Western Port Local Coastal Hazard Assessment

Report 2 (R02) – Data Review

October 2013

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PROJECT DETAILS

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1. INTRODUCTION

1.1 Background

Melbourne Water commissioned Water Technology to undertake the Western Port Local Coastal Hazard Assessment (WPLCHA) project. The project has come about through a partnership between Melbourne Water, the Department of Environment and Primary Industries (DEPI), South East Councils Climate Change Alliance, Bass Coast Shire Council, Cardinia Shire Council, City of Casey and Mornington Peninsula Shire Council.

The WPLCHA is a component of the Department of Environment and Primary Industries Future Coasts program, and Western Port is one of four priority sites in which local coastal hazard assessments have or are currently being undertaken.

1.2 Scope

As detailed in the project brief, the scope of the WPLCHA is to provide information on the extent of coastal hazards and their physical impacts for the Western Port coastal environment. The WPLCHA is focussed on assessing the physical hazards of erosion and inundation. It does not include any subsequent assessment of impacts of the hazards on built, economic or social infrastructure, assets or values and does not include preparing adaptation responses to the physical hazards.

The information developed by the project will assist in planning for and managing coastal hazards. It will allow management agencies and other key stakeholders to identify and define triggers as the basis for short, medium and long term management responses. Specifically, the information will provide information, data and mapping to inform consistent policy and practice and support agencies in identification and management of risk, and undertake; strategic planning, statutory planning, infrastructure maintenance and replacement schedules, natural asset management, and business planning and budgetary processes that are responsive to a changing climate, its impacts and opportunities.

The boundaries of the study area for the WPLCHA project are described as follows:

- Cape Schanck to West Head, along the shoreline of Western Port to the bridge at San Remo
- Inland from the Western Port shoreline will remain undefined enabling the assessment to be as far into the catchment as relevant
- All of the coast of French Island and the north side of Phillip Island from the bridge at Newhaven to the western extremity of Phillip Island (Seal Rocks), but excluding the south side of Phillip Island from Seal Rocks to the Bridge at Newhaven.

The study itself was split into two components:

- Part A - a broad scale Western Port wide coastal hazard assessment, and
- Part B - four local scale coastal hazard assessments.

1.3 Reporting & Outputs

This document is part of a series of reports produced as part of the Western Port Local Coastal Hazard Assessment project. It should be read in conjunction with the following:

- Report 1: Summary Report
- **Report 2: Data Review**
- Report 3: Methodology Overview
- Report 5: Erosion Hazards
- Report 6: Critical Locations

This report documents the available data that has been collected and collated for this project along with a brief overview of any specific data gaps identified.

The GIS data collated has been compiled into a project GIS in ArcGIS (version 10.1) which is the central spatial database for the project team. The project GIS has been continually updated throughout the project. The project GIS has been used to undertake analysis for the hazards assessment and to generate supporting maps and mapping layers.

2. DATA REVIEW

2.1 Previous Studies

A full bibliography of previous studies has been provided by the DEPI and updated by the study team during the course of this review. The bibliography is provided in a separate spreadsheet, Appendix A. This spreadsheet was updated during the project and a final version included with the study outputs. Key studies and groups of studies are summarised below.

Table 2-1 Overview of previous Western Port studies

Study Era	General Summary
Pre-Shapiro (pre-1974)	A handful of studies were completed on Western Port prior to the Westernport Bay Environmental Study (Shapiro, 1975). The earliest literature identified is the survey of soils and land utilisation by Goudie (1942). The pre-Shapiro studies were mostly undertaken in the late 1960s to early 1970s, and focused on the areas of geomorphology, hydrodynamics, birds, mangroves, invertebrates and fish.
Shapiro Studies (1973-76)	The Westernport Bay Environmental Study (Shapiro, 1975) was a broad environmental study encompassing land studies, social and economic studies and marine studies. A total of 58 separate reports were made to the Westernport Bay Environmental Study between 1973 and 1976. Each report was numbers with an ESS (Environmental Study Series) number between 52 and 116. The Shapiro studies had a broad-reaching scope including hydrodynamics, water quality, geomorphology, vegetation seagrass, mangroves, birds, fish, marine mammals, invertebrates, benthos, dredging, soils, climate, and social and economic studies.
Post-Shapiro ESS Studies (1975-84)	There was an increase in research on Western Port after the completion of the Shapiro Studies. The Environmental Study Series was continued with further interpretation of the data from the Westernport Bay Environmental Study. In addition, a number of theses and journal articles on Western Port were published in this period. The focus of research at this time covered the same areas as the Shapiro studies and also extended to sediments, erosion, oil spills, archaeology, and pest plants. The increased volume of Western Port literature decreased in the early 1980s.
Late 20th Century Studies (1985-99)	There was something of a scientific hiatus on Western Port following the wind-down of the environmental study series. Only 127 pieces of literature on Western Port have been identified during this 15 year period, compared to 240 in the previous 12 years. At this time, policy documents and strategies were first being developed for the region and monitoring and condition reports began to be undertaken.

Study Era	General Summary
	Renewed research interest in birds, fish, dredging and climate was apparent at this time, as well as continuing research into water quality, mangroves, seagrass and invertebrates.
Recent Studies (2000-present)	Post-2000, the volume of research again increased, with a renewed interest in hydrodynamic and water quality models and sediment transport studies. Research on seagrass, mangroves, birds and invertebrates continued steadily, while there was an increase in research on saltmarsh, fish, mammals and climate change. There was continued growth in policy and strategy documents, accompanied by condition and monitoring reports. In 2011 the State Government of Victoria, Port Phillip and Westernport CMA and Melbourne Water jointly commissioned a broad overview study of Western Port, titled "Understanding the Western Port Environment". This study sought to synthesise the previous research and present a summary of the current state of knowledge across a number of key research areas.

2.2 Aerial Photography and Imagery

Both historical and current aerial photography were provided by DEPI.

2.2.1 Historical Aerial Photography

Historical aerial photos were provided for five key locations as detailed in Table 2-2. A number of photos were available for each location, spanning the years from 1947 to 2008.

Table 2-2 Historical Aerial Photography provided by DEPI

Location	Year	Scale/Resolution	Colour
Corinella Point	1956	50cm	B&W
	1969	50cm	B&W
	1974	15cm	Colour
	1981	15cm	Colour
	2008	15cm	Colour
Lang Lang to Jam Jerrup	1947	50cm	B&W
	1969	50cm	B&W
	1973	50cm	Colour
	1985	50cm	B&W
	1990	50cm	Colour
	2008	15cm	Colour
Sandy Point	1957	50cm	B&W
	1968	50cm	B&W

Location	Year	Scale/Resolution	Colour
	1974	50cm	Colour
	1989	50cm	Colour
Somers Beach	1957	50cm	B&W
	1968	50cm	B&W
	1974	50cm	Colour
	1987	50cm	Colour
	1989	50cm	Colour
	2006	35cm	Colour
Tooradin	1968	50cm	B&W
	1970	50cm	B&W
	1985	50cm	B&W
	2006	35cm	Colour

A mosaic of photographs for each location is provided in Appendix B. The following initial interpretation of this imagery was provided by Chris Sharples to DEPI prior to the commencement of this project (refer notes from 15th September 2012).

