominent in the large bowl. Water stains emanating from the joint between transition toe and base suggests that significant ground water flows are present in the area up hill of the facility. It is assumed that the ground water is causing swelling of the surrounding ground, which in turn is displacing the transition slabs in the bowl. Surface water on the skate area, coupled with displaced structural elements presents a major risk item to users. Investigations into the origins of the groundwater should be undertaken, with rectification works addressed immediately.

RISK RATING: HIGH

CONDITION ASSESSMENT - CONCRETE TO COPING JOIN (CHS)

CONCRETE TO COPING JOIN (CHS):

The transition and platform concrete adjacent to the circular coping on the bowls and quarter pipes is severely deteriorated. In the deep end of the bowl the coping is rusted through, exposing sharp edges. The coping is necessary in these locations for users to perform tricks on, often at speed, and due to the depth of the features, at height. The deterioration of the concrete and coping in these areas presents the opportunity for scooters, skateboards, and BMX pegs to become lodged in the rough concrete, consequently throwing a rider off their vehicle. The condition of the coping in the bowl is a high risk item, and should be addressed immediately.

RISK RATING: HIGH

CONDITION ASSESSMENT - COPING TOLERANCE

COPING TOLERANCE:

The coping offsets around the facility are not in line with modern practices. Typically, coping should sit 10mm above ramp platforms, and sit proud 8mm off ramp transition faces. These standard offsets dimensions are set to encourage coping tricks, and to allow smooth use of the transition ramps. Across most of the facility, the coping sits flush with the platform level, while transition offsets vary from 10mm to approximately 25mm. This inconsistency across the facility doesn't promote user confidence in the terrain of the features.

RISK RATING: HIGH

CONDITION ASSESSMENT - HAZARDOUS CONCRETE JOINT






HAZARDOUS CONCRETE JOINT:

Expansion joints across the facility have enlarged over time, and grown to as wide as 20mm in some instances. Furthermore, due to repetitive impact action from skateboard wheels, the edges of these joints are showing signs of deterioration and chipping. Wide joints present a hazard on the skate area where the smaller wheels of scooters and skateboards can become lodged while the user is travelling at speed, consequently throwing the rider off their vehicle. Unexpectedly being thrown while travelling at speed has the potential to result in serious harm to the user.

RISK RATING: HIGH

CONDITION ASSESSMENT - ROUGH SKATE SURFACE AREA






ROUGH SKATE SURFACE AREA:

In a number of locations, the skate slab has become weathered and worn, exposing the aggregate in the concrete. Furthermore, there are locations where repairs and patches to the slab have been undertaken, which are in turn degrading. It is imperative that skate surfaces are smooth, as rough areas result in a bumpy and jarring sensation when ridden over, while also presenting an abrasive surface that can cause harm when a user comes into contact. This is a high priority item and should be addressed immediately

RISK RATING: HIGH

CONDITION ASSESSMENT - WATER LEAKING / PONDING

WATER PONDING:

Despite the weather on the day of inspection being warm and sunny, there is evidence of water ponding on the skate surface. There is water staining present on the southern side of the spine ramp. Local users informed that water remains present in that location for long periods of time after rain events, suggesting that the slab in that area of the facility is not properly graded to deal with wet weather events. Wet skate surfaces are a hazard due to users slipping out at high speeds. The causes for the water seepage and ponding should be investigated and addressed immediately.

RISK RATING: HIGH

FUNCTION ASSESSMENT

OUTDATED FUN BOX DESIGN

The fun box located near the vert wall is out dated and not designed to modern skate practices. The small ledge is set too low, and doesn't extend into the flat bank transition. The rail is too low and is only able to be accessed from one side, and is essentially unusable due to being positioned adjacent to other features. Minor repairs on the rail and ledge have left exposed sharp metal edges, which will cause serious harm if a user is to come into contact with them.

SHADE, SEATING AND REFUGE

There is a small shelter at the southern edge of the park which provides minimal shade and seating. Other than this shelter, there is little to no shade or seating available to users, It is important to provide users with adequate seating options, as well as ample shade to escape the sun. At the time of inspection the shelter was not casting shade onto the seating below.

FENCING AND LIMITED ACCESS

The facility is surrounded by fencing, with access limited by a staggered fence treatment. Furthermore, the facility is set back from the fence and car park. This gives the facility an "exclusive" and "back of house" feel, and doesn't encourage passive users to enter.

LIMITED OPPORTUNITY FOR BEGINNERS

The facility caters to both intermediate and advanced users, with little to no opportunity for beginners. This does not allow for new users to the to practice or increase skill levels, and encourages less skilled users to use the more advanced areas of the facility. This can lead to collisions with more advanced users.

SITE EROSION

Erosion is present around the perimeter of the facility, with some evidence of previous repairs. The underside of the concrete slab is exposed, with the surrounding area being predominantly exposed dirt. This encourages dust and dirt to be introduced to the skate area, which in turn creates a slippery concrete surface. Larger dirt and stone particles also present the risk of becoming jammed under rider's wheels.

REDUNDANT LEDGE

There is a ledge with coping edge running adjacent to the quarter pipe on the eastern side of the facility. There is no run up for this feature for it to be used as a ledge, and its presence next to the quarter pipe presents a distraction to users using said quarter pipe. The coping on the ledge is rusted, misshapen, and exposed, and presents a risk to users using this feature.

DEBRIS ON SKATE SURFACE

Debris is spilling on to the skate surface from the adjacent landscaped area. Dirt, sticks, and small rocks present a risk to users where wheels can become jammed on the debris while at high speed. Regular maintenance on the facility should include sweeping and cleaning all skate surfaces.

USER MODIFICATIONS

BMX users have created a fly out / step up jump out of the bowl. This indicates that there are insufficient features for BMX users to ride in the park. Furthermore, the dirt used to create the step up is spilling on to the skate surface, creating a rough riding surface for skateboard and scooter riders. A more permanent feature should be included for BMX riders, as well as regular maintenance undertaken to clean all skate surfaces.

KEY CONDITION FINDINGS

In summary, the key condition findings are:

FEATURES AND OBSTACLES

- There is evidence of ground water seeping through the bowl which is displacing the transition slabs.
- The concrete surface is worn in most areas of the facility, with substantial cracking, chipping and differential settlement.
- Concrete to coping deterioration is apparent throughout the entire skate park.
- Coping in the bowl is rusted through, while the coping tolerance across the facility is not to standard practices.
- Expansion joints have widened to a width that is not acceptable for skate surfaces.
- Concrete cancer was not deemed to be present at the facility.

LANDSCAPE

- There is erosion present around the perimeter of the facility.
- The south eastern section of the facility appears to be graded incorrectly, and as such does not drain storm water sufficiently.

KEY FUNCTION FINDINGS

In summary, the key function findings are:

SKATE FUNCTION

- Most of the facility functions adequately, however there are some areas particularly within the street area that are out dated.

OVERALL DESIGN & LAYOUT

- There is little to no allowance for beginners.
- There are limited flow lines around the facility, directly affecting the potential user capacity. Users tend to travel along two main flow lines, disregarding the majority of the park.
- There are limited refuge areas for users.

LANDSCAPE & AMENITY

- The facility has on site car parking.
- The facility is fenced in, with a back of house feel.
- There is no DDA access to the facility.
- There is no toilet facility,
- The facility has two bins, a drinking fountain and a small shelter.
- The facility has limited seating.
- There is no safety signage upon entry to the facility.

OVERVIEW OF KEY FINDINGS

Based on the key condition and function findings, the ratings in accordance with the Facility Ranking System are as follows:

CONDITION

The facility has been given a condition rating of:

RATING 4 - POOR (SCORE 2/5)

Assuming condition repair works are undertaken, including regular and scheduled maintenance, we estimate the facility has approximately 25% of life remaining (approximately 5 years).

FUNCTION

The facility has been given a function rating of:

RATING 4 - POOR (SCORE 2/5)

OVERALL

The key findings of the skate facility assessment has identified the facility has achieved a 'POOR' rating for condition and a 'GOOD' rating for function, and as such is not achieving its full potential.

The facility has been given an overall rating of:

RATING 4/10 - POOR.

Several items need to be addressed to bring the facility up to an 'EXCELLENT' rating. Reassessment of the design to improve both the function and condition of the facility will be required to achieve this. The following 'FUTURE DIRECTION' section of this report provides different options on how to achieve the best possible rating.

FUTURE DIRECTION

The following options have been prepared with respect to repair and redevelopment works.

These options aim to improve the safety, condition and function of the facility to varying levels.

To allow flexibility with the facility's development the options have been provided to work with varying budgets and time frames, to suit availability of funding and council objectives.

All approaches should consider a level of community engagement to ensure community acceptance.

The facility's condition will require ongoing observation, appraisal and maintenance to provide a high level of condition and function and to ensure the lifetime of the facility is maximised.

OPTION 1

REPAIRS OF CONDITION FINDINGS ONLY

This option addresses the rectification of condition items only. The refurbishment can be carried out at different levels depending on the desired lifespan that is required of the facility.

This option is a short term solution to fix high priority safety hazards, as well as groundwater issues. These works, in conjunction with regular maintenance, are deemed as the minimum required works to ensure the facility can fulfil its remaining life. This option does not address functional issues, however will extend the life span of the facility for a further 2 - 4 years.

ORDER OF PROBABLE COSTS

The order of probable costs to undertake the repair of condition items is as follows:

$300,000 - $400,000

Total cost is exclusive of GST.

