Weather Bomb 12 June 2006

Storm Surge Report

Prepared by Rachael Medwin
Environment Bay of Plenty
Operations Publication 2008/01

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NEW ZEALAND

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E mahi ngatahi e pai ake ai te taiao

Environment Bay of Plenty
REGIONAL COUNCIL

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Tables

Chapter 1: Introduction

On 12 June 2006 a cold front associated with a rapidly developing low pressure zone passed over the Eastern Bay of Plenty. Bringing with it heavy rain and strong winds, generating a sizeable storm surge. This event was different to most significant storm surge events in that the peak storm surge level was reached at low tide and not high tide. This report summarises the details concerning this event, the magnitude of the storm and relevant meteorological factors concerned. This data is of considerable value for future re-estimates of coastal hazards including design maximum sea levels.

Chapter 2: Storm surge components

Storm surge occurs as a result of coastal storms and super elevates of sea level along the coast. There are many factors involved in generating a storm surge. The three principal components are:

- Barometric setup
- Wind setup
- Estuary effects

Within an estuary there is often an additional set up or set down, this is known as the estuary effect.

2.1 Barometric setup

As barometric pressure falls below the level of 1014 mb (which is defined as standard pressure) sea level rises above normal. The relationship is that for every millibar drop in pressure sea level rises by 1 cm.

The tidal heights in the Almanac are given in Chart Datum and are converted into Moturiki Datum by subtracting 0.963 from the Almanac height. This level then needs to be raised by 0.1 m at locations east of Matata and then a further 0.1 m for those locations east of Omaio; this is in order to make account for the earth's spherical shape.

2.2 Wind setup

The surface shear stress of the wind (called the geostrophic wind) travelling over the sea surface drives water in the prevailing wind direction. An onshore wind thus drives a wedge of water against the land. The magnitude of the height of this wedge is called the wind setup.

The size of the wind setup is complex to calculate and is dependent on several factors including:

- Intensity, duration and direction of high winds.
- Coastline bathymetry.
- Coastline geometry. The concave shape of the Bay of Plenty coast is likely to enhance setup levels.

2.3 Estuary effects

There are two components involved in estuary effects:

- Hydraulic effects relating to influx of freshwater, outlet controls, depth and channelling of water.
- Spatial differences in water levels due to the differential effect of wind stress.

Chapter 3: Synoptic situation

Full details of the synoptic situation including synoptic charts, special weather bulletins and the track of the cyclone are presented in Appendix I.

A low centred over the eastern Tasman Sea developing rapidly, moved swiftly over the central North Island around midday Monday, bringing stormy conditions, heavy rain and damaging winds to the North Island of New Zealand. A summary of the relevant meteorological data in the Bay of Plenty is given in Table 1 below.

In comparison the 1% AEP barometric pressure is 981 mb, with extreme coverage and central pressures expected to be even lower and 1% AEP winds speeds are 34-36 m/s.

Table 1 Weather Bomb Meteorological Recordings (12 June 2006)

12/06/2006 Weather Bomb Event Meteorological Recordings			
Site	**Peak Wind Gust (m/s)**	**Peak Average Wind speed (m/s)**	**Minimum Barometric Pressure(mb)**
Edgecumbe	23.61	15.06	-
Whakatane Airport	29.3	18.5	989.6 at 1700hrs
Tauranga Airport	24.2	14.9	990.3 at 1500hrs
Whakatane Wharf			988.3 at 1500hrs
Tauranga at Omokoroa			989.9 at 1615hrs
Note: Peak average wind speed for Whakatane and Tauranga Airports is taken on 1 hour duration. For Edgecumbe it is based on 10 minute duration.			

Chapter 4: Recorded sea levels

Peak sea levels were recorded at a number of gauges for the event. Measurements of peak level at other sites were made by examining and surveying debris levels on the following day. The location of these additional sites is shown on Figure 1. This storm surge event was different to others reported on, as the peak storm surge was reached at low tide, not high tide. This means that the highest water level was reached at high tide but the greatest height above predicted tide height was reached at low tide.

Details of the peak sea levels, including the estimated storm surge are presented in the following Tables 2 and 3. The magnitude of a storm surge level is taken as the actual recorded peak water level minus the coinciding predicted tide level. Floating Astronomical Tide levels were taken from the Nautical Almanac these are the predicted levels, some values were calculated using secondary port calculations. All levels were converted to Moturiki Datum. The Nautical Almanac is in chart datum, this relates to -0.963 m Moturiki Datum. Peak levels were gathered from Environment Bay of Plenty data recorders and from surveyed levels taken post event.

At this stage it is not 100 percent clear to what extent the rivers influence the storm surge levels recorder within their mouths. Affected sites include the Whakatane and Opotiki Wharf recorders, the Thornton and Fords Cut (Kaituna) recorders. The flow in the relevant rivers at the time of a storm surge and the distance the recorder is from the open coast are factors that will influence our data collection at these locations.

Table 2 Weather Bomb Recorded Sea Levels at High Tide and associated Storm Surge (12 June 2006).

Location	Peak Time High Tide	Floating Astronomical Tide (m RL)	Peak Level (m moturiki datum)	Storm surge level (m)
Fords Cut	20:15	0.937	1.340	0.403
Ohiwa at Port Ohope	19:40	1.087	1.453	0.366
Opotiki Wharf	19:30	1.087	1.619	0.532
Thornton	18:45	1.037	1.572	0.535
Whakatane Wharf	19:15	1.037	1.369	0.332
Tauranga at Hairini	19:55	0.937	1.153	0.216
Tauranga at Omokoroa	8:30	0.837	0.947	0.110
Tauranga at Oruamatua	21:25	0.937	0.916	-0.021
Tauranga at Moturiki	19:35	0.937	0.974	0.037
A. Ohiwa at Harbour Sediment site 1**	-	1.087	1.340	0.253
B. Ohiwa at Harbour Road Reserve**	-	1.087	1.360	0.273
C. Ohiwa at Claydon Place**	-	1.087	1.380	0.293
D. Ohiwa at Harbour Sediment site 2**	-	1.087	1.320	0.233
E. Ohiwa at Kutarere Jetty**	-	1.087	1.530	0.443
F. Ohiwa at Ohiwa Loop Road Boat Ramp**	-	1.087	1.430	0.343
G. Ohiwa at Harbour Sediment site 9**	-	1.087	1.410	0.323

H. Ohiwa at Harbour Sediment site 10**	-	1.087	1.440	0.353
I. Ohiwa at Ohiwa Motor Camp**	-	1.087	1.550	0.463
Note: *Double asterisks (**) indicates locations that have been measured from debris levels the following day.*				
Note: *Locations of sites A- I are shown on figure1*				

Table 3 Weather Bomb Recorded Sea Levels at Low Tide and associated Storm Surge (12 June 2006).

Location	Peak Time Low Tide	Floating Astronomical Tide (m RL)	Peak Level (m RL)	Storm surge level (m)
Fords Cut	13:45	-0.663	0.003	0.666
Ohiwa at Port Ohope	14:15	-0.613	0.037	0.650
Opotiki Wharf	14:00	-0.413	0.094	0.507
Thornton	13:45	-0.563	0.165	0.728
Whakatane at Wharf	13:45	-0.563	-0.015	0.548
Tauranga at Hairini	14:25	-0.663	-0.234	0.429
Tauranga at Omokoroa	14:30	-0.663	-0.460	0.203
Tauranga at Oruamatua	15:30	-0.663	-0.122	0.541
Tauranga at Moturiki	13:00	-0.663	-0.557	0.106


LEGEND
Recorded Debris Locations
B = 1.36m
C = 1.38m
A = 1.34m
D = 1.32m
I = 1.55m
H = 1.44m
G = 1.41m
F = 1.43m
E = 1.53m
Surge Levels (m) Moturiki Datum
Ohope
Ohiwa Harbour
Ohakana Island
Uretara Island
Motuotu Island
Port Ohope
Ohiwa
Wainui
Cheddar Valley
Kutarere
Waingarara
Weather Bomb, 12th June 2006, Ohiwa Harbour Storm Surge
Printed at 24/09/07 12:29:43 by EBOP\medwinr
GeoView 1.2.2648.29291
Scale 1:49,925
0 0.25 0.75 1 2 3 4
kms
© Environment Bay of Plenty (the Bay of Plenty Regional Council)
N

Figure 1

Chapter 5: Discussion

5.1 Frequency of these events

The meteorological measurements (barometric pressure and wind speed) for the weather bomb on 12 June 2006 indicate that it was of significantly less intensity than a 100 year return period event. Whilst exact statistics are not available, it is likely that the weather bomb on 12 June 2006 has a similar return period to that of Cyclone Ivy, a 10 year return period magnitude.

The peak wind during this storm was very high (29.3 (gust), 18.5 (average), greater than that experienced in Cyclone Fergus (1996 - 26.3 (gust), 17 (average)) and Ivy (2004 - 22.14 (gust), 14.95 (average)).