Table 2-3 Initial Aerial Image Interpretation of sites in Western Port (extracted from C.Sharples, 2012)

Location	Interpretation
Balnarring Beach – Somers Beach	Sandy beach with sand and some rocky reefs offshore and backed by dune sands mantling a rising bedrock backshore; most observed shoreline (vegetation line) change is mainly erosion and accretion of the dune sands, with the backing bedrock being probably unaffected by any recent shoreline changes as yet. This location has some exposure to swell waves and may be affected by tidal currents. Most shoreline changes observed in the air-photos relate to two slight embayments to either side of a slightly protruding point with some bedrock exposure (little change occurred throughout at the point). Western embayment: • 1957 – 1974: Accretion (progradation) • 1974 – 1987: Little change • 1987 – 2100: Significant erosion and recession Eastern Embayment: • 1957 – 1987: Little change • 1987 – 2011: Significant erosion and recession Overall, the air photo record shows a stable to slightly accreting shoreline from 1957 to 1987, then significant erosion between 1987 and 2011. These changes would be consistent with the onset of the effects of sea-level rise, however other explanations may be available (requires more understanding of local

Location	Interpretation
	processes).
Sandy Point	Sandy beach and pro-graded sand spit, evidently subject to dominantly west to east longshore sand transport, probably driven partly by some attenuated swell as well as local westerly wind-waves; likely to be some tidal current influence here as well (air photos indicate a major tidal channel sweeping around close to the tip of the point). West of Sandy Point: • 1957 – 2011: Some variability but dominant trend throughout is major pro-gradation, with the sandy beach growing and also migrating eastwards. Around the tip of Sandy Point: • 1957 – 1974: Accretion (point growing) on eastern side of tip, progressively receding on south side of tip. • 1974 – 2011: Erosion and recession on eastern side of tip, continued and accelerated recession on south side of tip. North of Sandy Point: • 1957 – 2011: Stable shoreline, very little change Overall the changes at Sandy Point appear characteristic of a prograding sandy spit with accretion west of and around the tip (exposed to longshore sand drift) and stability in the lee (north) of the tip. Phases of erosion around the tip are likely to be controlled by episodic migration of the tidal channel that sweeps around the tip, although examination of tidal channel movements in air photos from additional dates may be necessary to confirm this or point to alternative causes. The processes dominating the shoreline history at Sandy Point are probably strongly localised, hence critical time periods for air photos here would probably not be relevant to other parts of Western Port.
Tooradin	Mainly a muddy estuarine mangrove shore, with a hard artificial shoreline on the northern side of the township (not considered further), and a sandy beach (also artificial?) on the south-east side of the town. This site is not exposed to swell but receives locally-generated wind waves and river discharges. Mangrove shores: • 1968 – 2011: Generally little change, although in many areas there appears to be a slight shoreline accretion / progradation (of the order of about 5 metres) which may or may not be significant depending on the ortho-photo error margins. Observed mangrove shoreline stability or slight shoreline accretion (progradation) suggests catchment silt supply is sufficient for mangroves to capture mud fast enough to keep up with sea-level rise to date and perhaps even prograde a little – this is suggestive of a high sediment (silt & clay) load in the river, perhaps related to catchment disturbances. Sandy beach south-east of township: • 1968 – 1970: apparent major shoreline recession.

Location	Interpretation
	• 1985 – 2011: apparent shoreline recovery to 1968 position I assume this little sandy beach is mainly artificial in origin (it would naturally have been a muddy mangrove shore like surrounding areas), and I suspect the apparent changes relate partly to some uncertainty about exactly what shoreline features should be mapped to represent the shoreline here, and partly to artificial changes on the ground. In terms of understanding shoreline behaviour at Tooradin, the little sandy beach might best be discounted and attention paid mainly to the behaviour of the mangrove shores. With stability or slight accretion being the dominant shoreline trend here, there are no apparent periods of rapid change and thus no particularly critical times (within the 1968 – 2011 period) for air photo coverage of the broader area of comparable mangrove shores around northern Western Port (although note there could be other areas where some more significant changes have occurred).
Lang Lang to Jam Jerup	Mainly a sandy shore backed by 'soft' bedrock (semi-lithified sandstone) terrain which is mainly a low profile backshore in the northern area of the ortho-photos but rises into a high eroding soft sandstone cliff around a point towards the southern part of the air photos and continuing southwards (talus and slumped debris is abundant around the foot of the escarpment may have contributed to some confusion over what feature to map as the shoreline in some photos). This site is not exposed to swell but receives locally-generated wind waves. North of the point (mainly a sandy shore backed by a low profile backshore, now partly artificial but probably a low natural scarp in the past): • 1947 – 2012: Unmodified parts (northernmost area north of artificial seawall) mainly progressively receding throughout the period at roughly constant rate. Artificial shoreline section mostly stable since about 1969 due to artificial wall, interpretation of earlier shoreline movements difficult as artificial filling etc may have occurred when the wall was built. Around and south of the Point (mainly a high eroding scarp): • 1947 – 2012: Digitised shorelines (mainly scarp) unreliable as scarp is not clear in all photos (see also earlier discussion of this problem). Digitised shorelines suggest some accretion at times but this is highly unlikely as this sort of shoreline (semi-lithified sandstone bedrock) cannot recover naturally. It is reasonable to assume a progressive shoreline (scarp) recession has occurred here but careful review and editing of digitised shorelines would be needed to test this assumption. It appears likely the dominant shoreline behaviour trend at Lang Lang – Jam Jerrup has been a slow progressive shoreline recession in most areas except where artificial walls have been constructed to halt the erosion. This may in part be an ongoing long-term shoreline evolution trend (typical of many soft-rock shores which are still adjusting to the post-glacial sea-levels of the last 6,500 years), but an accelerating recession might be expected in response to recent sea-level rise (where the data clearly documents a progressive recession, it could be further analysed to see if the rate of recession has changed

Location	Interpretation
	significantly over the air photo period). Short of such additional analysis, the shoreline recession trend at Lang Lang – Jam Jerrup since 1947 appears roughly constant; hence there are no critical time periods for air photos of broader surrounding areas to capture phases of more rapid change.
Corinella Point	Not available at the time.

2.2.2 Current Aerial Photography

A complete 1m resolution photo mosaic captured December 2009 to January 2010 was available for Western Port from DEPI through the Coordinated Imagery Program (CIP). In addition, updated imagery captured in Dec 2011 was available for the north and western part shoreline of Western Port Bay.

Additional aerial imagery was available to the study team through previous projects (e.g. Neville Rosengren, geologic and geomorphic sites of significance) and was included the analysis.

2.3 Elevation

2.3.1 Terrestrial elevation

The Victorian Coastal 1m Digital Elevation Model (DEM) was available up to the 10 m AHD elevation for all of Victoria's coast line including Western Port Bay and islands. The DEM is derived from LiDAR data captured in 2007-09 for the Victorian Government Future Coasts project. A revised version of the Vicmap Coastal 1m Digital Elevation Model (DEM) in the Western Port study area was supplied by DEPI during the project. The extent of data received to date is shown Figure 2-1.

2.3.2 Bathymetry

Two bathymetric DEM data sets for Western Port Bay were made available from DEPI, while an additional bathymetric grid was supplied by the Environmental Protection Agency (EPA).

Table 2-4 Summary of Bathymetric Data Sets

Data set	Description	Source	Date Completed
Coastal Bathymetry	This dataset is based on information acquired between November 2008 and April 2009 to support the Victorian Governments Future Coasts Project	DEPI	NA
Multibeam Bathymetry	Bathymetry derived from Multi-beam Sonar, collected in June 2010 for sections of Westernport Bay	DEPI	2011
EPA 50m Grid	50m x 50m Bathymetric grid of Western Port	EPA	NA

Whilst the combined extent of the data sets cover the intertidal zone there are some gaps in the deeper channels to the north and west of French Island (Figure 2-1). Furthermore, the data sets have been captured separately and there are vertical elevation differences observed between them where they abut and/or overlap. The mean difference is 0.05 cm which is within the vertical tolerance of both data sets. However in some instances the differences were more significant (up to 20 m) and may be due to changes in the substrate surface due to the different capture dates and the dynamic environment of the area.