ORDER OF WORKS

ULLADULLA SKATE FACILITY

Date of inspection: 13/08/18 | **Condition Rating:** 4 - POOR | **Name of Inspector:** Alex Boyd

Site Address: Camden St, Ulladulla, NSW, 2539 | **Reserve Name:** Ulladulla Sports Park

ITEM DESCRIPTION	CAUSE OF DEFECT	PRIORITY OF WORKS	REQUIRED ACTION	RECOMMENDED MONITORING REQUIREMENTS	RECOMMENDED ACTION TIME FRAME
HIGH PRIORITY ITEMS					
STRUCTURAL DISPLACEMENT	HAZARD DETERIORATION AGE	HIGH	DEMOLISH BASE OF BOWL AND AFFECTED TRANSITION SLABS. INSTALL SUB SURFACE DRAINAGE IN TRANSITION SURFACE AND IN BASE OF BOWL, TO DRAIN BACK TO EXISTING BOWL DRAIN. REINSTATE BOWL AND TRANSITION SLABS.	6 MONTHLY	1 -2 MONTHS
MAJOR CRACKS	HAZARD DETERIORATION AGE	HIGH	CHASE OUT CRACK, CLEAN RECESS, FILL WITH MULTI-PURPOSE EPOXY ADHESIVE REPAIR PASTE, AND SAND BACK SMOOTH TO EXISTING SURFACE LEVELS.	6 MONTHLY	1 -2 MONTHS
SURFACE CHIPPING	HAZARD DETERIORATION AGE	HIGH	GRIND BACK CHIPPED EDGE, CLEAN OF ALL DEBRIS AND DUST, FILL WITH MULTI PURPOSE ADHESIVE REPAIR PASTE, AND SAND BACK SMOOTH TO EXISTING SURFACE LEVELS.	6 MONTHLY	1 -2 MONTHS
DIFFERENTIAL SETTLEMENT	HAZARD	HIGH	GRIND BACK CONCRETE SURFACE OF HIGHER SIDE OF SLAB TO SMOOTH AND TAPERED FINISH, ALLOWING SURFACE TO SMOOTHLY GRADE BETWEEN LEVELS.	6 MONTHS	IMMEDIATELY
CONCRETE TO COPING JOIN (CHS)	HAZARD DETERIORATION AGE	HIGH	SAW CUT AND CHIP AWAY CRACKS, REINSTATE SURFACE PROFILE WITH REINSTATEMENT MORTAR, STRIKE OFF LEVEL WITH SURROUNDING CONCRETE SURFACE, STEEL TROWEL FINISH. REPLACE COPING IN LOCATIONS WHERE RUSTED AND DETERIORATED.	6 MONTHLY	IMMEDIATELY
COPING TOLERANCE	INCORRECT CONSTRUCTION	HIGH	SAW CUT AND DEMOLISH PLATFORM AND TRANSITION SLAB 200mm EITHER SIDE OF COPING. INSTALL NEW ROLLED COPING TO ACCEPTABLE TOLERANCES AND TIE INTO EXISTING SLABS. POUR NEW CONCRETE TO COPING, ENSURING TRANSITION RADII AND STANDARD ACCEPTABLE OFFSETS ARE MAINTAINED.	6 MONTHLY	1 -2 MONTHS
HAZARDOUS CONCRETE JOINT	HAZARD DETERIORATION AGE	HIGH	CHASE OUT JOINT, CLEAN RECESS, FILL WITH MULTI-PURPOSE EPOXY ADHESIVE REPAIR PASTE, AND SAND BACK SMOOTH TO EXISTING SURFACE LEVELS.	6 MONTHLY	IMMEDIATELY
ROUGH SKATE SURFACE AREA	HAZARD DETERIORATION AGE	HIGH	GRIND BACK CONCRETE SLABS TO REMOVE ROUGH SURFACE, ENSURE GRINDED AREAS ARE FEATHERED EVENLY TO MEET SURROUNDING SURFACE LEVELS TO ENSURE NO KINKS OR BUMPS IN RIDING SURFACE.	6 MONTHLY	1 - 2 MONTHS
WATER PONDING	HAZARD DETERIORATION AGE	HIGH	DEMOLISH BASE SLAB. RENSTATE BASE SLAB WITH CORRECT GRADE TO DRAIN OFF SKATE SURFACE.	6 MONTHLY	1 - 2 MONTHS
LOW PRIORITY ITEMS					
MINOR CRACKING	DETERIORATION AGE	LOW	SPECIALIST CRACK INJECTION REPAIRS.	6 MONTHLY	6 MONTHS

OPTION 2 (RECOMMENDED)

CONSTRUCTION OF A NEW DISTRICT LEVEL FACILITY

This option involves the demolition of the existing facility, addressing any existing groundwater issues, and the construction of a modern, district level youth precinct. The new facility would be comparable to the existing facility in capacity and function.

The new facility would introduce modern style skate features to the skate park, while also catering to various user skill levels. There is potential to incorporate existing iconic features such as the vert wall into the new design.

Landscape conditions would be considered, such as introducing sports lighting, additional seating, shade shelters, improved pedestrian access, and repositioning the skate park closer to the car park to open up the area.

Different levels of these works are possible and are to be explored when a defined budget is in place. The works should focus on providing for a wider range of user types and skill levels. New layout and design options should be developed further with community and client engagement.

This option is a cost effective solution that addresses all condition and function items outlined in this report, and will provide the Shoalhaven City Council with a district level facility, and will extend the life span of the facility for a further 15-20 years.

ORDER OF PROBABLE COSTS

The order of probable costs to undertake the repair of condition and installation of functional items is as follows:

DESIGN:
GEOTECHNICAL ASSESSMENT, SITE SURVEY, DESIGN, AND ENGINEERING:
$35,000 - $50,000

CONSTRUCTION:
DEMOLITION OF EXISTING PARK:
$40,000 - $60,000

CONSTRUCTION OF NEW FACILITY:
$500,000 - $700,000

PROVISIONAL ITEMS:
SPORTS LIGHTING:
$80,000 - $120,000

$655,000 - $930,000

Total cost is exclusive of GST.

OPTION 3

CONSTRUCTION OF A NEW REGIONAL LEVEL FACILITY

This option involves the demolition of the existing facility, addressing any existing groundwater issues, and the construction of a larger, regional level youth precinct.

The new facility would introduce modern style skate features to the skate park, while also catering to various user skill levels. Additional youth activation and recreation such as parkour, half court basketball, ping pong tables, and BBQ and picnic areas could also be considered.

Landscape conditions, such as introducing sports lighting, additional seating, shade shelters, improved pedestrian access, and repositioning the skate park closer to the car park to open up the area would also aid in raising the status of the precinct.

Different levels of these works are possible and are to be explored when a defined budget is in place. The works should focus on providing for a wider range of user types and skill levels. New layout and design options should be developed further with community and client engagement.

This option will provide the Shoalhaven City Council with a district level facility, and will extend the life span of the facility for a further 15-20 years.

ORDER OF PROBABLE COSTS

The order of probable costs to undertake the repair of condition and installation of functional items is as follows:

DESIGN:
GEOTECHNICAL ASSESSMENT, SITE SURVEY, DESIGN, AND ENGINEERING:
$50,000 - $70,000

CONSTRUCTION:
DEMOLITION OF EXISTING PARK:
$40,000 - $60,000

CONSTRUCTION OF NEW FACILITY:
$800,000 - $1,200,000

PROVISIONAL ITEMS:
SPORTS LIGHTING:
$100,000 - $150,000

$990,000 - $1,480,000

Total cost is exclusive of GST.

04 SUMMARY

ONGOING ACTIONS

Once a skate facility is in place, it is key to understand the ongoing upkeep required to maintain these spaces to a level of safe and functional condition.

All facilities require ongoing maintenance to upkeep them and have them functioning safely. With this in mind, it is estimated that facilities designed and constructed to best practice principles, meeting the required tolerances and specifications of current industry standards, will have a functional life of approximately 20 years before major repairs, renovation or renewal is needed.

The following provides an insight into the level of ongoing maintenance required.

0-10 YEARS

Maintenance should be regular and of a minor nature.

10-15 YEARS

Maintenance will increase in frequency and scale.

15-20 YEARS

Maintenance will require a high level of care.

Over time, the facility will be exposed to user wear and tear, environmental impacts and natural weathering. These factors impact the concrete, steel, timber, surface treatments, painting and other components that form a facility.

It may be difficult to rate older facilities in this way as they may not have been designed and constructed to the appropriate quality.

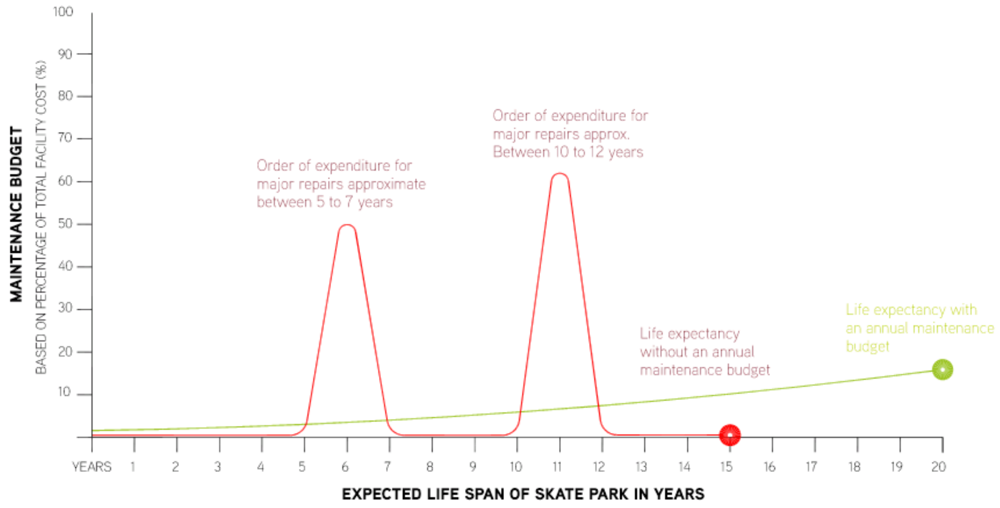
Maintenance of these facilities is also extremely important for the function to remain relevant and safe, and to prolong the life of the facility. The Royal Society for the Prevention of Accidents suggests that annual maintenance budgets for action wheeled sports facilities should be 10% of facility value/build cost.

The development of a maintenance manual specific to the facility, including a maintenance schedule is key and will provide clear directions and objectives for the upkeep of each of the facilities.

Facilities need to be effectively maintained and developed in order to cater for these newly emerging skate styles, allow for progressive challenge and for skill development of users within the facility.

MAINTENANCE SCHEDULING

For the longevity of a facility and its upkeep, regular ongoing maintenance should be budgeted for and undertaken. The table below demonstrates the cost expense of not regularly maintaining a facility and the impact on life-span.



05 APPENDICES

STANDARDS + GUIDELINES

At present, there are no Australian Standards or formal industry standards that exist for skate and BMX facility design, construction, maintenance and management. There are several guidelines developed by various organisations on the design and construction of action wheeled sports facilities. These guidelines are useful for providing general knowledge about these facilities, but they are not regulatory or absolute.