The minimum barometric pressure recorded at Whakatane airport was 989.6 very similar to that produced during Cyclone Ivy (989.6) but not as low as the 1% AEP barometric pressure of 981 mb.

5.2 Recorded storm surge levels

Unlike many storm surge events during this particular storm the peak storm surge effect was measured at low tide making it only possible to gain peak storm surge levels from site where there are tidal recorders. Data gathered from debris marks records the highest elevation the water reached; this was the level at high tide, which produced a higher water level but lower storm surge effect.

The highest storm surge level was recorded at Ohiwa at Port Ohope as 0.737 m. It is likely that other places around the Ohiwa Harbour reached higher levels (assumption is made from looking at levels in Table 3 at Kutarere Jetty and Ohiwa Harbour Road where levels exceeded that for Ohiwa at Port Ohope).

Within Tauranga Harbour, storm surge levels have been calculated for sites at Haurini, Oruamatua and Omokoroa. Table 3 shows the storm surge levels at these sites to range from 0.20 m to 0.54 m.

5.3 Storm surge component for 12 June 2006

At Whakatane low tide was at 1345 with peak wind speeds reached at 1300 and minimum barometric pressure at 1445-1500. All are within 2 hours of each other. Using the Ohiwa at Port Ohope data, the following appear to be the storm surge components at low and high tide.

Low Tide		
Astronomical Tidal Height	-0.613m RL	
Barometric Setup	0.244m	Taken at time of low tide
Wind Setup	0.406m	
Total	0.037m	
High Tide		
Astronomical Tidal Height	1.087m RL	
Barometric Setup	0.231m	Taken at time of high tide
Wind Setup	0.135m	
Total	1.453m	

The "static" storm surge component is thus the sum of the barometric setup and wind setup and for Ohiwa Harbour at Port Ohope is 0.65 m at low tide and 0.37 m at high tide.

For Tauranga Harbour, the "static" storm surge component is 0.43 m at low tide and 0.22 m at high tide, based on the peak levels at the Hairini gauge and astronomical tide of -0.66 m (low tide) and 0.94 m (high tide).

Thus the "static storm surge" was 0.22 m greater at Ohiwa than Tauranga (at low tide), reflecting the storm direction and concave geometry in the Eastern Bay of Plenty.

5.4 Estuary effects

Different estuary effects are principally caused by the wind stress across the body of water, causing an "estuary" wind setup and wave runup (also perhaps wave setup). The quantum of these in the 12 June 2006 weather bomb can be determined from the different levels recorded at the various sites, as compared to the respective Moturiki and Ohiwa recorders (although it is possible that the Ohiwa recorder has a minor wind "setdown"). The effects are presented in Table 4.

Table 4 Recorded Estuary Effects (12 June 2006)

Location	Peak Level (m RL)	Estuary Effect (m)
A. Ohiwa at Harbour Sediment site 1**	1.340	-0.113
B. Ohiwa at Harbour Road Reserve**	1.360	-0.093
C. Ohiwa at Claydon Place**	1.380	-0.073
D. Ohiwa at Harbour Sediment site 2**	1.320	-0.133
E. Ohiwa at Kutarere Jetty**	1.530	0.077
F. Ohiwa at Ohiwa Loop Road Boat Ramp**	1.430	-0.023
G. Ohiwa at Harbour Sediment site 9**	1.410	-0.043
H. Ohiwa at Harbour Sediment site 10**	1.440	-0.013
I. Ohiwa at Ohiwa Motor Camp**	1.550	0.097
Tauranga at Hairini	1.153	0.179
Tauranga at Omokoroa	0.947	-0.373
Tauranga at Oruamatua	0.916	-0.614
Note: *Double asterisks (**) indicates locations that have been measured from debris levels the following day.*		
Note: *Locations of sites A- I are shown on Figure1*		

Chapter 6: Conclusion

The weather bomb of 12 June 2006 produced a significant storm surge event. Had the peak coincided with high tide the magnitude of the resulting water elevations would have been significantly larger. This storm was unlike other significant events in that the peak storm surge was measured at low tide not high tide.

Barometric pressure and wind data recorded during the event suggest the storm to have around a 10 year return period.

The maximum storm surge elevations were recorded at Thornton, Opotiki and in the Ohiwa Harbour. The levels recorded in the Western Bay of Plenty were well below the levels recorded in the Eastern Bay of Plenty, reflecting the influence of the concave nature of the Bay of Plenty and the direction of the weather system.

Chapter 7: References

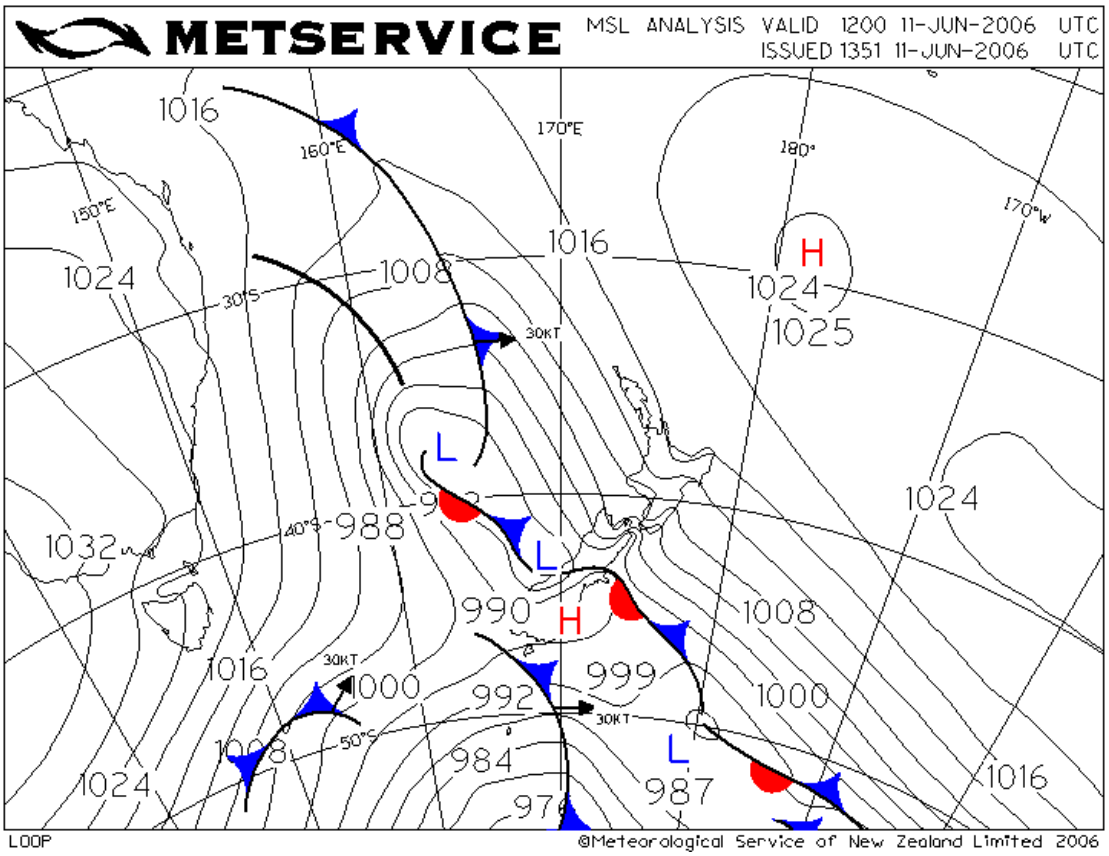
Arts, V, 2005, Cyclone Ivy: Magnitude of Storm Surges Recorded and Implications for Design Maximum Sea Levels. Environment Bay of Plenty Operations Report No 2005/04.

Blackwood, PL, March 1997: Cyclone Fergus and Drena Storm Surge: Report on the Magnitude of Storm Surges Recorded and Implications for Design Maximum Seal Levels. Environment Bay of Plenty Operations Report No 97/1.