The final project bathymetric DEM used in the hydrodynamic and spectral wave model was created by merging the three data sets described in Table 2-4 and the Vicmap 1m coastal DEM, using a prioritisation routine to apply highest resolution data where available. The Vicmap 1m coastal DEM was used to provided coverage of all of the terrestrial land above approximately 0–1m AHD. The DEPI coastal bathymetry dataset covered the majority of the intertidal zone and the multibeam data provided coverage of the main channels and the Western Entrance and Rhyll segments. The remaining gaps, including a number of the tidal channels in the upper North Arm were then infilled using the EPA 50m bathymetric grid.

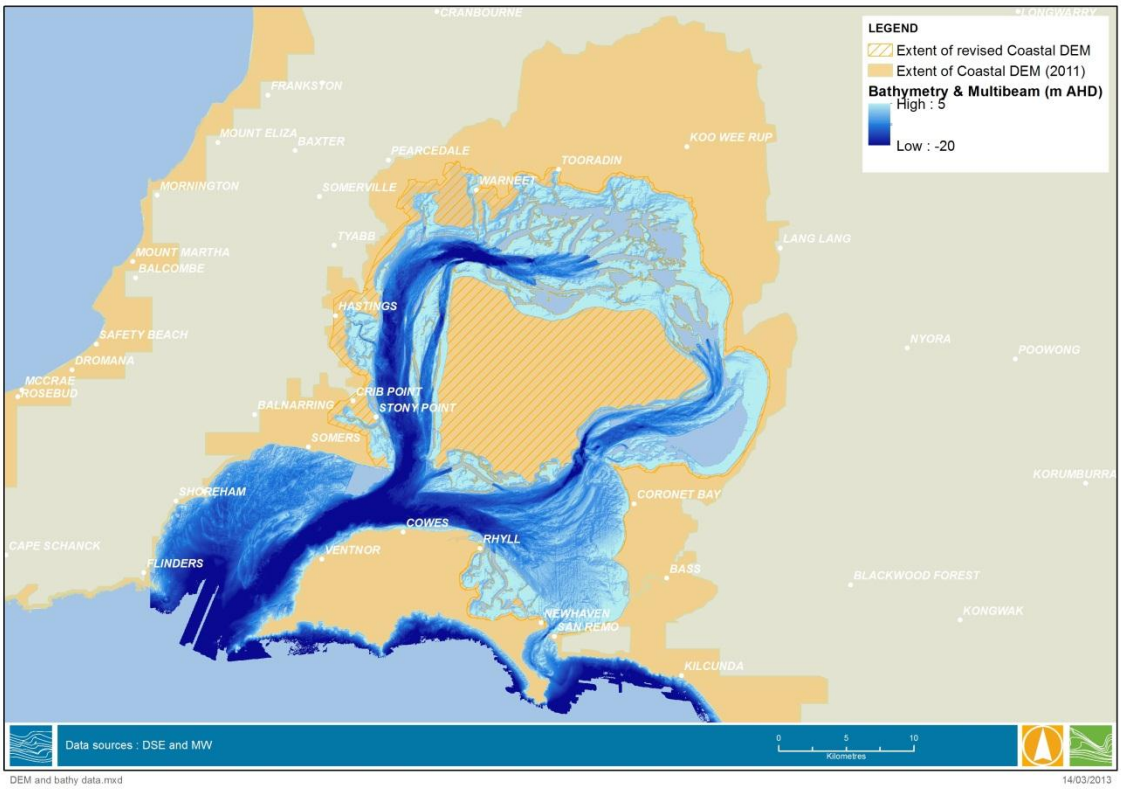

Figure 2-1 Extent of DEM and Bathymetric data received to date for Western Port Bay.

2.4 Catchments and waterways

Catchments, waterways and drains GIS data sets have been provided by Melbourne Water for the entire catchment, as shown in Figure 2-7.

2.5 Structures

General arrangement drawings for 23 waterway crossings of major highways in the study area were provided by VicRoads (Table 2-5).

Table 2-5 Structure drawings provided by VicRoads (where two drawings were provided for one crossing, these were for dual carriageways)

VicRoads Ref.	Road	Location
SN0678	Bass Highway	Bass River Bridge
SN0957/SN6819	Bass Highway	Bay Road
SN0958/SN3346	Bass Highway	Red Bluff Creek
SN3118/SN8346	South Gippsland Highway	Wylies Drain
SN3119/SN8349	South Gippsland Highway	Western Contour Drain
SN3121	South Gippsland Highway	Little Tooradin Creek
SN3123	South Gippsland Highway	Allsop's Inlet
SN3124/SN8358	South Gippsland Highway	Cardinia Catch Drain
SN3125/SN8350	South Gippsland Highway	Lyall's Inlet
SN3126/SN8359	South Gippsland Highway	Cardinia Creek
SN3127/SN8360	South Gippsland Highway	Moody's Inlet
SN3128	South Gippsland Highway	Little Bunyip River
SN3129/SN8356	South Gippsland Highway	Bunyip River
SN3130/SN6560	South Gippsland Highway	Yallock Creek
SN3131/SN6559	South Gippsland Highway	Yallock Channel
SN3133/SN6558	South Gippsland Highway	Monomeith Drain
SN3134	South Gippsland Highway	Unnamed Channel 500m NW of Lang Lang River
SN3135/SN6555	South Gippsland Highway	Lang Lang River
SN3136/SN6553	South Gippsland Highway	Lang Lang Floodway
SN6561/SN6562	South Gippsland Highway	Yallock Outfall Drain
SN6955/SN6995	South Gippsland Highway	Sawtells Inlet
SN8354	South Gippsland Highway	MacGregors Drain
SN8355	South Gippsland Highway	Deep Creek

Culvert details were also provided in GIS format by Casey City Council for their local government area, as shown in Figure 2-2.