The Skate Facility Guide (2001) by Sport and Recreation Victoria states; "....this Skate Facility Guide is intended as a general reference source....".

CONVIC, through industry and professional experience, judgement and expertise in facility design and construction, ensure appropriate standards and guidelines are used to minimise risk and increase safety within facilities.

Specific to the sport of skating; some elements do not conform to Australian standards for access and fall heights. The Australian Standards are referred to where a risk is identified at the interface between skate elements and pedestrian/viewing areas. This may be within or at the periphery of the facility.

For example, a 1000mm high drop could be designed as a feature of a facility that skaters would perform tricks over. This is acceptable, given the context. However, if the platform of a quarter pipe is 1000mm high and has an uninterrupted fall to the ground; the handrail and balustrade requirements of the Building Code may still apply and be adopted,

Standards and Guidelines that have been referred to in compiling this document include:

- Sport and Recreation Victoria - "The Skate Facility Guide"
- Sport and Recreation Victoria - "Sport and Recreation - Access for All"
- Building Code of Australia 2008
- AS 4685.1 - 2004: Playground Equipment - General Safety Requirements and Test Methods
- AS 4486.1 - 1997: Playgrounds and Playground Equipment - Development, Installation, Inspection, Maintenance and Operation
- Department for Community development - "Urban Design Guidelines for Creating Youth Friendly Spaces"
- Design Standards for Urban Infrastructure Part 15: Playgrounds and Playground Equipment
- The Royal Society for the Prevention of Accidents - Play Safety Information Sheet No: 27 - Skateboarding Safety and Play Safety: Skateboarding: Skate park Maintenance Costs
- British Standard BS EN 14974:2006 - Facilities for Users of Roller Sports Equipment - Safety Requirements and Test Methods

A facility assessment is an important step in reducing risk, however, risk management as per AS 4360 - 2004: "Risk Management" and HB 246 - 2004: "Guidelines for Managing Risk in Sport and Recreation" is beyond the scope of this document. All Australian standards and guidelines should be reviewed in addition to this document by a suitable qualified Risk Manager for Council.

The scope of this document does not include an assessment of the facility's compliance with the Disability Discrimination Act.

TERMINOLOGY

A brief explanation of terms used in this document:

FACILITY - Relates to a space that caters to action wheeled sports activities including skateboard, BMX, scooter, in-line skate, roller skates and sports modified wheelchairs.

TRICKS - A specific action or move utilising the element of use that relates to a set performance in the flow of movement on the features or components of the facility.

GRIND - A trick performed by a rider where they are to slide along a section of coping or concrete ledge without the use of their wheels.

HAZARD - Any item posing an immediate risk to the safety of participants.

ACTIVE USER - Someone who is actually riding the facility on a skateboard/BMX/scooter or similar.

INACTIVE USER - Someone who is part of the session, but is waiting for their turn when the active user is finished.

OBSERVER - Someone who is watching the activity on the facility.

PARTICIPANT - Someone who may be an active user, an inactive user or observer at the facility.

DISCLAIMER

CONVIC, it's employees, agents, directors and other entities shall not be liable for any loss, damage, claim or costs that may arise from any damage or injury of any kind whatsoever in relation to this document or the maintenance and use of skate and BMX facilities generally.

While all due care and consideration has been undertaken in the preparation of this document, CONVIC do advise that all recommendations, actions and information provided in this document is based upon our experience in the field of skate and BMX facility design and construction.

CONVIC and its employees are not qualified to provide legal, medical, financial or risk management advice. Suitably qualified experts in these fields should be consulted to provide further information.

All cost estimates are provided as a guide only. Confirmation of approach is to be established through consultation with Council and the community.

The estimates are based on currently available industry prices. Facility construction is a specialised trade and CONVIC have based costs on recently tendered projects. This is an estimate of probable costs only, all components of which are subject to design complexity, escalation in construction, labour and material costs.

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Memo

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MARITIME & AVIATION.

To	:	Christopher Morley & Paul Rintoule, Origin Capital
From	:	Patrick Lawless, RHDHV
Date	:	25 June 2018
Copy	:	Gary Blumberg, RHDHV
Our reference	:	PA1731_Mollymook_StudyApproach_v6
Subject	**:**	**SOUTH MOLLYMOOK BEACH COST BENEFIT AND DISTRIBUTIONAL ANALYSIS COASTAL HAZARD ASSESSMENT PROPOSOSED STUDY APPROACH**

1. Overview

Shoalhaven City Council (Council) has developed a draft Coastal Zone Management Plan (CZMP) to guide the management of its sandy beaches and rocky cliffs. This investigation is underpinned by coastal hazard assessments carried out over the past decade.

Coastal hazards threaten public and private assets at Mollymook Beach. The draft CZMP lists a number of actions to reduce the risk of coastal hazard at Mollymook Beach including review of revetment installations at South Mollymook. Royal HaskoningDHV (RHDHV) investigated foreshore stabilisation and developed a staged upgrade to the existing walls. Concept designs were prepared for four seawall types covering 300m of foreshore (RHDHV, 2016).

To progress the design development of any prospective foreshore stabilisation works, a number of activities were recommended for consideration including a formal Cost Benefit Analysis (CBA) covering a range of options including protection. Including the base case of 'do nothing', four long-term options have been identified to manage coastal hazards at South Mollymook Beach:

Option 1	Base case/ status quo (Do nothing/ Emergency Response)
Option 2	Managed retreat
Option 3	Protection
Option 4	Protection and beach nourishment

In 2017, Origin was engaged by Council to carry out the CBA and a distributional analysis (partitioning of benefits to affected property and asset owners) for the above options.

Royal HaskoningDHV (RHDHV) were retained by Origin to carry out a risk-based coastal hazard assessment for South Mollymook Beach to inform the CBA and distributional analysis, in accordance with the requirements of the *NSW Coastal Management Manual Part C: Coastal Management Toolkit, Using Cost Benefit Analysis to Assess Coastal Management Options: a Guide for Local Councils* (OEH, 2015). This memo outlines the proposed approach for the coastal hazard assessment, for consideration and acceptance by Council and the study team.

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2. CBA Scenarios

The following section summarises the study team's understanding of each scenario to be considered in the CBA.

2.1 Option 1 - Base Case/ Status Quo

The base case is "business as usual". At South Mollymook Beach this would involve retention of the existing poor seawall structures and continued piece-meal maintenance as they become increasingly damaged in storms. The likelihood of complete seawall failures in severe storms would increase. Council would continue to scrape the lower beach and from time to time and place the sand on the upper beach covering the gabion seawall to increase its life and protect beach users from stab injury caused by broken and corroded gabion baskets. Overtopping of the seawalls in severe storms would become more problematic as the sea level rises. Council's existing "make safe-make good" strategy would continue involving signage and barricades to manage the public risk from eroded areas and continued repairs to "make safe make good".

Experience suggests that property owners would take matters into their own hands if government does not step in to manage the erosion problem. This would typically involve ad hoc dumping of rock or large debris (e.g. car bodies) to protect their land from coastal erosion. Non-engineered protection structures usually lead to additional erosion problems at neighbouring foreshore properties.

Eventually the existing seawalls at South Mollymook would fail completely (storm damage greater than 30%), with the clean-up effort expected to far exceed controlled demolition and removal at an earlier point in time.

2.2 Option 2 - Managed Retreat

Managed (or planned) retreat allows the shoreline to advance landward unimpeded, involving the deliberate breaching or removal of existing coastal protection structures. As the shore erodes, buildings and other infrastructure are either demolished or relocated inland with vacated areas rehabilitated for public use allowing for continued access to the shoreline and residual dune system, despite recession.

Managed retreat involves establishing buffers and thresholds to trigger demolition or relocation of structures as they become threatened by erosion.

While the policy emphasises retreat, a managed retreat approach may allow some basic erosion control measures using soft-stabilisation techniques to prolong the life of shorefront buildings and other infrastructure for a limited, defined period of time. However, hard stabilisation structures or repeated beach renourishment are generally not permitted.

In the UK, managed retreat is now more frequently being selected as the preferred engineering approach to addressing coastal management problems. However, its use generally in coastal engineering is unquestionably controversial. To avoid messy legal battles, managed retreat would be expected to include relocation assistance and/or buy-back programs to help with relocation costs or to compensate property owners when their property becomes unusable.

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2.3 Proposed approach to assess Options 1 and 2

The proposed approach to assess Options 1 and 2 in the CBA is summarised below. Further details are provided in **Section 5**.

- 30% damage for full failure of a coastal protection structure is recommended in the *Shore Protection Manual* (SPM) (CERC, 1984).
- Our understanding of the existing under-capacity of gabion wall, rock wall and concrete wall at South Mollymook based on reported extracts in **Attachment 1**, and available design drawings.
- RHDHV believes that it has enough information to characterise the combination of shoreline recession and storm erosion events that will result in full failure of these three structures – this would feed directly into the coastal hazard risk assessment.
- Under Option 1 and 2, for all events up to full failure we will assume that the walls will be restored to their present condition.
- Following full failure under Option 1, our assessment will assume that the protection structures are "made safe, made good" but not fully removed. Unsafe, loose or otherwise hazardous materials would be removed, but remnant materials/ part-structures would remain. This remnant would continue to provide some albeit depleted protection until such time the whole remnant is unsafe and needs to be removed.
- Following full failure under Option 2, our assessment will assume that the structures are fully removed immediately.

Regarding treatment of impacted property under Options 1 and 2, we propose as follows:

- Public assets and services are treated the same under Options 1 and 2. When damaged in storms they are repaired to their present condition. When damaged by coastal hazards to the extent that they are no longer viable as assessed by the relevant authority, they are relocated or removed.
- For private assets under Option 2, when the stability of a structure is compromised by erosion and considered unsafe from an engineering perspective (FOS<1.5[1]) or its use is not feasible due to loss of services, its consent lapses and it is "purchased" by the government. Three separate triggers would apply (consistent with *WA Draft Planned or Managed Retreat Guidelines*, August 2017):
  - Trigger 1 – Foundation of the asset affected by Zone of Reduced Foundation Capacity (ZRFC), or
  - Trigger 2 – Public road no longer available to provide legal access, or
  - Trigger 3 – Water, sewerage or electricity no longer available and have been removed by the relevant authority due to coastal hazards.
- For private assets under Option 1, the reality would be that a very similar process would apply compared to Option 2. For the purpose of our assessment we propose that it would be the same except that:
  - Trigger 1 would in effect occur later when the minimum buffer between the erosion escarpment and the structure is reduced (assume say FOS=1.2 applies[1]), and
  - The "purchase" arrangement under Option 2 is replaced by "compulsory acquisition" under Option 1. The more threatened property now is devalued in the market place and the property owner manages to retrieve from government only a proportion (say 50%) of the Option 2 purchase price , and
  - Council is embroiled in protracted legal battles with property owners at considerable expense to both parties.