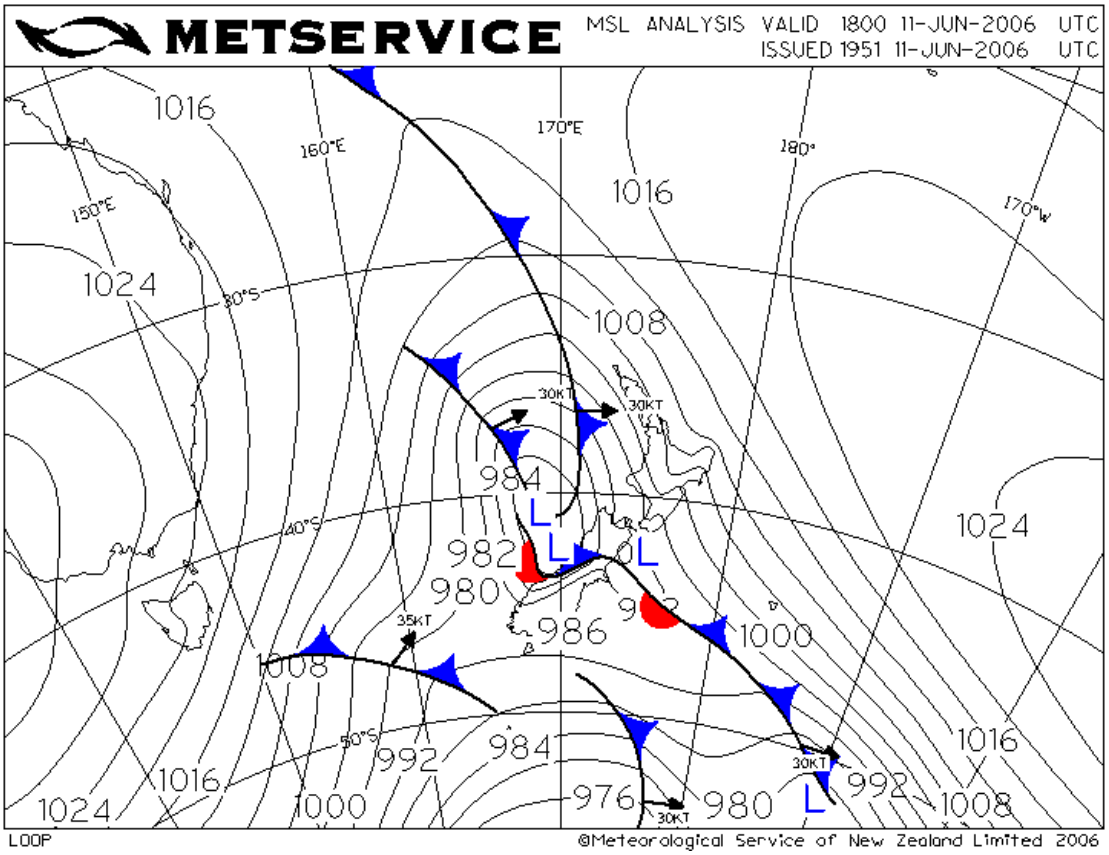
Appendices

Appendix I – Synoptic situation

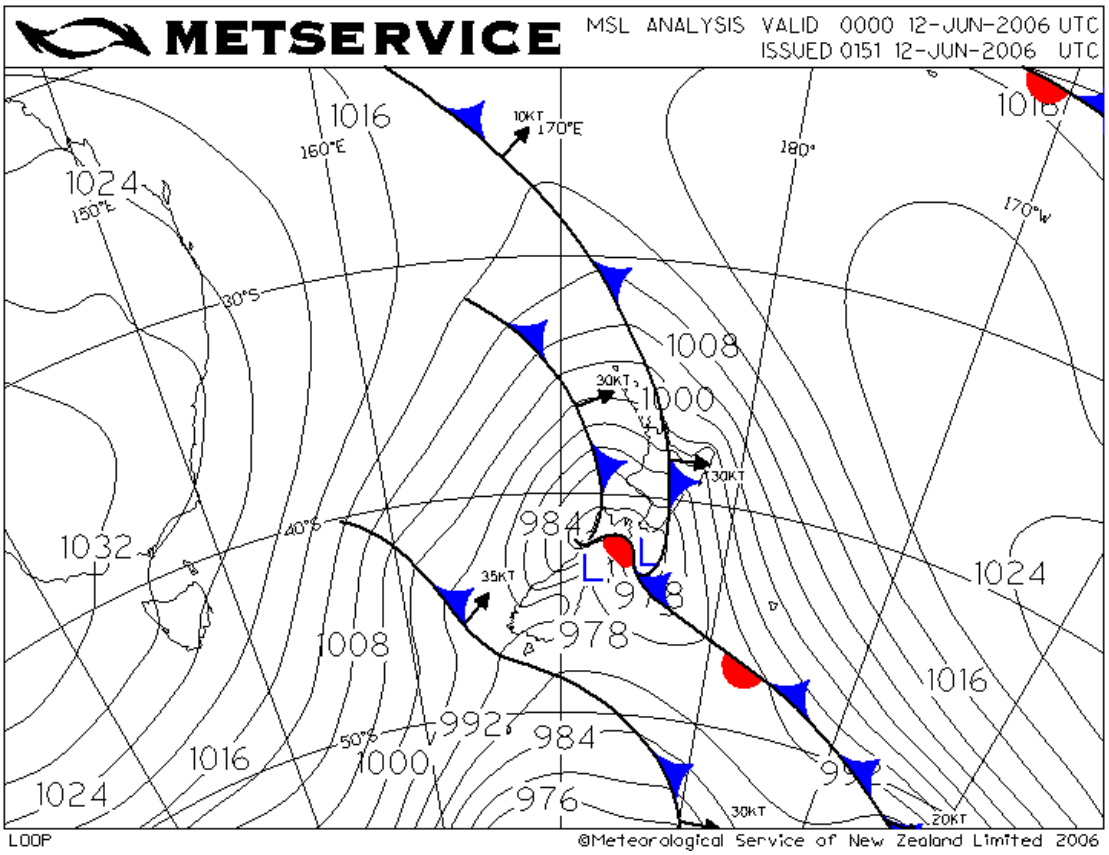
Met Service Weather Maps



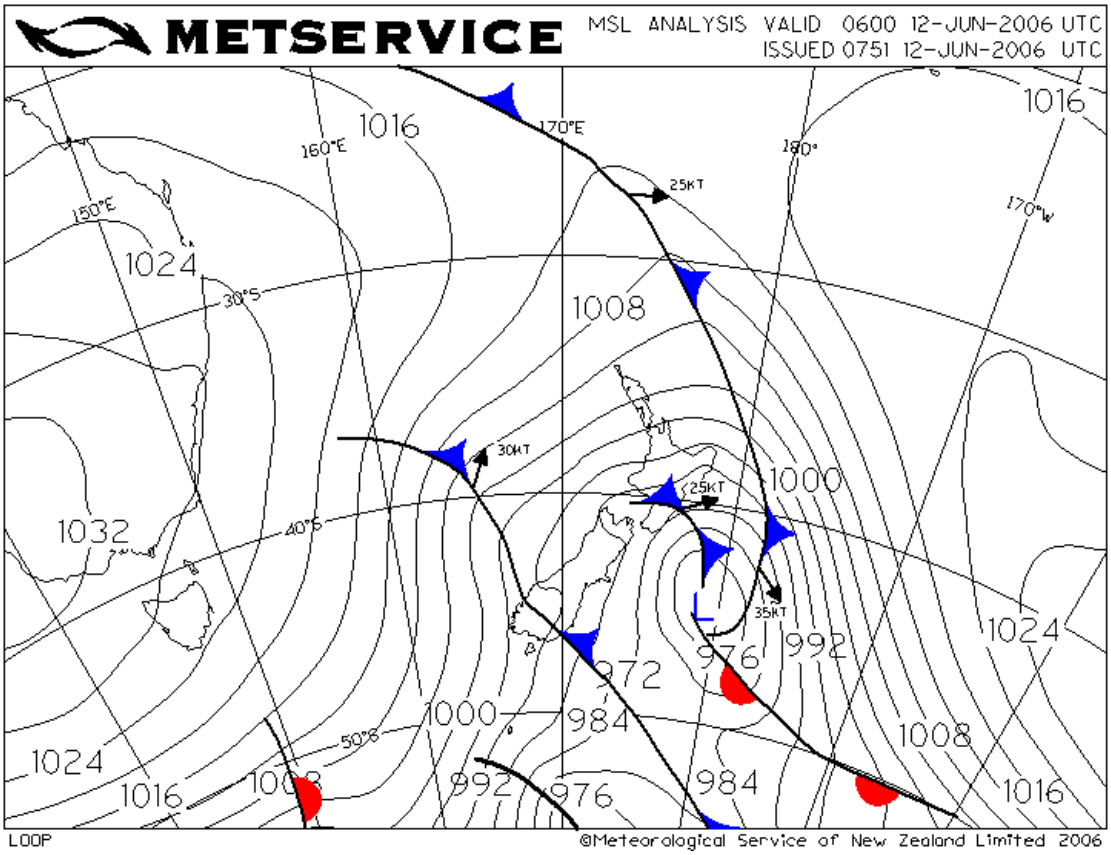
1351 11 June 2006



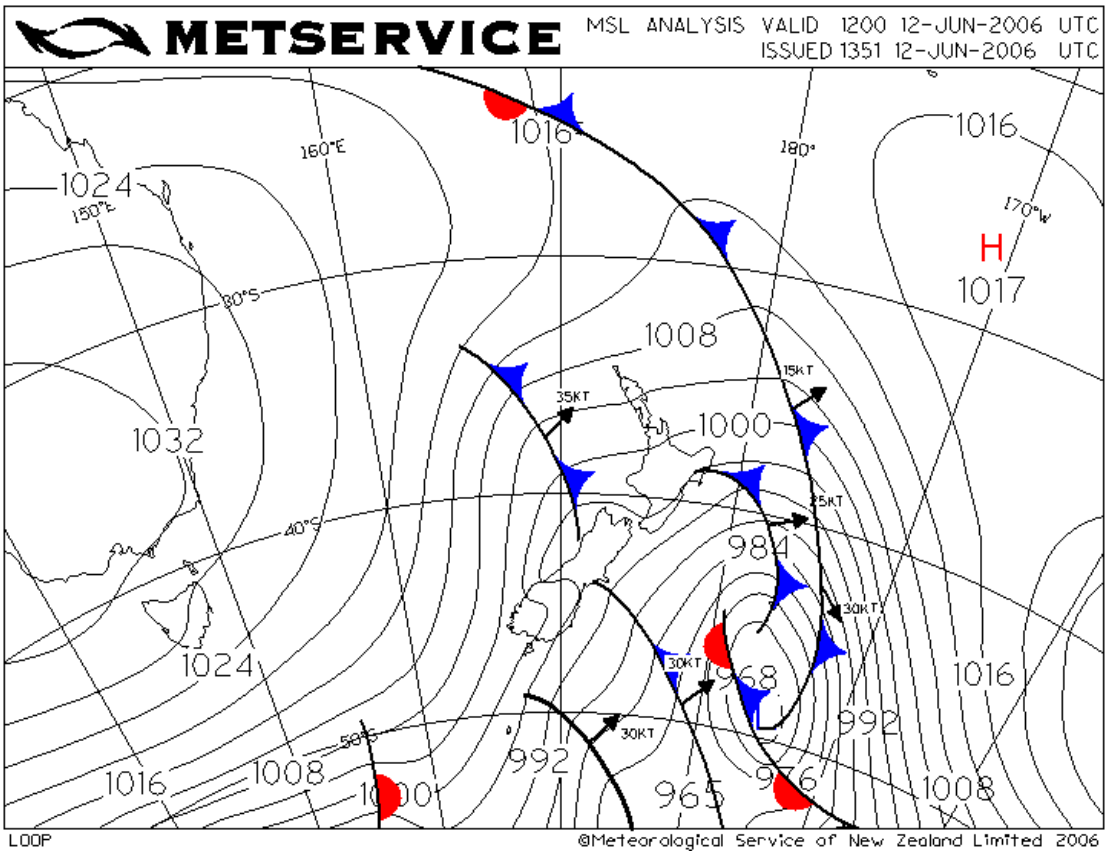
1951 11 June 2006



0751 12 June 2006



0151 12 June 2006



1351 12 June 2006

Met Service Issued Severe Weather Warnings

2760 05

Severe Weather Warning

SEVERE WEATHER WARNING.
ISSUED BY MetService AT 8:25 pm 11-Jun-2006

HEAVY RAIN AND STRONG WINDS FOR MANY PLACES - WIND WARNING EXTENDED TO NORTHERN HALF OF NORTH ISLAND, AND TO MARLBOROUGH AND NORTH CANTERBURY, HEAVY SNOW FOR SOUTH CANTERBURY

A low is deepening rapidly in the eastern Tasman Sea, and should quickly cross central New Zealand around midday Monday. Ahead of the low, gale north to northwest winds are bringing very heavy rain to the South Island west coast, and the headwaters of the Otago and Canterbury lakes and rivers, and heavy falls should spread to the ranges of Nelson and northwest Marlborough. Another 150 to 200mm of rain is likely in the ranges of Westland and on the main divide between Otira and Mount Aspiring, with lesser amounts near the coast and in the ranges of Nelson and northwest Marlborough.

A brief burst of heavy rain and severe northerly gales is also expected about higher areas of the North Island from Taranaki across the central plateau to the ranges of Bay of Plenty and northern Gisborne. Here, 60 to 100mm of rain is likely to fall during Monday morning or early afternoon.

A period of severe northerly gales, with damaging gusts of 120 to 150 km/h are expected over all the North Island. The wind warning has now been extended to cover the whole of the North Island, also Marlborough and north Canterbury.

Snow is expected to low levels in Canterbury, especially in the south, and some heavy falls are now expected down to 300 metres south of Banks Peninsula.

The heavy rain, especially over the South Island, is expected to cause local rivers and streams to rise rapidly and may result in localised surface flooding.People travelling through or residing in the North Island also Marlborough and north Canterbury are advised that the strong winds could cause damage to trees,powerlines and even lift roofs as well as make driving hazardous, especially for tall sided vehicles.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO
http://metservice.com/default/index.php?alias=mapsandobservations

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

HEAVY RAIN WARNING

AREA/S AFFECTED: WESTLAND SOUTH OF OTIRA, THE PAPAROA RANGE, THE HEADWATERS OF THE OTAGO AND CANTERBURY LAKES AND RIVERS FROM ARTHURS PASS TO MOUNT ASPIRING,THE RANGES OF NELSON AND THE RICHMOND RANGES, THE TARARUA RANGE, MT TARANAKI,THE RANGES FROM INLAND TARANAKI ACROSS THE CENTRAL NORTH ISLAND HIGH COUNTRY TO THE RANGES OF EASTERN BAY OF PLENTY AND NORTHERN GISBORNE.

FORECAST:

WESTLAND SOUTH OF OTIRA
In the 11 hours from 9pm Sunday to 8am Monday expect another 150-200mm of rain about the ranges and 40-60mm near the coast. Intensities reaching 25 to 35mm per hour about the ranges.