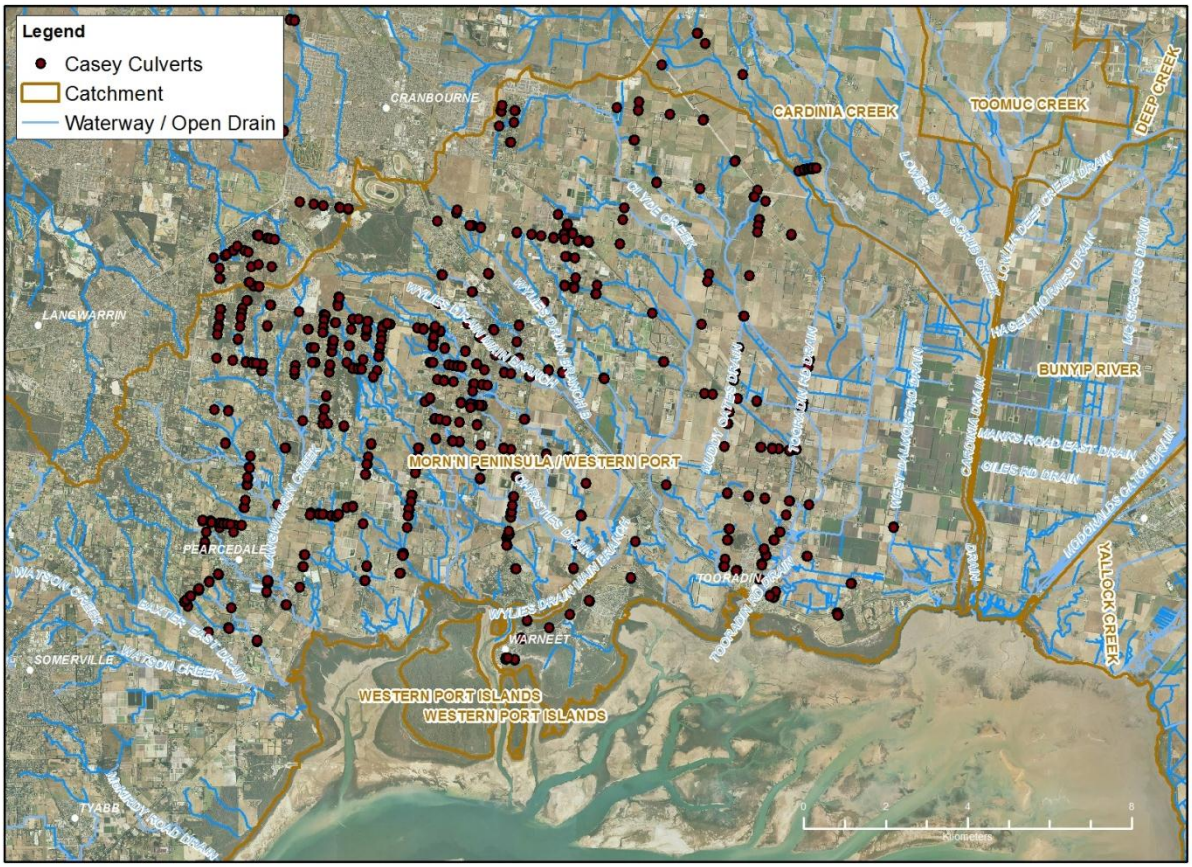

Figure 2-2 Culvert Layer provided by Casey City Council

2.6 Coastal assets and infrastructure

The following coastal mapping GIS data sets have been obtained for the study area.

Table 2-6 Coastal Mapping GIS Datasets

Data set	Description	Source	Date Completed
Victorian Coastal Levees	Coastal levees captured by DEPI for the Future Coasts Program	DEPI	2011
Victorian Coastal Protection Structures	Captured by DEPI for the Future Coasts Program and includes structures such as Breakwaters, Groynes, Revetments, Seawalls, Wharves etc.	DEPI	2011 Reviewed as part of the Future Coasts SECAP project (2011/2012).

2.7 Meteorology

2.7.1 Wind

Water Technology has previously sourced wind data for two sites within the project study area, and one nearby; Cerberus, Rhyll (as shown in Figure 2-3), and Pound Creek. Further wind data is available for neighbouring sites such as at Phillip Island Penguin Reserve, Wonthaggi and Cranbourne Botanic

Gardens from the Bureau of Meteorology (BOM) but was not required for this study. In addition to the listed measured wind dataset, the United States National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Prediction (NCEP) global reanalysis dataset provides hindcast reanalysis of wind conditions from 1981-2010, with a grid cell roughly centred over Western Port.

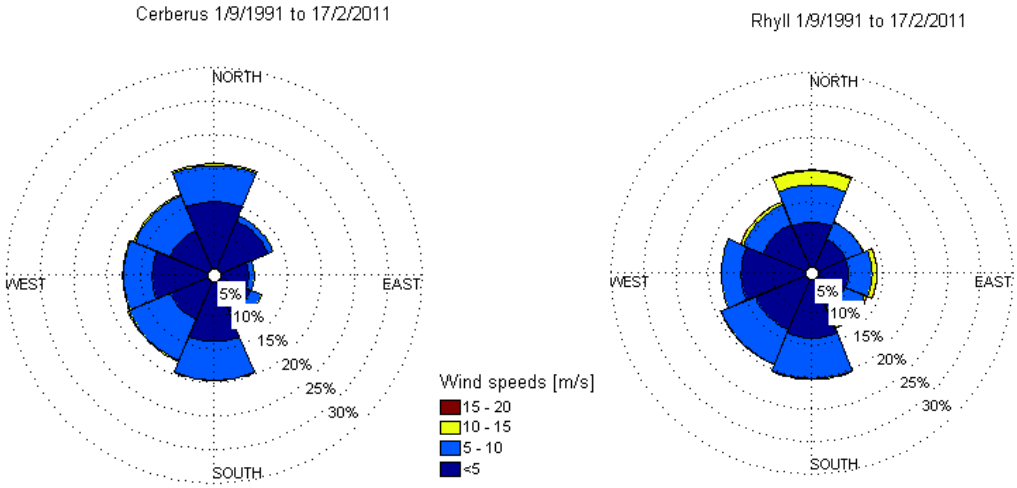

Figure 2-3 Wind Roses for Cerberus and Rhyll (1991-2011)

2.7.2 Rainfall

There are 20 currently recording daily rainfall stations in the catchment and approximately 66 historical stations. Daily rainfall data for all current and historic stations is available from the Australian Bureau of Meteorology (BOM).

There are 3 pluviograph stations within the catchment and a number more outside the fringes of the catchment.

The locations of the daily rainfall and pluviograph stations are shown in Figure 2-7.

2.8 Tide and Sea Level

Measured water level data is available from Stony Point and Tooradin (Table 2-7, Figure 2-4). Locations for the gauging stations are shown in Figure 2-7. Water level data from both gauges, along with current data (described in the following section), were used to calibrate the Western Port Bay Hydrodynamic model to a range of tidal and storm surge conditions.

Table 2-7 Tide Gauging Stations in Western Port

Station Number	Location	Operator	Data Period	Frequency
71004	Stony Point	BOM	1993-2012	Hourly
228399	Tooradin	Melbourne Water	2010-2012	10 minute

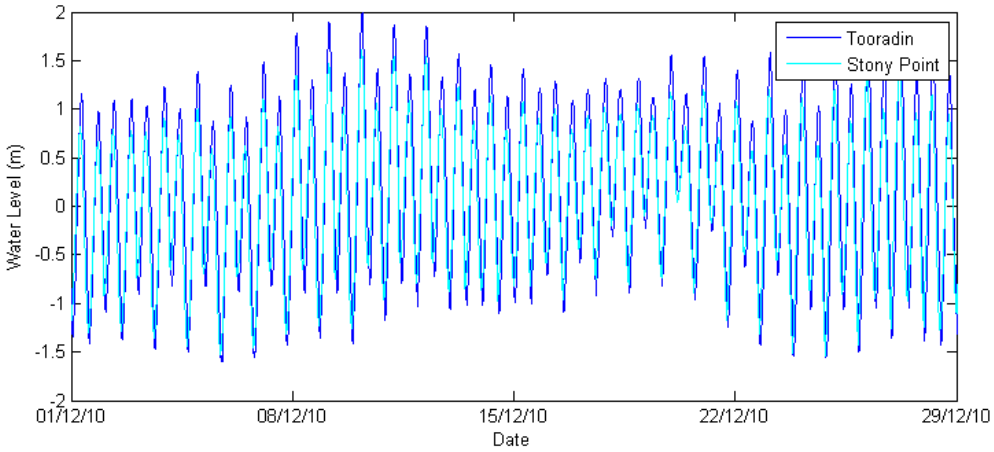

Figure 2-4 Example Time Series of Water Level Data at Tooradin and Stony Point

Water level data from Lorne was also sourced and used to assess and develop the non-tidal water level (residual) water levels outside of Western Port Bay. Figure 2-5 provides an example time series of the tidal, non-tidal and total water levels at Lorne.