[1] During typical everyday conditions encountered no less than 7 days following a severe storm.

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2.4 Option 3 - Protection

Previous investigations have developed a concept design for upgraded foreshore stabilisation at South Mollymook Beach (RHDHV, 2016). A four stage project to protect 295m of shoreline has been developed involving:

Stage	Chainage (m) from S end	Existing wall type	Proposed upgrade[3]
1	190 - 245	Sandstone block wall	Retain existing sandstone wall incorporating appropriate backfill works and repair stormwater outlet.
2	0 - 150	Gabion revetment	Removal of the southern-most 150m of the existing gabion seawall fronting the Golf Club and replace with a rock revetment, if feasible cover the new revetment with sand and vegetate.
3	150 - 190	Gabion revetment	Incorporate 40m stepped concrete or sandstone wall in front of the northern end of the Golf Club site, up to existing sandstone block wall, and include showers.
4	245 - 295	Concrete wall	Construct 50m stepped wall in front of existing concrete wall.

Because the existing seawalls would not protect the foreshore in a design storm, all four stages of the upgrade works contemplated in RHDHV (2016) would be designed and implemented concurrently as a single project under Option 3. The design life for the new works is 50 years.

Since the line of the foreshore is fixed by the upgraded seawalls, eventually the beach fronting the walls would be lost as the sea level rises and the coast recedes. While beach profile monitoring would take place under all options including Option 3, this protection option on its own does not include beach nourishment.

It is noted that the Concept Design Report (RHDHV, 2016) has not yet been adopted by Council and also that the proposed concept designs would likely be modified before any practical implementation. This will be acknowledged in the CBA, however the overall cost of design development or the protection scheme would not change significantly, i.e. the CBA outcomes would be valid regardless of any future design changes.

2.5 Option 4 – Protection and Amenity Nourishment

This option comprises the Protection option plus beach nourishment to deliver acceptable beach width for amenity purposes. The existing nominal accreted Mean High Water (MHW) beach width at South Mollymook is assessed to range between 20m and 50m, increasing from south to north (based on review of 10 air photos taken between 2004 and 2016). It is proposed to deliver amenity nourishment as part of this option with a minimum MHW beach width of 10m.

[3] Full investigation of stormwater assets in and immediately behind the existing seawalls would be carried out as part of the upgrade design. The upgrade design would include re-establishment of the beach profile.

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Beach nourishment campaigns would take place approximately every 5 years with the sand placements designed to recede such that the minimum 10m MHW beach width is in place at the commencement of successive nourishment campaigns. In practice, the exact timing of nourishment campaigns would vary according to beach conditions, available sand sources and the like.

3. Probabilistic Assessment of Coastal Hazards

Traditionally, coastal hazard assessments have been undertaken under a deterministic approach, whereby each input variable is assigned a single value (e.g. 'design' storm demand, sea level rise projection, etc. with generally conservative estimates applied).

A probabilistic approach allows each input parameter to randomly vary according to appropriate probability distribution functions. The randomly sampled parameters are repeatedly combined in a process known as Monte-Carlo simulation. All outputs from the Monte-Carlo simulation are collated to develop a probability curve for shoreline erosion during a study period. A separate probability curve would be developed for regularly spaced profiles distributed across the study area at South Mollymook Beach. It is proposed that these would coincide with the 12 OEH photogrammetric profile locations in Blocks 1 and 2 as shown below in **Figure 1**.

SA18.255 - Attachment 1

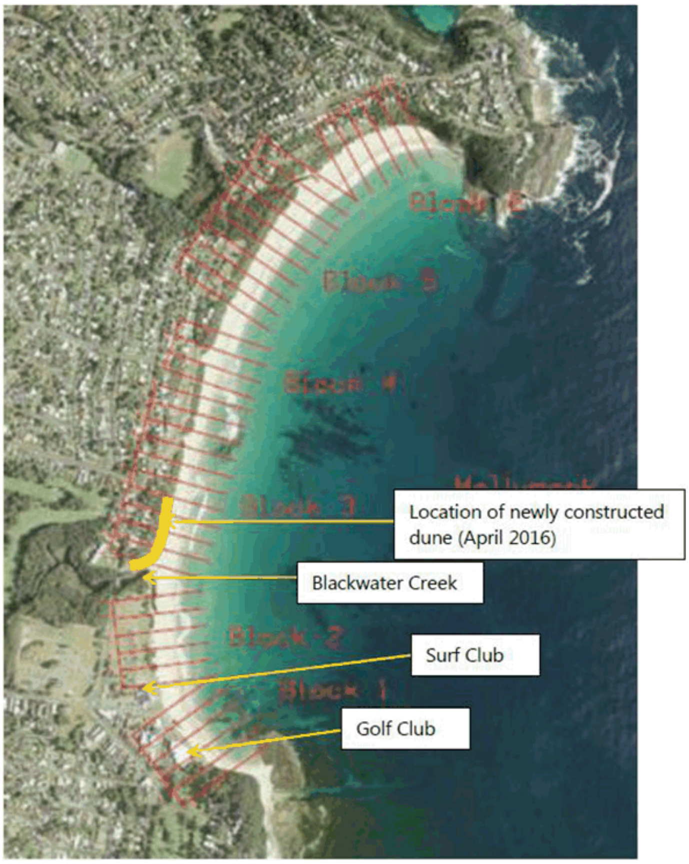

Figure 1: OEH Photogrammetric Profile Locations (Source: Advisian, 2016)

4. Probabilistic Input Parameters

The key input variables in the probabilistic analysis include:

1. Shoreline movement due to sediment budget differentials – 'Underlying Recession';
2. Sea level rise and the recession response to sea level rise (SLR) – 'SLR Recession;
3. Event-based erosion due to storm activity – 'Storm Demand'

4.1 Underlying Recession

Advisian (2016) reviewed available photogrammetry and beach survey data for the period 1944 to 2016 and determined that Mollymook Beach was stable during this period (**Figure 2**).
Advisian (2016) adopted a long-term (underlying) recession of zero for Mollymook Beach.

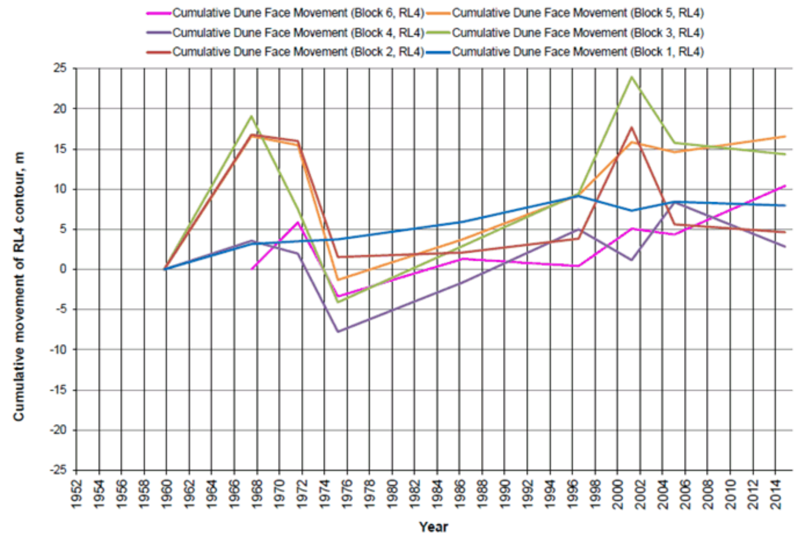

Figure 2: Beach change over time, Mollymook. Top: Volumetric face analysis; Bottom: Dune face analysis (Source: Advisian, 2016)

The random underlying recession values used in the Monte-Carlo simulations would be defined by a triangular probability distribution (**Figure 3**). A triangular distribution is defined by three values: the minimum value ‘a’, the maximum value ‘b’, and the peak/mode (most likely) value ‘c’.

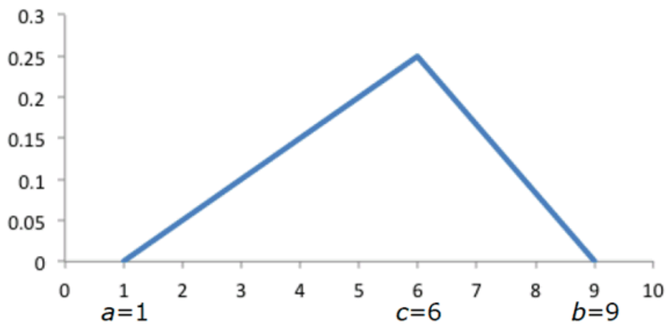

Figure 3: The probability density function of a triangular distribution

The photogrammetry data was analysed in further detail to determine appropriate input parameters for the triangular distribution. The adopted analysis period included photogrammetry data collected between 1959 and 2014, as per Advisian (2016).

Photogrammetry profiles located in the vicinity of the two creek entrances (Block 3 Profiles 1 to 4, and Block 5 Profiles 9 to 10) were excluded from the analysis because beach change in these areas over time may be related to shifting entrance regimes and/or discrete entrance opening and closing

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events rather than underlying beach change; including these profiles may therefore confound the analysis.

Rates of shoreline change were obtained from the NSW Beach Profile Database operated by OEH[4]. For each of the profiles, the rate of change of the 4 m AHD contour position was derived by linear regression; that is, by determining the line of best fit (least squares error) in each case[5]. Average rates of shoreline movement for Mollymook Beach are plotted in **Figure 4**. Key statistics summarising these results are presented in **Table 1**. Note that positive values indicate shoreline accretion, and negative values indicate shoreline recession.