THE HEADWATERS OF THE OTAGO AND CANTERBURY LAKES AND RIVERS FROM ARTHURS PASS TO MOUNT ASPIRING
In the 11 hours from 9pm Sunday to 8am Monday, expect about 150mm near the divide, and over 80mm falling within 15km east of the divide. Intensities reaching 20mm per hour.

THE PAPAROA RANGE
In the 12 hours from 9pm Sunday to 9am Monday, expect 100-120mm of rain.Heaviest falls after midnight, when intensities could reach 15 to 25mm per hour.

THE RANGES OF NELSON
Rain is expected to become heavy Sunday night. In the 12 to 15 hours from 9pm Sunday, expect 100-140mm of rain. The heaviest falls are kely early Monday morning, when intensities could reach 15 to 25mm per hour for a time.

THE RICHMOND RANGE
Rain becoming heavy overnight. In the 12 to 15 hours from midnight Sunday, 100mm is likely in some places. Heaviest falls are expected Monday morning, when intensities could reach 15 to 25mm per hour for a time.

THE TARARUA RANGE
In the 12 hours from 3am Monday, 70 to 100mm of rain is likely about higher slopes in a gale to severe gale northwest flow.

MT TARANAKI
In the 6 to 9 hours from 3am Monday, around 100mm is likely about higher parts of the mountain in a gale to severe gale northerly flow.

THE RANGES FROM INLAND TARANAKI ACROSS THE CENTRAL NORTH ISLAND HIGH COUNTRY TO THE RANGES OF EASTERN BAY OF PLENTY AND NORTHERN GISBORNE
In the 6 hours starting from 5am in the west and 9am in the east, pect 60 to 90mm of rain in a gale to severe gale northerly flow.

FREEZING LEVEL/SNOW CONDITIONS: South Island freezing level remaining about 2000 metres during the event. Heavy snow likely down to 1400 metres.

STRONG WIND WARNING

AREA/S AFFECTED: ALL THE NORTH ISLAND, ALSO MARLBOROUGH, AND CANTERBURY NORTH OF HAWARDEN
FORECAST:

ALL THE NORTH ISLAND EXCEPT WELLINGTON
Northerly gales are expected to develop in many areas overnight. A period of severe gales is likely from early Monday morning and into the afternoon, with possible damaging gusts of 120 km/h.

WELLINGTON, MARLBOROUGH AND CANTERBURY NORTH OF HAWARDEN
Northerlies up to severe gale with gusts 120 km/h in exposed places

are expected overnight and Monday morning. Strongest winds are likely to be about higher areas, including the hill tops around Wellington, with gusts there possibly reaching 150 km/h for a time.
The winds should ease slowly from the south during the morning, with a southerly change pushing northwards.

HEAVY SNOW WARNING

AREA/S AFFECTED: CANTERBURY SOUTH OF BANKS PENINSULA
FORECAST:

In the 9 hours from 10pm Sunday to 7am Monday, expect up to 15cm of snow to
accumulate down to 300 metres, with lighter falls down to 200 metres.

NEXT SEVERE WEATHER WARNING WILL BE ISSUED AT OR BEFORE
9:00am Monday 12-Jun-2006

Forecast prepared by: Mark Pascoe

For further information after 9pm Sun contact Duty Forecaster Paul Bruce
A service provided through a contract with the Crown

2025 11 June 2006

2760 05

Severe Weather Warning

SEVERE WEATHER WARNING.
ISSUED BY MetService AT 8:53 am 12-Jun-2006

HEAVY SNOW ABOUT CANTERBURY SPREADING UP TO THE KAIKOURA COAST AND EASING FROM THE SOUTH. STORMY CONDITIONS FOR THE NORTH ISLAND.