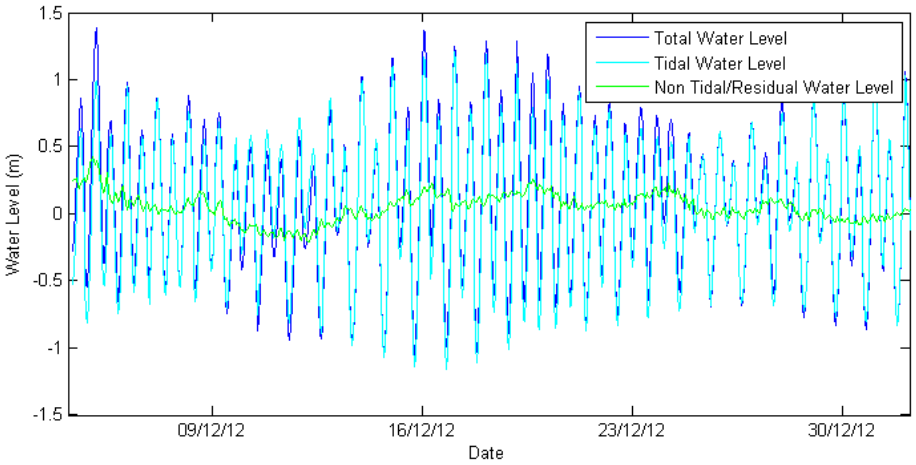

Figure 2-5 Example of a Decomposed Water Level Time Series at Lorne Showing the Total, Tidal and Non-Tidal Water Level Variations

2.8.1 Current Data

Current velocity data was available from the Environmental Protection Agency (EPA) in the form of three stationary Acoustic Doppler Current Profiler (ADCP) deployments within Western Port Bay, and two ADCP transects.

The three stationary ADCP instruments provided both U and V current velocity components at 1m increments throughout the water column, above the instrument. The instruments were deployed between the 8th of March and 17th of June 2011.

The ADCP transect measurements were conducted over a typical spring tidal cycle over the 14th and 14th of June, 2011, and provide lateral and depth averaged current speed, and flux through both the Western and Eastern arms. The location of the ADCP transects is shown in Figure 2-6.

Figure 2-6 Location of ADCP transects in Western Port

2.9 Inundation mapping

Two different coastal inundation data sets are currently available which map coastal inundation with sea level rise scenarios (with and without storm surge) based on simplified methodologies. The Victorian Future Coasts project has produced GIS data sets for current, +0.2m, +0.47m and +0.82m sea level rise scenarios with storm surge.

Melbourne Water has also prepared flood mapping for the 1% AEP coastal inundation for the entire Western Port area for current mean sea level and the 100 year sea level rise scenario (+0.82m). This mapping includes an allowance for tidal surge, wave set-up and wind impacts on levels.

The two data sets closely align within the Western Port Bay area (albeit the MW data set does not include data for French Island) but differences can be observed in the Port Phillip Bay region where the MW data set has taken into account bunding and road infrastructure that may restrict inundation. Both data sets were provided to the study team in GIS format.

It should be noted that this study (WPLCHA) has revised the inundation mapping for current mean sea level and sea level rise scenarios using hydrodynamic modelling. A comparison has been made between these previously developed datasets and the new inundation modelling. Refer Report 5 of the study for further comments.

2.10 Flow Gauging

Instantaneous flow data for gauges in the Western Port catchment was sourced from Melbourne Water and the Victorian Water Resources Data Warehouse (www.vicwaterdata.net). Additional monthly instantaneous flow values were sourced from the State Rivers and Water Supply Commission "Blue Book", (RWC, 1990). The gauging stations within the Western Port catchment are listed in Table 2-8.

Table 2-8 Instantaneous Flow Gauging Stations in Western Port catchment

Station Number	River	Station Name	Data Period
227231A	Bass River	Glen Forbes South	1973-present
228208A	Lang Lang River	Lang Lang	1974-1981
228209B	Lang Lang River	Hamiltons Bridge	1980-present
228213A	Bunyip River	Iona	1971-present
228217C	Toomuc Ck	Pakenham	1971-present
228228A	Cardinia Ck	Cardinia	1974-present
228232A	Yallock No 4 Drain	Bayles	1978-1984
228225A	Yallock Outfall	Cora Lynn	1981-present
228226A	Stony Ck	Shoreham	1985-1989
227219A	Bass River	Loch	1966-2012
228201B	Tarago	Drouin West	1974-present
228206B	Tarago	Neerim	1980-present
228207A	Bunyip	Headworks	1980-present
228212A	Bunyip	Tonimbuk	1975-present
228214A	Diamond Ck	North Bunyip	1980-1987
228219C	Tarago	Neerim South	1974-present
228222A	Cardinia Ck	Beaconsfield Upper	1974
228224A	Tarago	Tarago Reservoir (Head Gauge)	1992
228230A	Cardinia Ck	D/S Muddy Creek Junction	1975-2000
228238A	Tarago East B	U/S Neerim Br. (Elton Road	1993-present
228700A	Bunyip Channel	Headworks	1984-1987
228701A	Tarago Channel	Flyne No 1	1984-1987
228702A	Tarago Channel	Woodlands (U/S of Junction	1984-1987

Figure 2-7 Catchment and waterway data, rainfall and stream gauges in Western Port catchment

2.11 Catchment Models

Catchment hydrologic models (typically RORB models, http://eng.monash.edu.au/civil/research/centres/water/rorb/) were available from previous Water Technology projects in the Western Port Catchment, and also from Melbourne Water for other major catchments (Table 2-9). Two hydraulic rainfall-on-grid models were also available from previous Water Technology projects.

Table 2-9 Catchment models available within Western Port catchment

Type of Model	Location	Source
RORB – parameters reconciled to rational method	Tooradin Inlet	Water Technology
RORB – parameters reconciled to rational method	Wylies, Muddy Gates and Western Outfall Drains	Water Technology
RORB – standard parameters	Cardinia Creek	Melbourne Water
RORB – standard parameters	Deep and Toomuc Creek	Melbourne Water
RORB – standard parameters	Yallock Creek	Melbourne Water
RORB – standard parameters	Lang Lang River	Melbourne Water
RORB – standard parameters	Bass River	Melbourne Water
TUFLOW Rainfall on Grid	Warringine Creek at Crib Point	Water Technology
TUFLOW Rainfall on Grid	Somers Creek	Water Technology

2.12 Geology & Geomorphology

Victorian Geology data has been sourced from the DEPI GIS data sets for the Warragul and Queenscliff 1:250,000 mapping (Geol250). A Geomorphological Units data set (GMU250) sourced from DEPI has also been compiled. This data set incorporates geological and soils information includes attributes indicating susceptibility to sheet, gully and wind erosion and land slips.

The GIS data set of geological sites of significance (based on **Sites of Geological and Geomorphological Significance in the Westernport Bay Catchment (1984)** by Neville Rosengren) was sourced from DEPI.

The project team also requested any geology reports pertaining to the South Gippsland Highway from VicRoads. This information could be purchased from VicRoads, however upon review of the costs and benefits it was decided by the project team that the additional information did not warrant the additional costs to the project.

2.13 Ecology

The following ecological GIS data sets have been obtained for the study area.