Table 1: Mollymook Shoreline Change Rates (1959 to 2014) – Key Statistics

Statistic	Rate of Positional Change (m/year)
Minimum	-0.24
Maximum	0.91
Median	0.17
Mean	0.15
5th percentile	-0.18
95th percentile	0.37

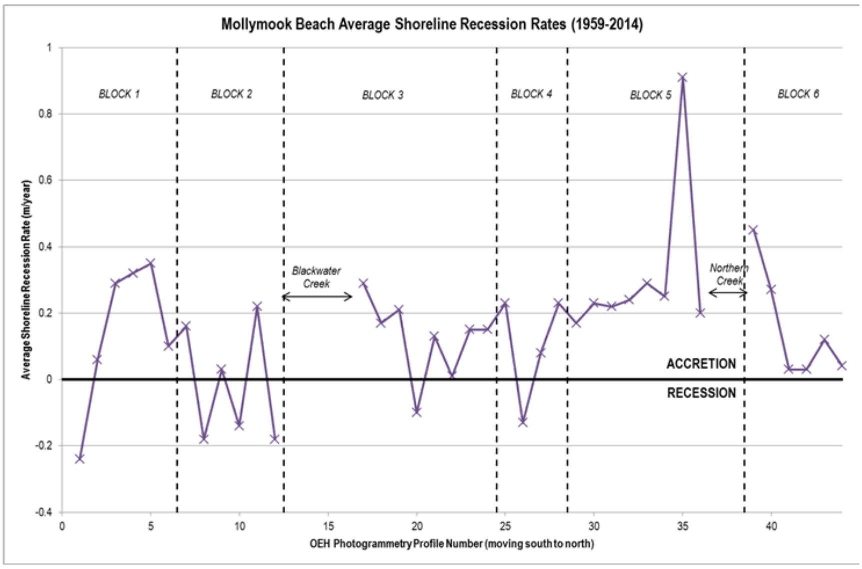

Figure 4: Mollymook Beach Shoreline Change Analysis

These results indicate that Mollymook Beach was perhaps generally accretionary during the analysis period, with an average accretion rate of 0.15 m/year. Average shoreline movement rates vary

[4] Available online: www.nswbpd.wrl.unsw.edu.au (viewed 30/4/18).

[5] This does not imply that there were uniform rates of positional change between dates of photography.

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between around -0.2 m/year (recession) and 0.9 m/year (accretion), and are generally similar across the entire length of the beach.

Based on the range of shoreline recession values determined from beach profile analysis, the input values proposed for use in Monte-Carlo simulations are summarised in **Table 2**. The following should be noted:

- The preliminary minimum and maximum values adopted correspond to the 5th and 95th percentile values (respectively), rather than the statistical minimum and maximum values. This was considered to be appropriate because the statistical minimum and maximum values may be outliers that are non-representative of the true bounds of actual shoreline movement, such as the maximum accretion rate of 0.91 m/year recorded at Block 5, Profile 7.
- The preliminary 'mode' value adopted corresponds to the statistical median value (0.17 m/year), rather than the statistical modal value (0.29 m/year). This was considered to be appropriate because the median rate of shoreline movement is considered to represent the most likely outcome for the entire length of Mollymook Beach, which is the required input for the triangular distribution.
- The preliminary values were adjusted to account for any SLR recession that may have occurred at Mollymook Beach during the analysis period. This was based on an average SLR of 0.8 mm/year over the historic record (1966 to 2010, White et al., 2014) and a modal Bruun factor of 45 (refer **Section 3.2**). This resulted in a reduction in recession of 0.036 m/year.

Table 2: Mollymook Beach Shoreline Recession - Inputs for Probabilistic Analysis

Statistic	Rate of Positional Change (m/year)	
	Preliminary Values	Adopted Values[6]
Minimum	-0.18	-0.14
Maximum	0.37	0.40
Mode	0.17	0.20

4.2 SLR Recession

SLR may result in shoreline recession due to readjustment of the beach profile to the new coastal water levels. Bruun (1962; 1983) proposed a methodology to estimate shoreline recession due to sea level rise, the so-called Bruun Rule. The Bruun Rule is based on the concept that sea level rise will lead to erosion of the upper shoreface, followed by re-establishment of the original equilibrium profile. This profile is re-established by shifting it landward and upward. The Bruun Rule is illustrated in **Figure 5** below:

[6] Adjusted with the modal Bruun factor and a SLR rate of 0.8 mm/year (White et al., 2014).

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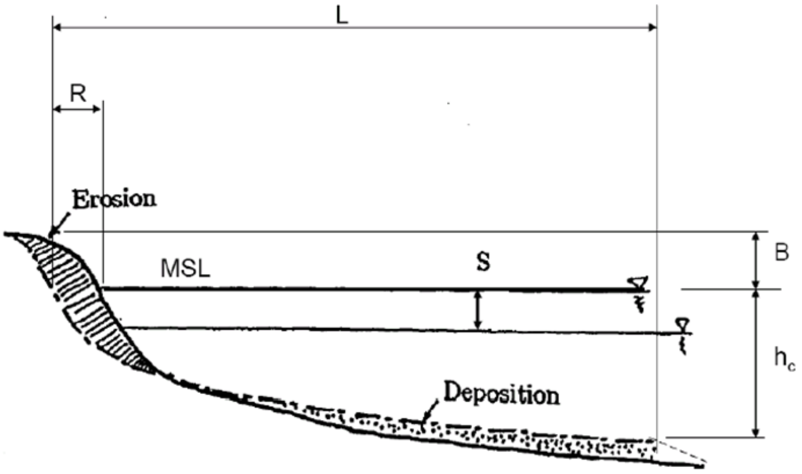

Figure 5: Bruun Rule

The Bruun Rule equation is given by:

$$R = \frac{S}{(h_c + B)/L}$$

where:	R	= shoreline recession due to sea level rise;
	S	= sea level rise (m)
	hc	= closure depth
	B	= berm height; and
	L	= length of the active zone.

The denominator in the above equation ($(h_c + B)/L$) is the offshore beach slope extending to the depth of closure, h_c, which is defined by Bruun (1962) as *"the outer limit for the nearshore littoral drift and exchange zone of littoral material between the shore and the offshore bottom area"*. The inverse beach slope is also referred to as the 'Bruun factor'.

SLR recession is therefore a function of both SLR and the Bruun factor (i.e. R = S × BF). There is uncertainty regarding the selection of both of these parameters, as discssude below. As such, for the Monte-Carlo simulations, both of these parameters would be defined by separate triangular probability distributions.

Bruun Factor

Selection of an appropriate Bruun factor depends on the adopted depth of closure, which is defined in Bruun (1962) as *"the outer limit for the nearshore littoral drift and exchange zone of littoral material between the shore and offshore bottom area"*. There are numerous methods to estimate the closure depth, including:

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- analytical methods based on wave characteristics and sediment grain size characteristics;
- field methods based on survey data; and,
- field methods based on sedimentological data.

Advisian (2016) reviewed the above methods for Mollymook Beach and adopted an active beach slope of 1V:45H (i.e. Bruun factor = 45), based on a closure depth of 20 m. This value is considered to be appropriate for adoption as the 'mode', or most likely, Bruun factor in the probabilistic assessment.

Advisian (2016) also presented a range of possible closure depths for the study area. Minimum and maximum values considered to be reasonable for Mollymook Beach are as follows:

- Minimum closure depth of 9 m, based on the "inner" Hallermeier (1981, 1983) depth at the seaward limit of the littoral zone; and,
- Maximum closure depth of 29 m, based on the "outer" Hallermeier (1981, 1983) depth at the seaward limit of the shoal/buffer zone. This is consistent with the boundary between Nearshore Sand and Inner Shelf Sand which corresponds to those parts of the seabed considered to be active and relict (respectively) (Nielsen, 1994). This depth is considered to represent the seaward limit of reworking and onshore transport of beach sized sand under wave action.

The Bruun factors corresponding to each of the adopted closure depths were estimated based on characteristic beach profile data presented in Advisian (2016) and are summarised in **Table 3**.

Table 3: Mollymook Beach Bruun Factor – Proposed Inputs for Probabilistic Analysis

Statistic	Closure Depth	Bruun Factor
Minimum	9 m	28
Maximum	29 m	60
Mode	20 m	45

Sea Level Rise

Council adopted the following sea level rise projections on 10 February 2015 (taken from a benchmark year of 2014):

- 100mm for 2030
- 230mm at 2050
- 350mm at 2100.

These numbers correspond to the sea level rise projections associated with RCP6.0 (mid-range greenhouse gas emissions scenario) included in IPCC (2013, 2014). The adopted 2030 and 2050 projections have a 15% chance (high probability line) of being exceeded while the 2100 projection of 360mm has a 85% chance of being exceeded (low probability line).

It is proposed that the above values are adopted as the modal (most likely) input to the triangular probability distribution for SLR. The minimum and maximum sea level rise trajectories would be established to cover the full range of IPCC projections, namely, to locally adjusted projections of RCP 2.6 (lower bound) and RCP 8.5 (upper bound), respectively.

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In summary, the proposed SLR scenarios to define the triangular distribution for SLR are as described below and presented in **Table 4**:

- Minimum value: RCP 2.6 (low)
- Maximum value: RCP 8.5 (high)
- Mode (most likely) value: RCP 6.0 (various)[7]

Table 4: Proposed Minimum, Modal and Maximum Sea Level Rise Projections

Year	Minimum Trajectory RCP2.6 (low)	Modal Trajectory RCP6.0 (various[7])	Maximum Trajectory RCP8.5 (high)
2014	0.00	0.00	0.00
2020	0.02	0.03	0.04
2030	0.05	0.10	0.11
2040	0.10	0.15	0.18
2050	0.13	0.23	0.27
2060	0.15	0.26[8]	0.38
2070	0.18	0.29[8]	0.51
2080	0.22	0.32[8]	0.66
2090	0.24	0.34[8]	0.81
2100	0.26	0.37	1.00

The CBA report will thoroughly explain why RCPs other than 6.0 are applied to capture minimum and maximum values.

4.3 Summary – Recession Probability

Random values for SLR, Bruun factor, and underlying recession would be simulated using triangular distributions, as indicated in **Figure 6**. The values for these variables can be combined in a Monte-Carlo process with 10^6 iterations to give a total shoreline movement along the beach.