A rapidly deepening low is forecast to cross central New Zealand around the middle of today, bringing stormy conditions to the North Island, with potentially damaging winds for many parts of the North Island through to this afternoon. Gusts of 120 to 150 km/h are possible just about anywhere over the North Island, but most especially about higher areas & exposed coastal regions. A brief burst of heavy rain is also likely about the Tararuas and higher areas of the North Island from Taranaki across the central plateau to the ranges of Bay of Plenty and northern Gisborne. Here, 60 to 100mm of rain is likely to fall during Monday morning or early afternoon.

Heavy snow over South Canterbury should gradually ease this morning and clear this afternoon, with another 5cm likely. The heavy snow over North Canterbury is expected to persist through to about midday, with another 10 to 15cmcm likely in places down to near sea level. The snow should ease in North Canterbury early afternoon and clear by late afternoon. Heavy snow is also expected to spread into the Kaikoura Coast area, with 10cm of snow likely here down to 200 metres from mid morning through to late afternoon, before clearing this evening.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO
http://metservice.com/default/index.php?alias=mapsandobservations

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

HEAVY RAIN WARNING

AREA/S AFFECTED: WESTLAND SOUTH OF OTIRA, THE PAPAROA RANGE, THE HEADWATERS OF THE CANTERBURY LAKES AND RIVERS, THE RANGES OF NELSON AND THE RICHMOND RANGES,THE TARARUA RANGE, MT TARANAKI, THE RANGES FROM INLAND TARANAKI ACROSS THE CENTRAL NORTH ISLAND HIGH COUNTRY TO THE RANGES OF EASTERN BAY OF PLENTY AND NORTHERN GISBORNE
FORECAST:

WESTLAND SOUTH OF OTIRA
The heavy rain should ease this morning and clear by early afternoon. In the 2 to 4 hours from 9am today, another 30 to 50mm of rain is likely, mainly north of the Glaciers.

THE PAPAROA RANGE
The heavy rain should ease later this morning and clear this afternoon. In the 3 to 5 hours from 9am today, another 30 to 60mm of rain is likely.

THE RANGES OF NELSON AND THE RICHMOND RANGE

the heavy rain should ease around midday then clear later in the afternoon. In the 4 to 6 hours from 9am today, another 40 to 60mm of rain is likely.

THE TARARUA RANGE AND MT TARANAKI
The heavy rain should ease around mid-afternoon. In the 5 to 7 hours from 9am today, another 50 to 70mm of rain is likely about higher slopes.

THE RANGES FROM INLAND TARANAKI ACROSS THE CENTRAL NORTH ISLAND HIGH COUNTRY TO THE RANGES OF EASTERN BAY OF PLENTY AND NORTHERN GISBORNE
In the 6 hours starting from 9am in the west and midday in the east, expect 60 to 80mm of rain in a gale to severe gale northerly flow.

STRONG WIND WARNING

AREA/S AFFECTED: ALL THE NORTH ISLAND
FORECAST:
ra
ALL THE NORTH ISLAND
A period of severe northerly gales is likely for many areas through to early afternoon, with possible damaging gusts of 120 to 150 km/h. The winds should turn squally westerly from Manawatu northwards during the afternoon, with possible localised gusts of 120 km/h through to the evening.

HEAVY SNOW WARNING

AREA/S AFFECTED: CANTERBURY SOUTH OF ASHBURTON, CANTERBURY FROM ASHBURTON NORTHWARDS, KAIKOURA COAST AREA
FORECAST:

CANTERBURY SOUTH OF ASHBURTON
Heavy snow should gradually ease this morning and clear this afternoon, with another 5cm likely in places.

CANTERBURY FROM ASHBURTON NORTHWARDS
The heavy snow is expected to persist through to about midday, with another 10 to 15cm likely in places down to near sea level. The snow should ease early afternoon and clear by late afternoon.

THE KAIKOURA COAST AREA
Heavy snow is expected to develop to low levels by mid to late morning, with up to 10cm likely down to 200 metres between 9am and 4pm today, before clearing early evening.

WARNINGS NO LONGER IN FORCE

HEAVY RAIN WARNINGS HAVE BEEN LIFTED FOR: THE HEADWATERS OF THE OTAGO LAKES AND RIVERS
NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

Fax for Environment BOP at FROM METSERVICE on 0800... 12-Jun-06 8:57 AM Page 3 of 3

STRONG WIND WARNINGS HAVE BEEN LIFTED FOR: MARLBOROUGH, AND
CANTERBURY NORTH OF HAWARDEN
NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

NEXT SEVERE WEATHER WARNING WILL BE ISSUED AT OR BEFORE
3:00pm Monday 12-Jun-2006

Forecast prepared by: Andy Downs

A service provided through a contract with the Crown

0853 12 June 2006

Fax for Environment BOP at FROM METSERVICE on 0800569329 12-Jun-06 20:12 PM Page 1 of 2

2760 05

Severe Weather Warning

SEVERE WEATHER WARNING.
ISSUED BY MetService AT 8:10 pm 12-Jun-2006

A BURST OF HEAVY SNOW TUESDAY MORNING FOR THE CENTRAL NORTH ISLAND PLATEAU
ALL OTHER WARNINGS LIFTED

The low that brought severe weather to many places over the last day or so is now heading out towards the Chatham Islands. All warnings associated with this low are now lifted.

However, a cold front is moving over the southern South Island. Forecasters expect this front to reach the central North Island Tuesday morning, and to produce a burst of heavy snow on the central plateau during the morning.

FOR THE LATEST WEATHER AND FORECAST CHARTS PLEASE GO TO
http://metservice.com/default/index.php?alias=mapsandobservations

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

HEAVY SNOW WARNING

AREA/S AFFECTED: THE CENTRAL NORTH ISLAND PLATEAU
FORECAST:

In the 6 hours from 7am to 1pm Tuesday, expect up to 10cm of snow down to 800 metres, with lighter falls down to 600 metres.

WARNINGS NO LONGER IN FORCE

HEAVY RAIN WARNINGS HAVE BEEN LIFTED FOR: WESTLAND SOUTH OF OTIRA, THE PAPAROA RANGE, THE HEADWATERS OF THE CANTERBURY LAKES AND RIVERS, THE RANGES OF NELSON AND THE RICHMOND RANGES, THE TARARUA RANGE, MT TARANAKI, THE RANGES FROM INLAND TARANAKI ACROSS THE CENTRAL NORTH ISLAND HIGH COUNTRY TO THE RANGES OF EASTERN BAY OF PLENTY AND NORTHERN GISBORNE

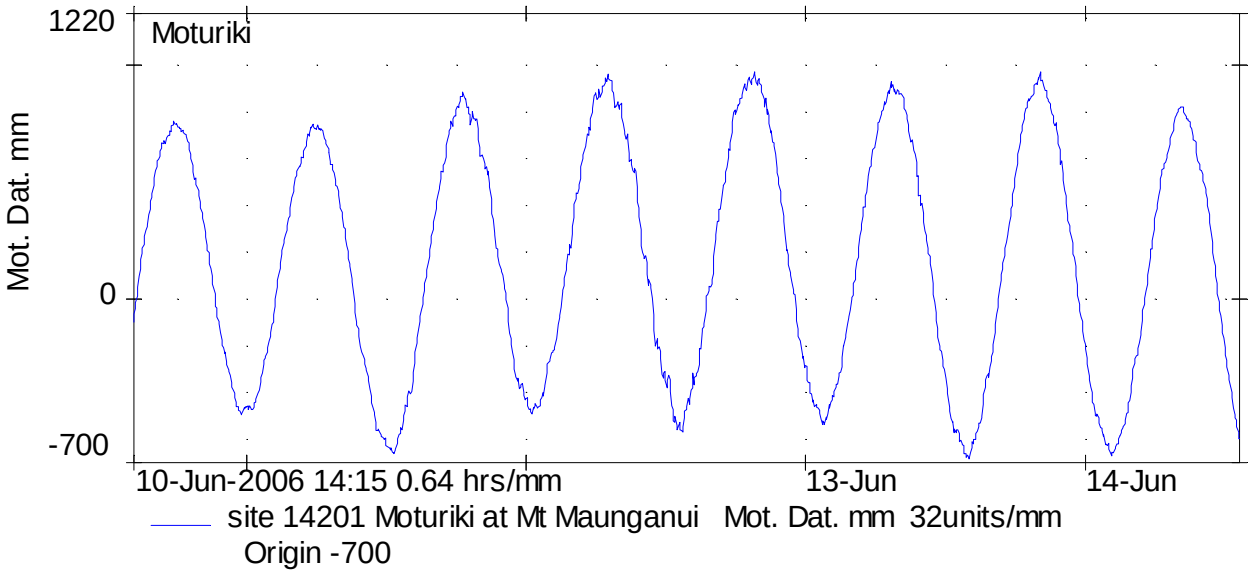
NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