Table 2-10 Ecological data sets sourced for this project

Data set	Description	Source	Date Completed
Intertidal EVC	Detailed mapping of coastal and		2011

Data set	Description	Source	Date Completed
Mapping	intertidal vegetation communities. The data includes over 20 different vegetation communities including saltmarshes, mangroves and estuarine wetlands.	DEPI Arthur Rylah Institute. Victorian Saltmarsh Study (2011).	
Pre-1750 Coverage of Intertidal Vegetation, Victoria	As above, for Pre-1750	DEPI Arthur Rylah Institute.	2011
Seagrass mapping	Seagrass mapping of Western Port including Seagrass and Algae in the near shore environment.	DEPI	1999

Data sets for sites of ecological significance (Biosites) and locations of significant flora and fauna were also provided by DEPI.

2.14 Groundwater

The following groundwater data sets have been sourced fort this project.

Table 2-11 Groundwater data sets sourced for this project

Data set	Description	Source	Date Completed
MW GDE mapping	Groundwater dependent ecosystems and refuges (regional scale data)	MW	Current
Melbourne Groundwater Atlas	Depth and quality of groundwater aquifers	DEPI	2010
SRW Groundwater Maps	Depth and quality of groundwater aquifers (South West)	Southern Rural Water (SRW)	2009
National GDE Atlas	Groundwater dependent ecosystems (national to state scale data)	Bureau of Meteorology (BOM)	2012

2.15 Cultural heritage

A GIS data set of Areas of Cultural Heritage Sensitivity has been sourced from Aboriginal Affairs Victoria (AAV) / DPCD. These are areas that are either known to have or have the potential to contain places and objects of Aboriginal cultural heritage. In addition, areas where cultural heritage surveys have been undertaken and areas that have RAP (Registered Aboriginal Parties) Applications have also been sourced.

2.16 Council Reports

The following project related reports were received from the project partner Councils.

- Biosis Research (2008). Flora and fauna of The Inlets, Koo Wee Rup, Victoria, Report prepared for Melbourne Water,
- Brett Lane & Associates, (2001). Rutherford Inlet North East Saltmarsh Protection Study – Analysis of Values and Threats, Report prepared for City of Casey,
- Coastal Engineering Solutions (2008). Tooradin Foreshore Reserve Coastal Process Study, Report prepared for DSE and Tooradin Foreshore Committee of Management,
- GHD (2010). Management Plan for Lang Lang Clay Banks Stabilisation, Report for Cardinia Shire Council
- Murphy, A. (1997). An Overview of the Aboriginal Archaeology within the "non-urban south and non-urban foreshore", Victoria, Report prepared for City of Casey,
- PPK Environment & Infrastructure, (date unknown). Rutherford Inlet Environmental Planning Study, Report prepared for City of Casey,
- Wallis Consulting Group (2010). Community Survey: Attitude to Climate Change, Report prepared for City of Casey,
- Wallis Consulting Group (2011). Usage of, and Attitudes towards, the Westernport Area, Report Prepared for City of Casey
- Wallis Consulting Group (2012). Findings of the Community Awareness Survey on Environmental Sustainability, Report prepared for City of Casey

3. GAP IDENTIFICATION

A gap and knowledge identification process was undertaken during the initial stages of the project. Much of the data or information initially identified was sourced by the project team and included within later stages of the project. The following outstanding data, information or knowledge gaps are summarised below and should be viewed in conjunction with those detailed in the Part A reports (R4 & R5) and Part B report (R6) which accompany this document.

3.1 Data or Information Gaps

3.1.1 Structures

Bridges and culverts along roadways within the study area can impact on the movement of water from the coastline into the catchments. The project team has incorporated those structures which impact flooding (where possible) within the hydrodynamic model. The Part A assessment has picked up key structures across the project area focussing on the South Gippsland Highway, while for Part B additional local structures were included. Local drainage structures within areas such as Tooradin have been included where relevant; however the scale of this WPLCHA project is such that detailed modelling of stormwater drainage networks is not possible.

3.1.2 Erosion rates

Researchers from CSIRO are currently undertaking a project to understand the processes and inputs of sediment from coastal erosion in Western Port. The primary study area is an 8 km stretch of actively eroding coastline located at the head of the embayment near the Lang Lang township.

To date the project is still underway and no project reports have been released. Information provided on the CSIRO project website (e.g. time lapse photos) has been utilised for this study.

3.2 Knowledge gaps

3.2.1 Vegetation

There is presently a poor understanding of how coastal vegetation responds to altered salinity and water regimes. There is some knowledge for mangroves on salinity responses and in general terms for water-level responses, but what is lacking is finely resolved information on both. The situation with saltmarshes and other types of estuarine vegetation (e.g. Juncus kraussii) is even poorer. For the present study the team has drawn upon all available knowledge in this area and highlighted the limitations and implication any limitations on the study outcomes (Refer to the Erosion Hazard Report, R5).

3.2.2 Erosion rates

All available information on sediments and erosion within the Western Port study area has been collated and assessed for this project. However there remains uncertainty about the likely erosion rates of specific areas under sea level rise conditions. The project team has therefore highlighted the limitations and implication of any limitations on the study outcomes. (Refer to the Part A reports (R4 & R5) and Part B reports (R6) for further detailed discussion).

4. REFERENCES

Biosis Research (2008). Flora and fauna of The Inlets, Koo Wee Rup, Victoria, Report prepared for Melbourne Water,

Brett Lane & Associates, (2001). Rutherford Inlet North East Saltmarsh Protection Study – Analysis of Values and Threats, Report prepared for City of Casey,

Coastal Engineering Solutions (2008). Tooradin Foreshore Reserve Coastal Process Study, Report prepared for DSE and Tooradin Foreshore Committee of Management,

GHD (2010). Management Plan for Lang Lang Clay Banks Stabilisation, Report for Cardinia Shire Council

Murphy, A. (1997). An Overview of the Aboriginal Archaeology within the "non-urban south and non-urban foreshore", Victoria, Report prepared for City of Casey,

PPK Environment & Infrastructure, (date unknown). Rutherford Inlet Environmental Planning Study, Report prepared for City of Casey,

RWC (1990) *Victorian Surface Water Information to 1987*, Volume 3, River Basins 1-5, Rural Water Commission of Victoria, Armadale, Victoria.

Sharples, C. (2012). Preliminary notes on an ortho-rectified air photo time series for Western Port, Notes by Chris Sharples, 15th September 2012

Wallis Consulting Group (2010). Community Survey: Attitude to Climate Change, Report prepared for City of Casey,

Wallis Consulting Group (2011). Usage of, and Attitudes towards, the Westernport Area, Report Prepared for City of Casey

Wallis Consulting Group (2012). Findings of the Community Awareness Survey on Environmental Sustainability, Report prepared for City of Casey