[7] The adopted 2030 and 2050 projections correspond with the RCP6.0 (high) estimates (i.e. high probability line), while the 2100 projection correspond with the RCP6.0 (low) estimates (i.e. low probability line).

[8] SLR estimates for the proposed 'modal' trajectory between 2050 and 2100 were linearly interpolated between the adopted 2050 and 2100 values.

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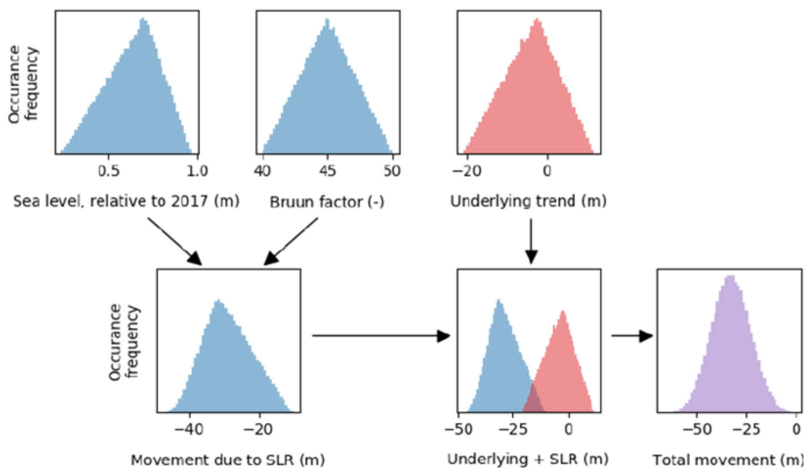

Figure 6: Methodology for combining random values to estimate shoreline movement (Source: WRL, 2017)

Note: for the Protection + Nourishment scenario (CBA Option 4), the amenity nourishment scheme would effectively limit the total shoreline recession that can be realised in reality. The same recession rates and distributions would be applied for each CBA Option, however the total recession distances (underlying plus SLR) would be truncated under Option 4 once beach widths reduce below 10m, based on the assumption that nourishment would be implemented at or around this time to restore suitable beach widths.

4.4 Storm Demand

Advisian (2016) assessed historical observations of short term erosion at Mollymook Beach due to major storm events, primarily May 1974 and June 2016, see **Figure 7**. Based on this assessment:

- A storm erosion demand of 90 m^3/m for the area fronting the Golf Club (this is limited to the beach berm only due to the presence of a protective revetment);
- A storm erosion demand of 150 m^3/m for the area fronting the Surf Club (limited, however, by the presence of the vertical concrete seawall immediately south of the Surf Club).

Based on the major storm event data points recorded at the southern end of Mollymook Beach, it would appear that storm demand values generally increase moving south to north through the study area. Consideration was given to adopting storm demand values for the probabilistic analysis that reflect this observed trend, however it was noted that the available data is primarily limited to two events only (May 1974 and June 2016), which is not considered to be a sufficiently robust dataset. The actual beach erosion realised along the study area in future storm events will be influenced by a wide variety of factors including wave direction and the possible formation of rip cells at discrete locations.

As such, the discretised design storm erosion values presented in Advisian (2016) would be adopted as the 100-year ARI storm demand values for the probabilistic assessment, i.e.:

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- photogrammetry Block 1 - 90 m^3/m;
- photogrammetry Block 2 - 150 m^3/m.

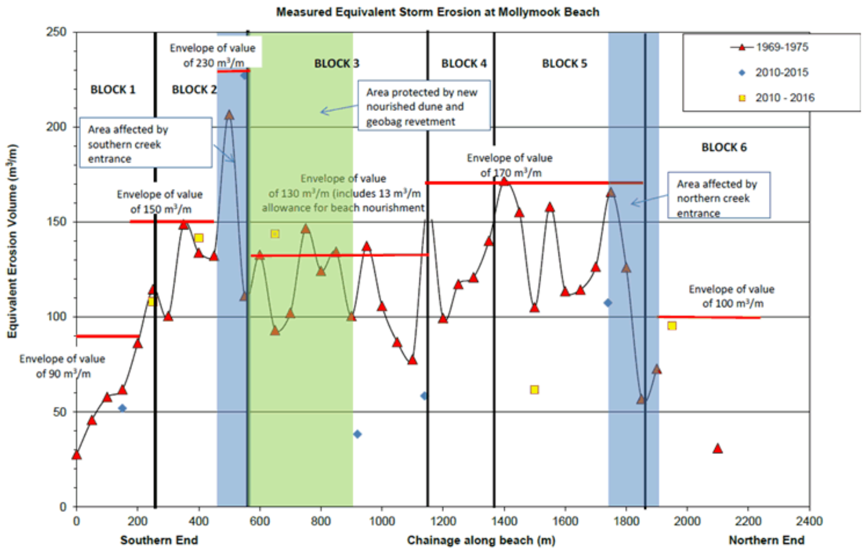

Figure 7: Measured equivalent storm demand at Mollymook Beach (Source: Advisian, 2016)

Storm demand probabilities for each year would be calculated using a uniform distribution of AEP values (**Figure 8**).

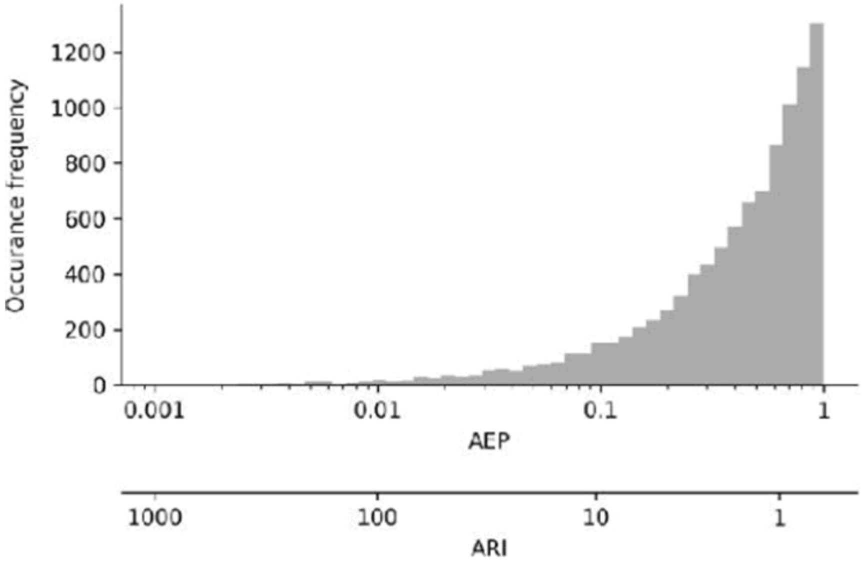

Figure 8: Uniform distribution of AEP values for generating storm demand volumes (Source: WRL, 2017)

The AEP values would be converted to erosion volumes using the distribution based on NSW beach erosion data described in Gordon (1987), based on the adopted 100 year ARI storm demand values (refer **Figure 9**). Gordon (1987) derived relationships between storm demand and average recurrence interval, in both "high demand" (at rip heads) and "low demand" (away from rip heads) areas, and depicted a relationship between storm demand (plotted vertically) and the logarithm of ARI (plotted horizontally) that was linear. The adopted 100-year ARI storm demand values were conservatively assumed to be "high demand" values.

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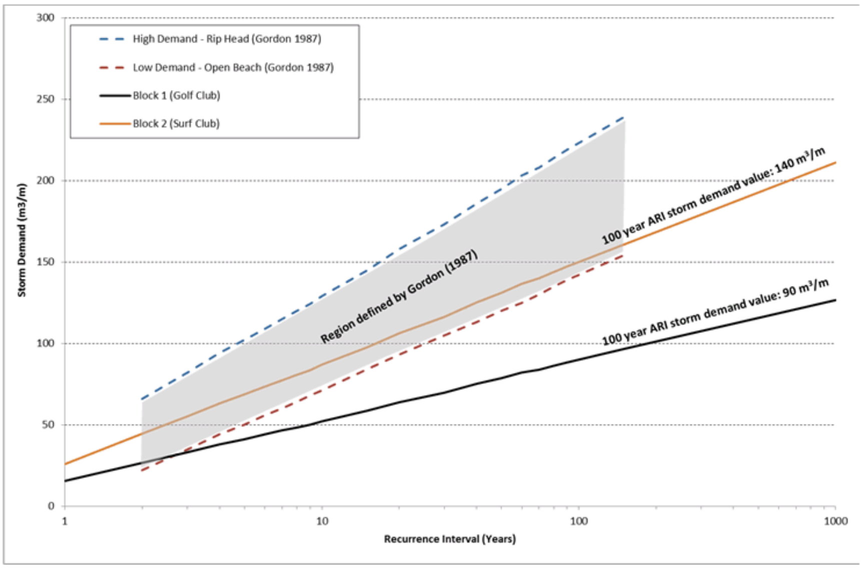

Figure 9: Relationship between storm demand and ARI as developed by Gordon (1987) along with proposed relationships for the study

The storm demand volumes would be converted to horizontal erosion distances to the back of the ZSA and ZRFC in accordance with the Wedge Failure Plane Model after Nielsen et al (1992), refer **Figure 10**. These calculations would be performed for each photogrammetry beach profile in the study area. The 2014 photogrammetry dataset would be used as the 'base' profile for calculation purposes, as per Advisian (2014).

In the CBA, it may be appropriate to adopt the ZSA position for assets such as the Golf Club that are founded on deep piles, whereas other assets founded on conventional piles (e.g. Surf Club) may need to include an allowance for reduced foundation capacity.

Action: assess each asset on a case by case basis to determine whether that asset would be adversely affected by erosion to the ZSA or ZRFC position (or neither). Note the requirements in the OEH CBA Guide that relate to impact of erosion on different property types and suggested treatment to account for economic loss.