STRONG WIND WARNINGS HAVE BEEN LIFTED FOR: ALL THE NORTH ISLAND
NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

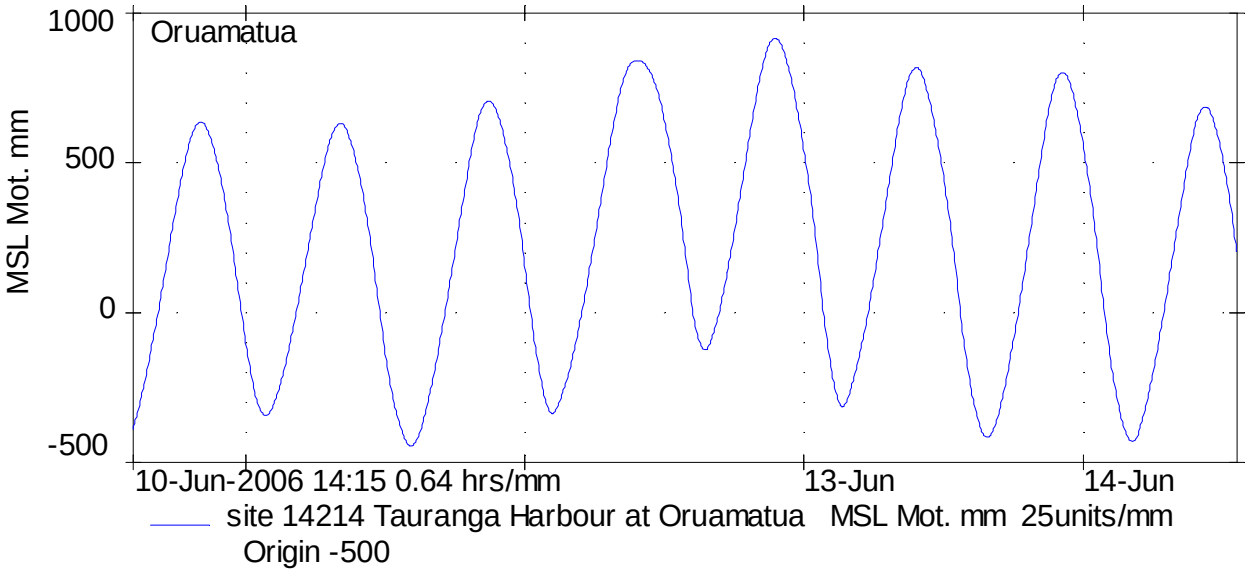
HEAVY SNOWFALL WARNINGS HAVE BEEN LIFTED FOR: CANTERBURY AND THE KAIKOURA COAST
NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