APPENDIX A BIBLIOGRAPHY

APPENDIX B AERIAL IMAGERY

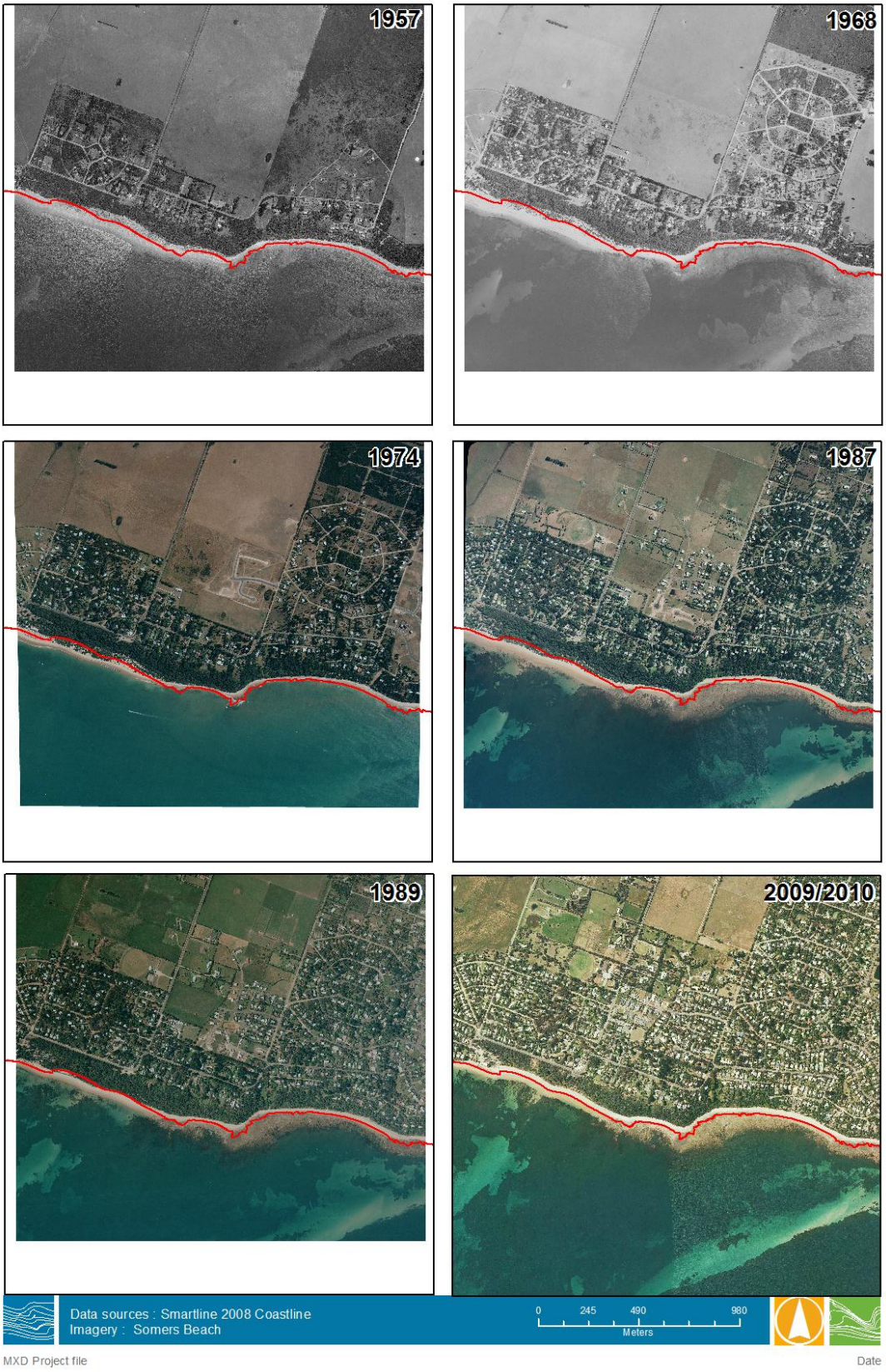

Table B-4-1 Somers Beach (1957-2009)

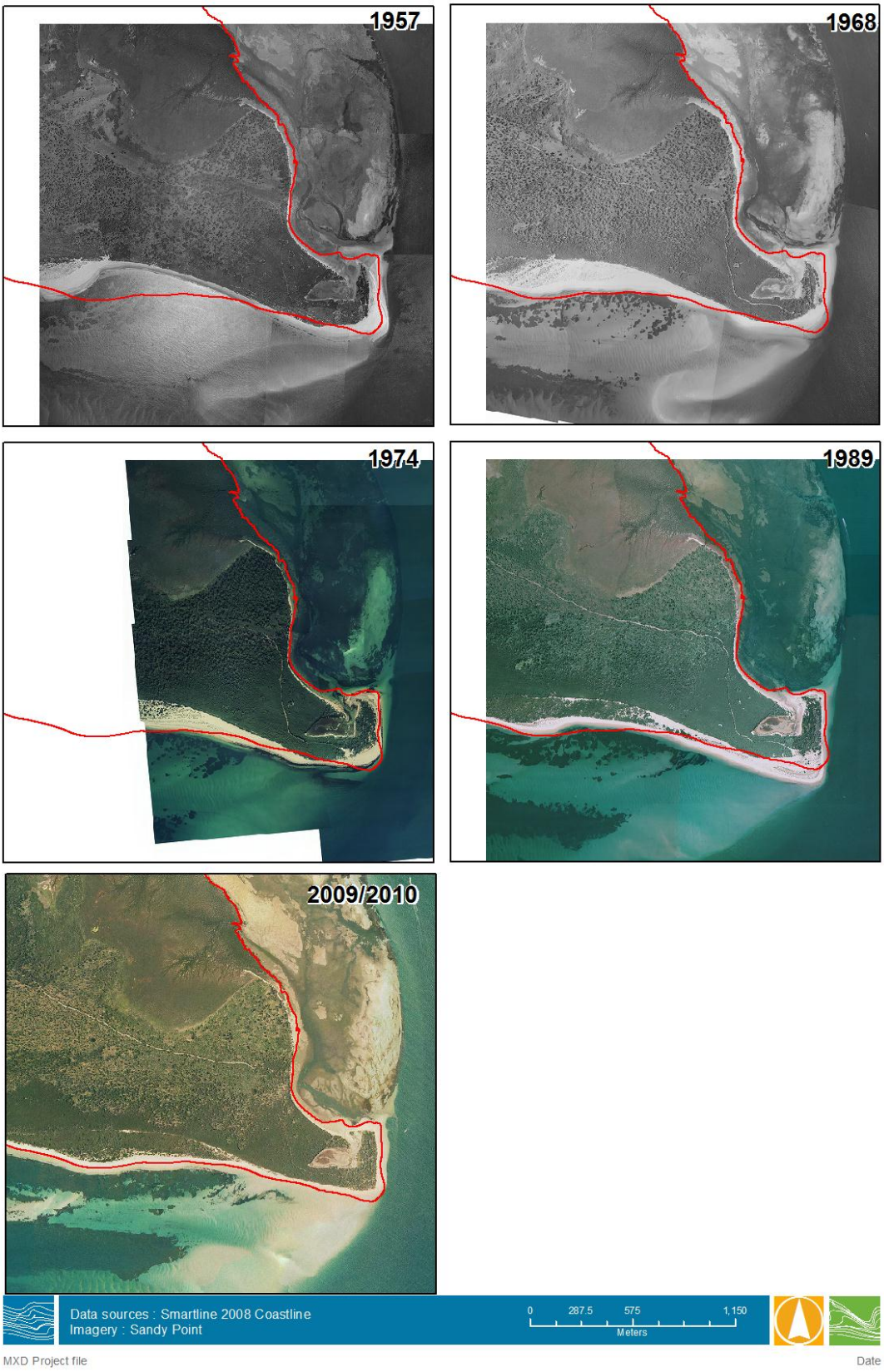

Table B-4-2 Sandy Point (1957-2010)

Table B-4-3 Tooradin (1967-2010)