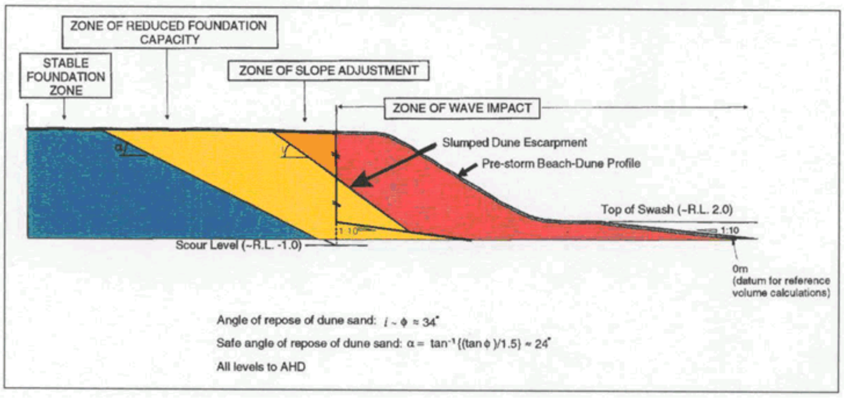

Figure 10: Wedge Failure Plane Model (Source: Nielsen et al, 1992)

For each year in the planning period, probabilities of storm demand would be randomly combined with the recession probabilities in a further Monte-Carlo simulation. It would be assumed that the beach recovers from any storm-driven erosion at the beginning of each year. The shoreline positions (due to storm demand, SLR recession and underlying recession) would be determined for each year and simulation (10^6 simulations). The most extreme erosion event (i.e. maximum shoreline movement) across the planning period would be defined for each simulation, and these values would be collated to assemble a probability distribution curve for shoreline movement (**Figure 11**).

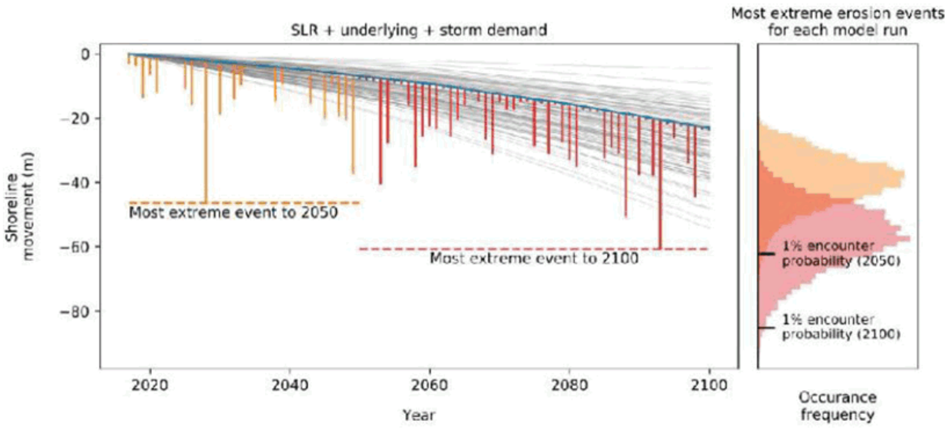

Figure 11: Example of simulated storm demand superimposed on background shoreline movement (Source: WRL, 2017)

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5. Influence of Protective Structures under Options 1 and 2

In general, the existing protective structures would be expected to limit (either entirely or partially) the amount of shoreline erosion that occurs landward of the structures during extreme erosion events. Key assumptions regarding the treatment of existing protective structures under Options 1 and 2 are outlined in **Section 2.3**.

In reality, the ability of the existing protective structures to limit the amount of landward shoreline erosion that occurs during extreme erosion events would depend on a variety of factors including:

- critical structural design features (e.g. constructed toe level, size of armour units etc);
- pre-storm ('existing') condition of the structure;
- intensity of erosion event resulting in damage to the structure.

For the purposes of the coastal hazard assessment, it would be assumed that the amount of shoreline erosion that occurs landward of an existing protective structure is a function of damage levels sustained by the structure, i.e. as damage levels increase, the structure has a reduced capacity to withstand erosional forces.

The critical levels of seawall damage (and related erosion events) that require definition for each structure are:

1. The threshold at which erosion would start to occur landward of the structure.
2. The threshold at which full structural failure occurs.

While SPM offers a quantitative definition of damage levels[9], this is not considered to be applicable for the current assessment. Rather, the two critical damage conditions for each structure would be defined in a largely qualitative manner that considers the three factors noted above, i.e. structural design features, existing structural condition, and erosion intensity.

The proposed methodology for implementing this approach is presented in **Figure 12** and summarised below. This methodology would be followed for each structure and for each year in the coastal hazard assessment.

- If the simulated shoreline erosion distance[10] is less than the present day beach width, it would be assumed that there is no interaction between the structure and coastal processes.
- If the simulated shoreline erosion extends a sufficient distance landward to start interacting with an existing protective structure, it would be assumed that the structure will start to experience damage.
- The threshold at which erosion would start to occur landward of the structure has been assumed to correspond with a nominal damage level of 10%.
- The threshold at which full structural failure occurs would correspond with a nominal damage level of 30% as per SPM.

---

[9] SPM recommends 30% damage for full failure of a coastal protection structure, where per cent damage is based on the volume of armour units displaced from the zone of active armour unit removal. Furthermore, it is normal practice to design coastal structures for 0 to 5% damage in the design storm, referred to as the 'no-damage condition'.

[10] As noted in **Section 4.4**, the simulated shoreline erosion distance is the sum of the erosion due to storm demand, SLR recession and underlying recession. As such, it has been assumed that erosion that causes damage to protective structures can occur due to any combination of these components.

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- For erosion events that result in damage levels between 10% and 30%, the structures would continue to provide some albeit depleted protection, i.e. the structure would resist a proportion of the horizontal erosion component that would otherwise fully occur landward of the structure if the structure was not present.
- It would be assumed that the proportion of the landward erosion component that is resisted by the structure will decrease linearly from 100% to 50% for damage levels between 10% and 30%. In other words, at full failure (30% damage), it would be assumed that half of the landward erosion component will be resisted by the remnant structure components, with the other half transmitted landward of the structure[11].
- For erosion events that result in damage levels greater than 30%:
  - Under Option 1, the remnant structure components would continue to provide some resistance to further landward erosion, however this resistance would be expected to diminish as damage levels increase. It would be assumed that the proportion of the landward erosion component that is resisted by the structure will decrease linearly from 50% to 0% for damage levels between 30% and 100%. In other words, an extreme erosion scenario that results in 100% damage to a structure (i.e. complete washout and removal) would not be resisted in any way by the existing protective structures or their remnant components.
  - Under Option 2, the structures are fully removed immediately following full failure (refer **Section 2.3**). Therefore, the landward erosion component is fully transmitted landward of the structure position in subsequent events.

Estimates of the corresponding shoreline erosion distances and volumes that would induce 10%, 30% and 100% damage for each structure are provided in **Table 5**[12]. The following should be noted:

- Present day shoreline distances and volumes between the shoreline and structure were measured between the structure toe and 0 m AHD shoreline position in the 2014 photogrammetry data.
- **Gabion wall structure**:
  - The constructed toe level is at RL -1, which is above the design scour level of RL -0.5, while the crest level is at around RL 6.
  - It would be expected that the gabion wall could fully withstand erosion events slightly greater than the minimum event required to expose the wall to coastal processes[13]. Therefore, it has been assumed that 10% damage levels would be sustained when erosion conditions are around 50% greater than this minimum event. The equivalent sand volume for this scenario is 81 m^3/m, which is equivalent to a storm demand ARI of around 60 years (refer **Figure 9**).
  - It has been assumed that 30% damage levels (full failure) would be sustained when erosion conditions are around 75% greater than the minimum event required to fully expose the wall to coastal processes[13]. The equivalent sand volume for this scenario

[11] At full failure (30% damage), it would be expected that the structure components will continue to provide reasonable resistance to erosion particularly at the base of the profile in the swash/scour zone. This performance would be somewhat similar to that of a rock toe mound with crest level at around RL 2 which was investigated in RHDHV (2014) and considered to provide a 75% reduction to the design erosion demand in the lee of the rock mound. As such, the adopted 50% reduction factor in landward erosion at full failure is considered to be appropriate for the coastal hazard assessment and is likely somewhat conservative.

[12] It should be noted that the gabion and block stone walls are located in photogrammetry Block 1 whereas the concrete wall is located in Block 2. This influences the interpretation of **Figure 9** for selection of storm demans and equivalent storm ARIs for **Table 5**.

[13] The minimum event required to expose the gabion wall to coastal processes would involve full erosion of the present day shoreline width of 45 m (equivalent sand volume 54 m^3), refer **Table 5**.

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is 95 m^3/m, which is equivalent to a storm demand ARI of around 150 years (refer **Figure 9**).

- **Block stone wall structure**:
    - The block stone wall crest level is at around RL 4, while its foundations are reported to be tied into stiff clay (PWD, 1987). Test pits carried out by RHDHV found the stiff clay to be present below around RL 0. It is therefore assumed that the structure toe level is at around RL 0.
    - PWD (1987) noted that the block stone wall was not designed to resist major storm wave attack and although its foundations are tied into stiff clay, the size of the rock (blockwork) is inadequate. The seawall crest is also relatively low for an open coast structure, and the thickness and integrity of the blockwork (number of layers and interlocking) and gross stability against sliding and overturning, are not known. There is also a major stormwater outlet at this location which aggravates sand loss from the beach in storms.
    - Therefore, the block stone wall is considered to be underdesigned for the purposes of fully resisting any erosion events greater than the minimum event required to expose the wall[14]. As such, it would be assumed that the threshold at which erosion would start to occur landward of the structure (i.e. the nominal 10% damage level) corresponds with this event[14].
    - The two-dimensional fabric of this structure would be expected to deliver bridging strength that protects against full failure when erosion extends to the structure toe. Therefore, it has been assumed that 30% damage levels (full failure) would be sustained when an erosion event equivalent to a 100-year ARI storm bite (90 m^3/m, refer **Figure 9**) occurs.

- **Concrete wall structure**:
    - The concrete wall structure fronting the surf club has a crest level at around RL 4, while the toe level is at around RL 2.5 (SCC Drawing 456-E6E, May 2006). Based on a design scour level of around RL 0 to -1, it is evident that the elevated toe level of the concrete wall significantly limits the ability of this structure to resist coastal erosion during extreme events. The wall crest level is also relatively low for an open coast structure and the seawall would therefore also be susceptible to wave overtopping and washout from behind the crest in storms.
    - Due mainly to the very elevated toe level, it would be assumed that the threshold at which erosion would start to occur landward of the structure (i.e. the nominal 10% damage level) corresponds with an erosion event that extends to 5 m seaward of the structure. The erosion scarp for such an event would be expected to slump in a manner that causes exposure of the base of the concrete wall, likely resulting in some minor structural damage. The equivalent sand volume for this scenario is 100 m^3/m, which is equivalent to a storm demand ARI of around 15 years (refer **Figure 9**).
    - It has been assumed that 30% damage levels (full failure) would be sustained when shoreline erosion fully extends to the structure, located 80 m from the shoreline. The equivalent sand volume for this scenario is 115 m^3/m, which is equivalent to a storm demand ARI of around 30 years (refer **Figure 9**).