2010 12 June 2006

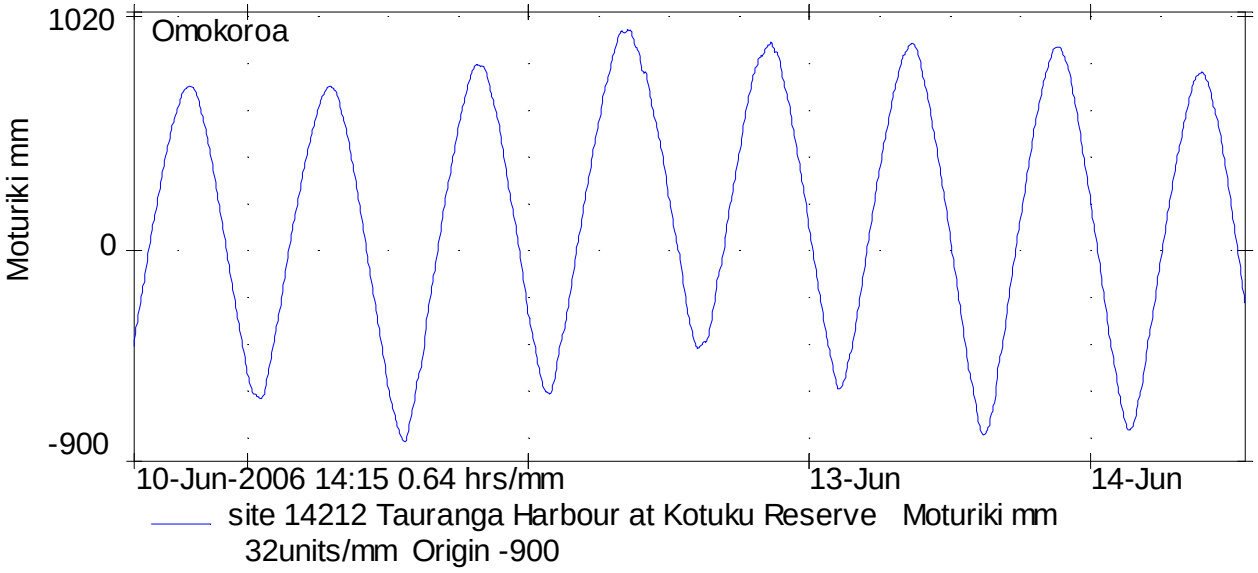
Appendix II – Recorded data graphs



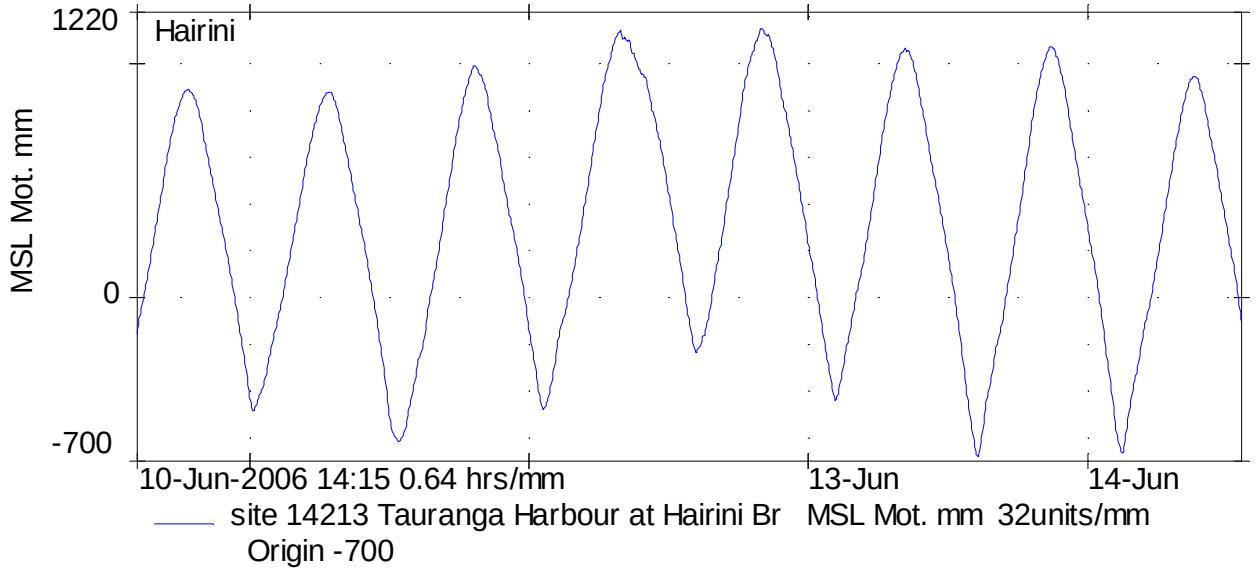
Moturiki Stage



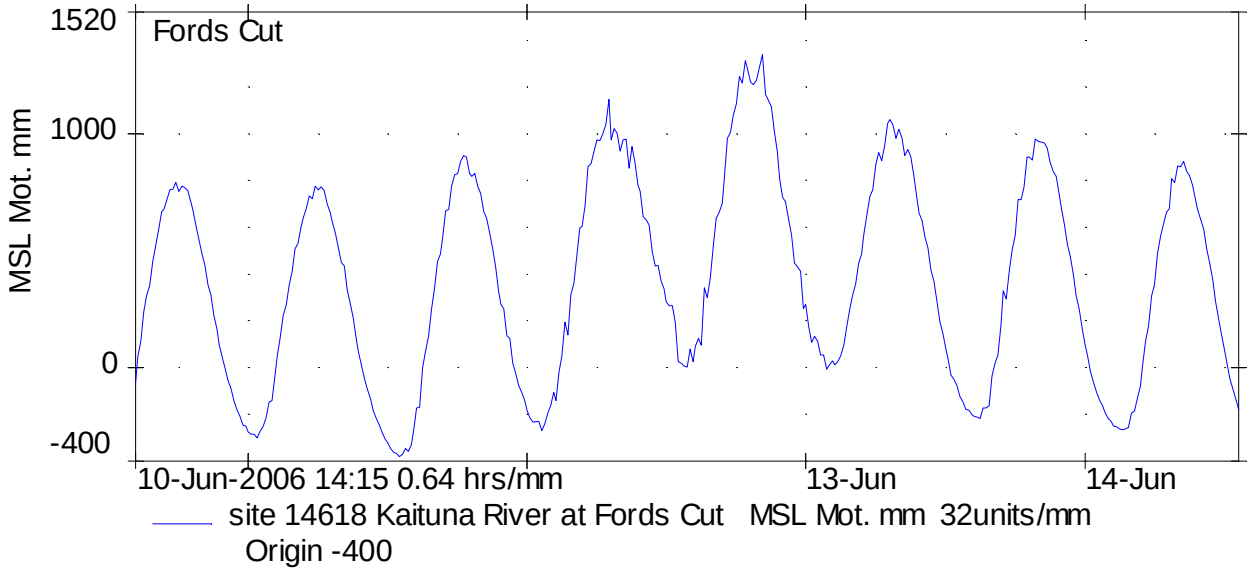
Oruamatua Stage



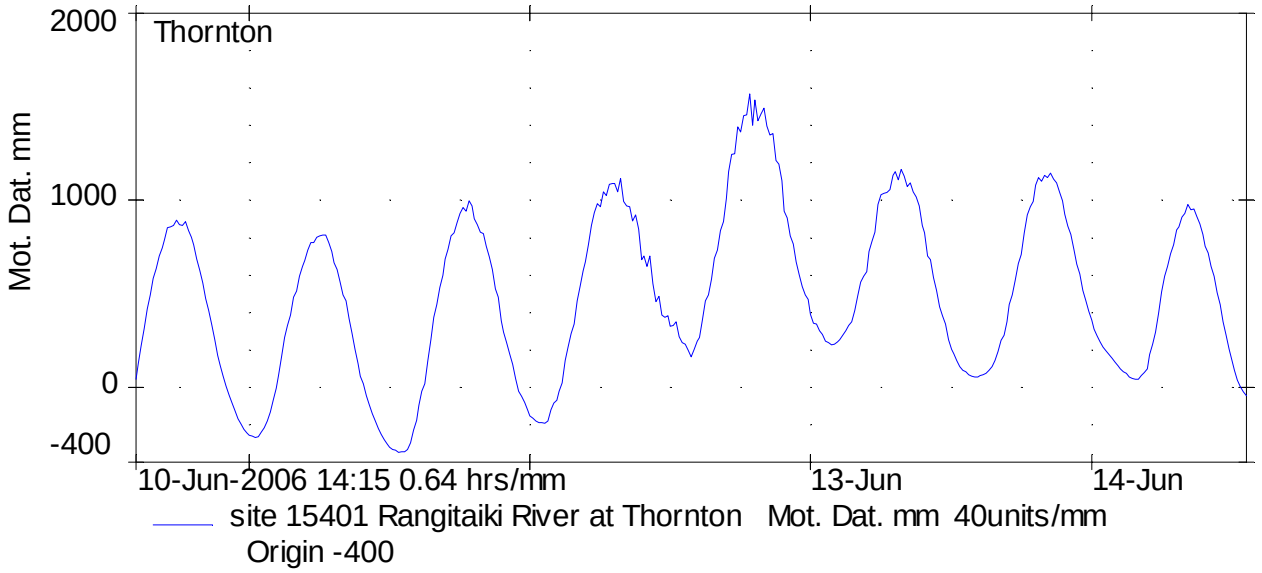
Omokoroa Stage