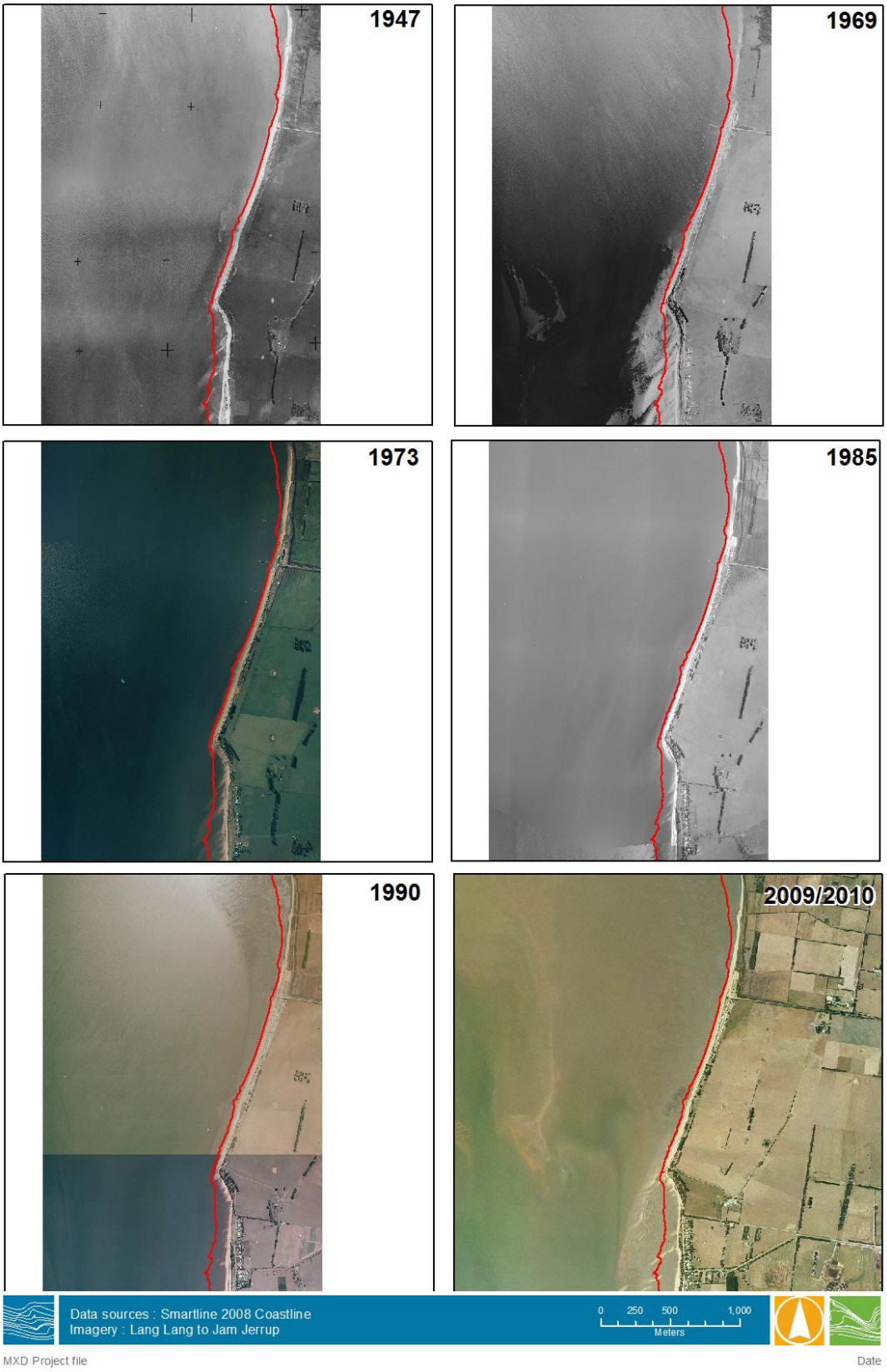

Table B-4-4 Lang Lang (1947-2010)

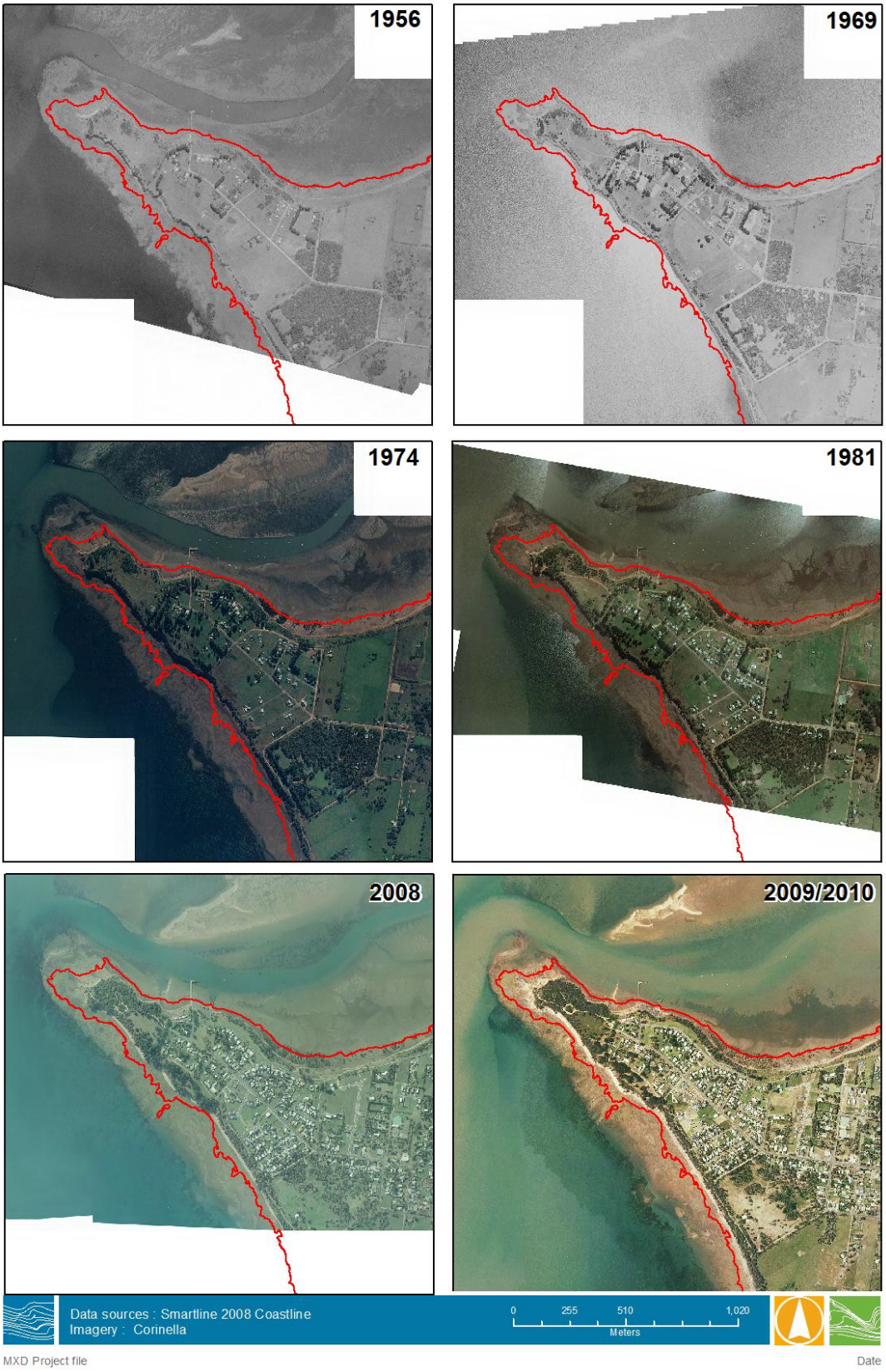

Table B-4-5 Corinella (1956-2010)