- The 100% damage levels for each structure have been linearly extrapolated based on the 10% and 30% damage levels.

[14] The minimum event required to expose the block stone wall to coastal processes would involve full erosion of the present day shoreline width of 66 m (equivalent sand volume 77 m^3), refer **Table 5**. This event is equivalent to a storm demand ARI of around 45 years (refer **Figure 9**).

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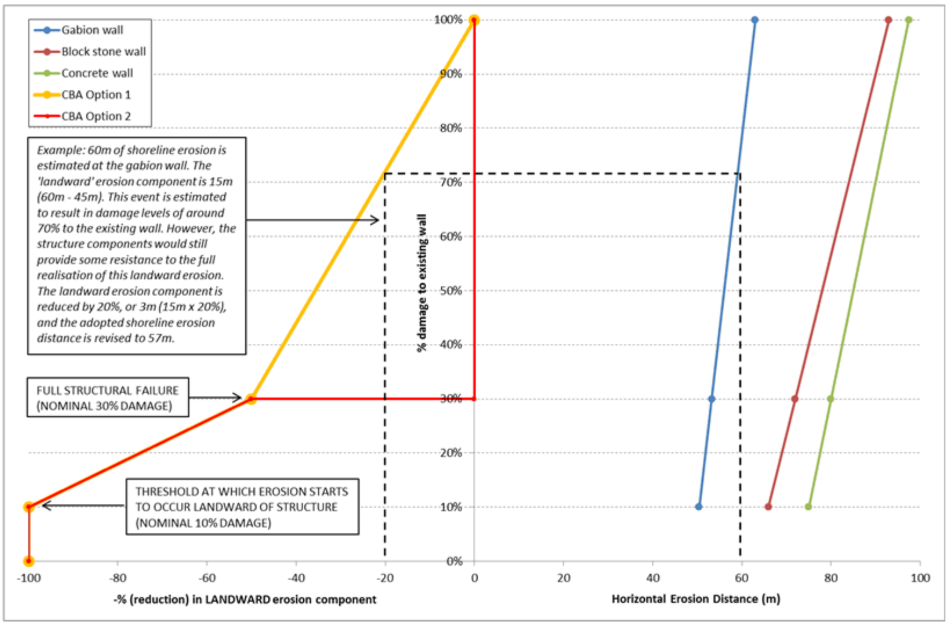

Figure 12: Attenuation of landward erosion due to presence of existing protective structures under Options 1 and 2

Table 5: Estimated erosion volumes and distances associated with 10%, 30% and 100% damage levels at the existing protective structures

Structure	Structure toe to shoreline		10% damage (threshold at which erosion starts to occur landward of structure)				30% damage (full structural failure)				100% damage (full loss of structure)			
	Distance (m)	Sand Volume (m^3/m)	Additional storm bite (m^3/m)	Total storm bite (m^3/m)	Equivalent Storm ARI	Total Equivalent erosion distance (m)	Additional storm bite (m^3/m)	Total storm bite (m^3/m)	Equivalent Storm ARI	Total Equivalent erosion distance (m)	Additional storm bite (m^3/m)	Total storm bite (m^3/m)	Equivalent Storm ARI	Total Equivalent erosion distance (m)
Gabion wall	45	54	27	81	60	50.4	14	95	150	53.2	53.5	148.5	>1000	63.0
Block stone wall	66	77	0	77	45	66.0	13	90	100	72.0	97	187	>1000	93.0
Concrete wall	80	115	-15	100	15	75.0	15	115	30	80.0	88	203	~700	97.5

RHDHV recognise that the assumptions developed to describe the relationships between beach erosion and structure damage are fairly generic and were based on limited guidance from established literature and our coastal engineering experience. However, for the purposes of the coastal hazard assessment they are considered to be valid, i.e. it is a methodology that provides a reasonable means of differentiating between CBA Options 1 and 2.

6. Key Output

A probability curve of shoreline retreat (example below) would be established for each of the photogrammetry beach profiles in the study area. Each asset considered in the CBA can be assigned separate probability curves based on the closest profile.

Three-yearly probability curves would be developed for each profile, covering the duration of the relevant planning periods (20 years and 50 years). These curves would allow Origin to determine the probability of each asset being impacted by shoreline erosion throughout the planning period.

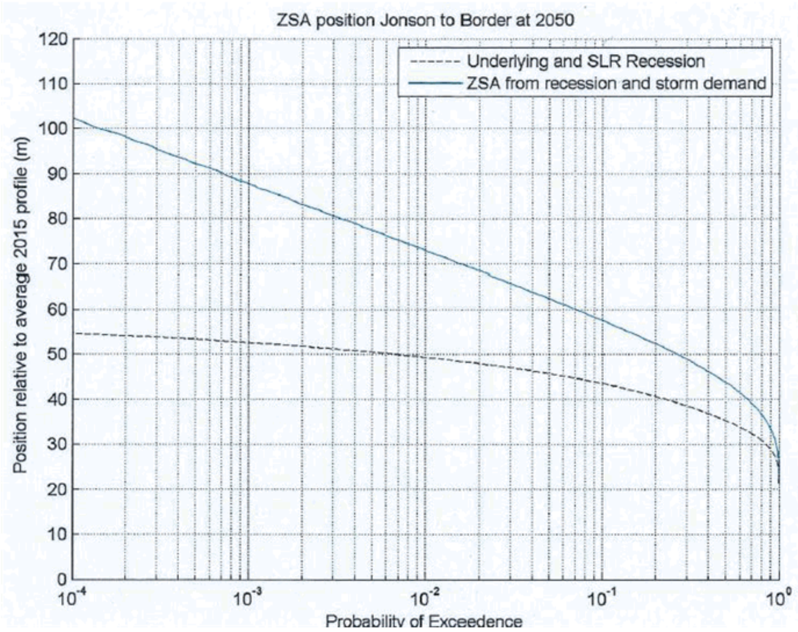

Figure 13: Example output showing probabilities of erosion and recession hazard (Source: WRL, 2013)

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RHDHV (2016), *Foreshore Stabilisation at Mollymook Beach (South) – Concept Design Report*, for Shoalhaven City Council, Final Report, 28 July 2016

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ATTACHMENT 1

Relevant extracts from reports relating to condition of existing seawalls at South Mollymook

1. **Shoalhaven Coastal Zone Management Study and Plan Document Number 3001209-004, Mollymook Beach Coastal Hazard Study Revision Status DRAFT (SMEC, July 2006)**

Some existing buildings lie within the present-day Zone of Reduced Foundation Capacity and several buildings (including the Surf Club) lie very close to the landward edge of the Zone of Wave Impact and Slope Adjustment. It is noted that the area in front of the surf club is protected by a seawall (Figure 4.1). However, this seawall does not appear to have been designed in accordance with sound coastal engineering standards.

It was recommended that the revetment designed by NSW Public Works Department (1992) to protect the infrastructure at the southern end of the beach and, specifically, the Golf Club, which is under immediate threat from storm erosion, be constructed.

2. **Shoalhaven Draft CZMP (v1, 10/5/12)**

According to CZMP, Mollymook SLSC and Golf Club are exposed to Extreme and High "mitigated risk" levels from coastal hazards for planning dates 2050 and 2100. (ie including the effects of existing management including the existing seawalls).

Action 12.7 of the CZMP states: Review the design of the revetment (previously designed by Public Works in 1992) which protects development and infrastructure at the southern end of Mollymook Beach. The revetment was not designed to meet sea level rise projections currently available. Maintain or reconstruct the revetment as necessary to apply best practice design. Modifications should include provision for disabled safe access to the beach.

3. **Mollymook Authorised Location report (RHDHV, 10/12)**

Report referenced Maunsell (2008) which established that the Club premises was at risk from coastal erosion over a 50 year period. Maunsell found that the beach frontage at the Club was protected by a gabion revetment but of insufficient capacity to provide 50 year protection due to a low and unacceptable Factor of Safety (FOS) against downslope failure, and because the fabric of the mattress could not be guaranteed for a further 50 years.

4. **Foreshore Stabilisation at Mollymook Beach (South) Concept Design Report (RHDHV, 28/7/16)**

The existing gabion revetment protecting the Golf Club was constructed at the southern end of Mollymook Beach following damage during the storm of May/June 1974. According to PWD (1987), the wall comprised placement of rock and soil, which would be insufficient to provide total protection to the Golf Club in future storms.

Little is known about the design and construction of the three other seawalls at South Mollymook Beach. According to PWD (1987), the 1974 storms destroyed part of the road at the corner of Golf Avenue and Ocean Street. The block stone wall in this area was "not designed to resist major storm wave attack and although its foundations are reported to be tied into stiff clay, the size of the rock (blockwork) is inadequate". There is also a major stormwater outlet at this location which aggravates sand loss from the beach in storms. It was noted during the site inspection by RHDHV personnel on

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16/08/12 and the 04/03/16 that the blockwork in the corner wall appeared to have settled from overlying concrete slabs, and timber had been inserted at one location to provide some support. Council's maintenance crew have also passed on the following comments:

- *over the past 12 years an unknown but substantial volume of concrete has been poured into voids behind the seawall;*
- *on one occasion 4m^3 of concrete was poured into a void opening which was the size of a dinner plate;*
- *geotextile fabric does not appear to form part of the wall construction;*
- *sections of footpath have subsided and been replaced exposing large voids behind the seawall;*
- *the stormwater pipe is 50 years old and pipe segments have separated.*

Minor damage to the seawall was also sustained following the East Coast Low event in June2016 which resulted in some of the sandstone blocks becoming dislodged. The extent to which the three other existing seawalls at south Mollymook Beach could be incorporated into a fully engineered seawall of say 50 year design life cannot be ascertained without detailed geotechnical investigation including further test pits and borehole drilling.