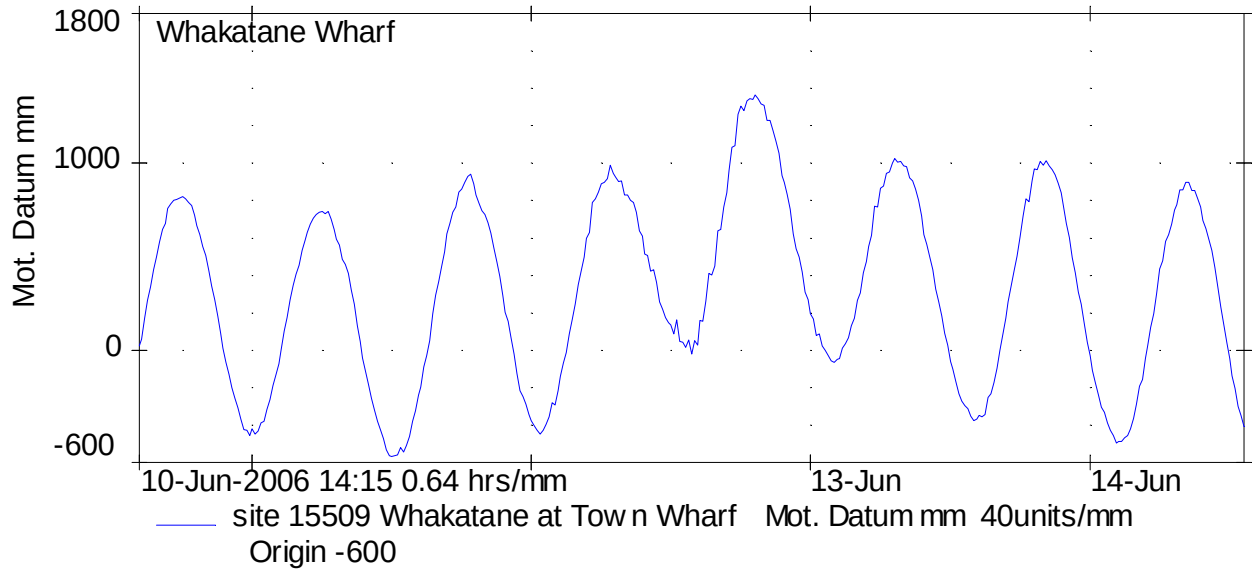
Hairini Stage



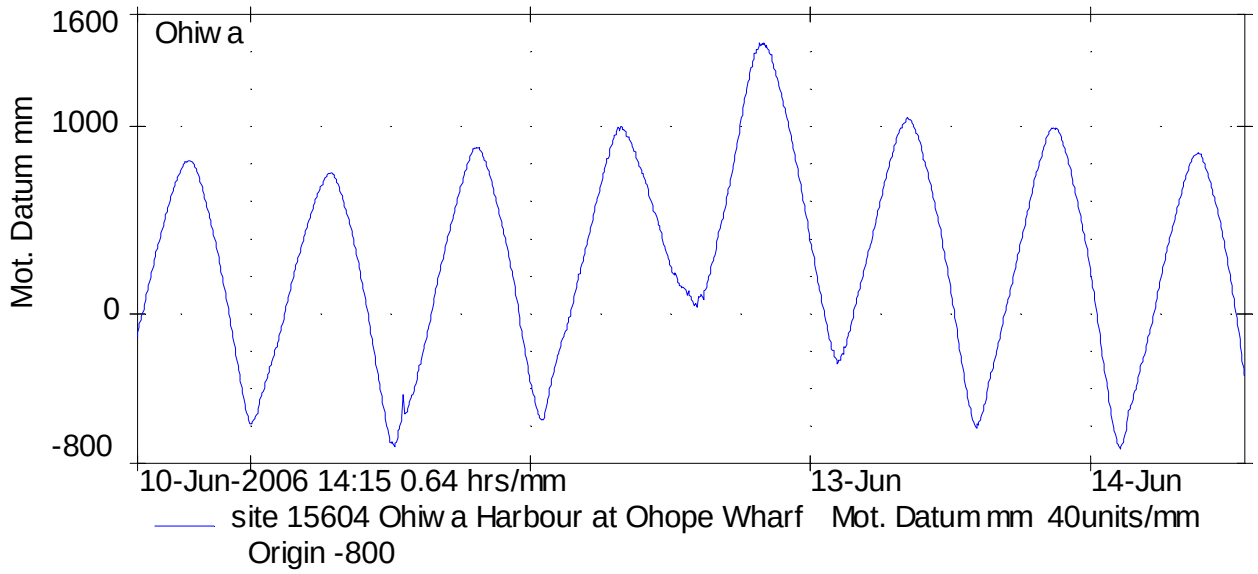
Fords Cut Stage



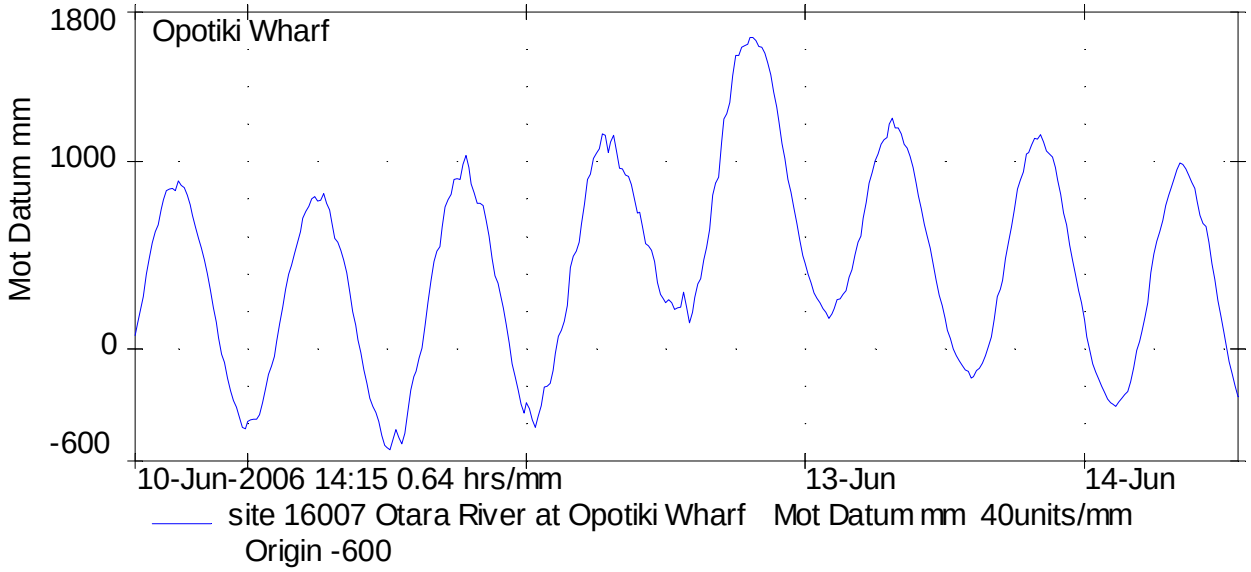
Thornton Stage



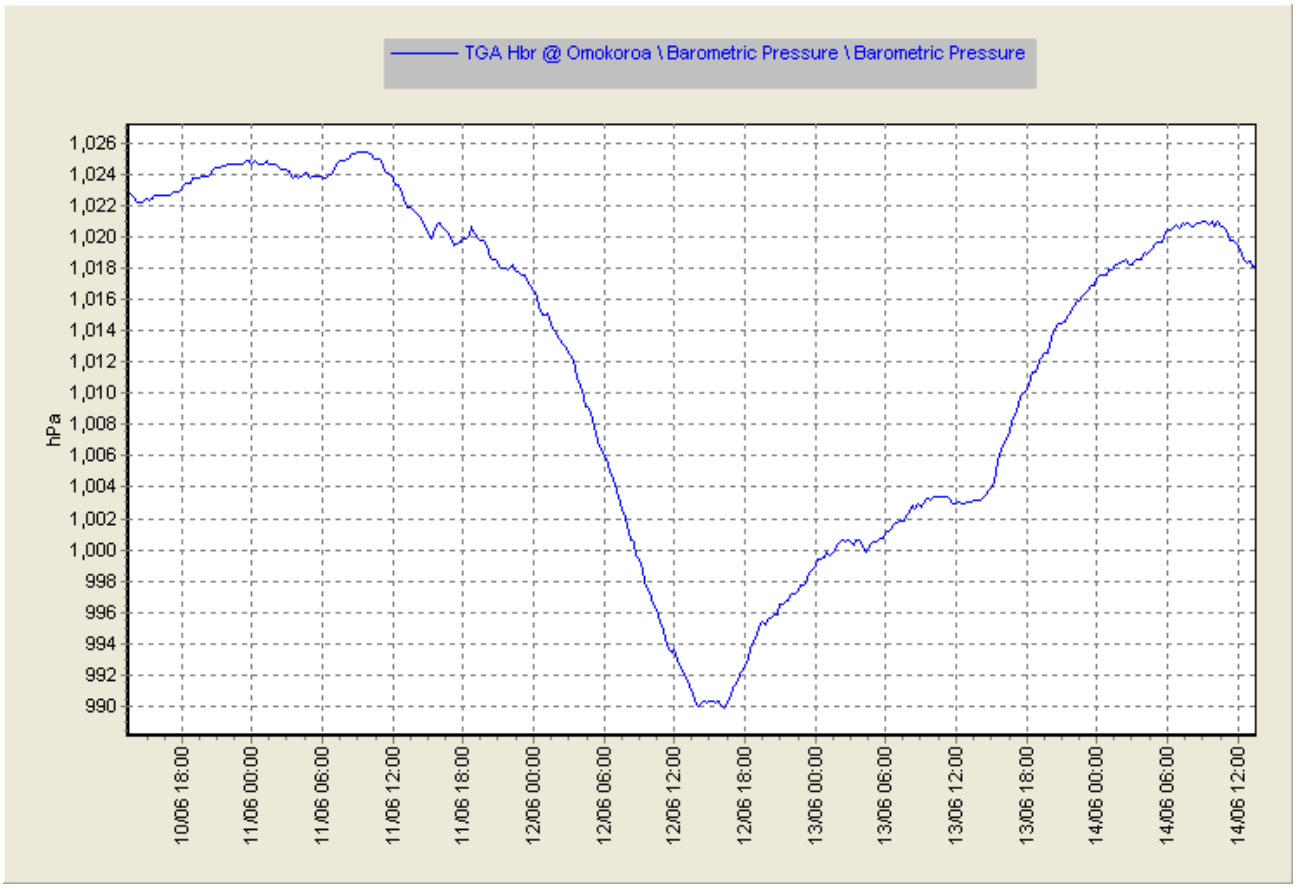
Whakatane Wharf Stage



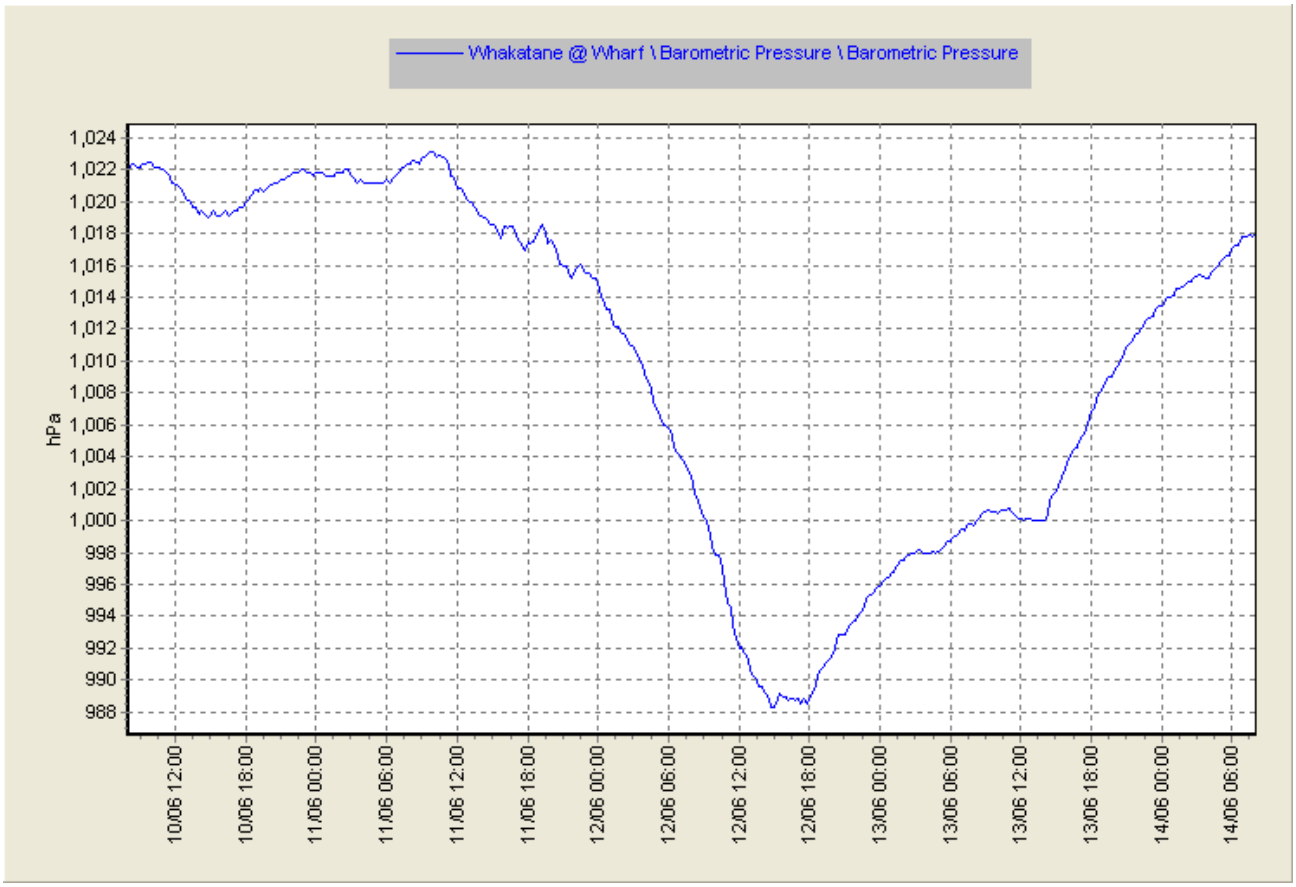
Ohiwa Stage



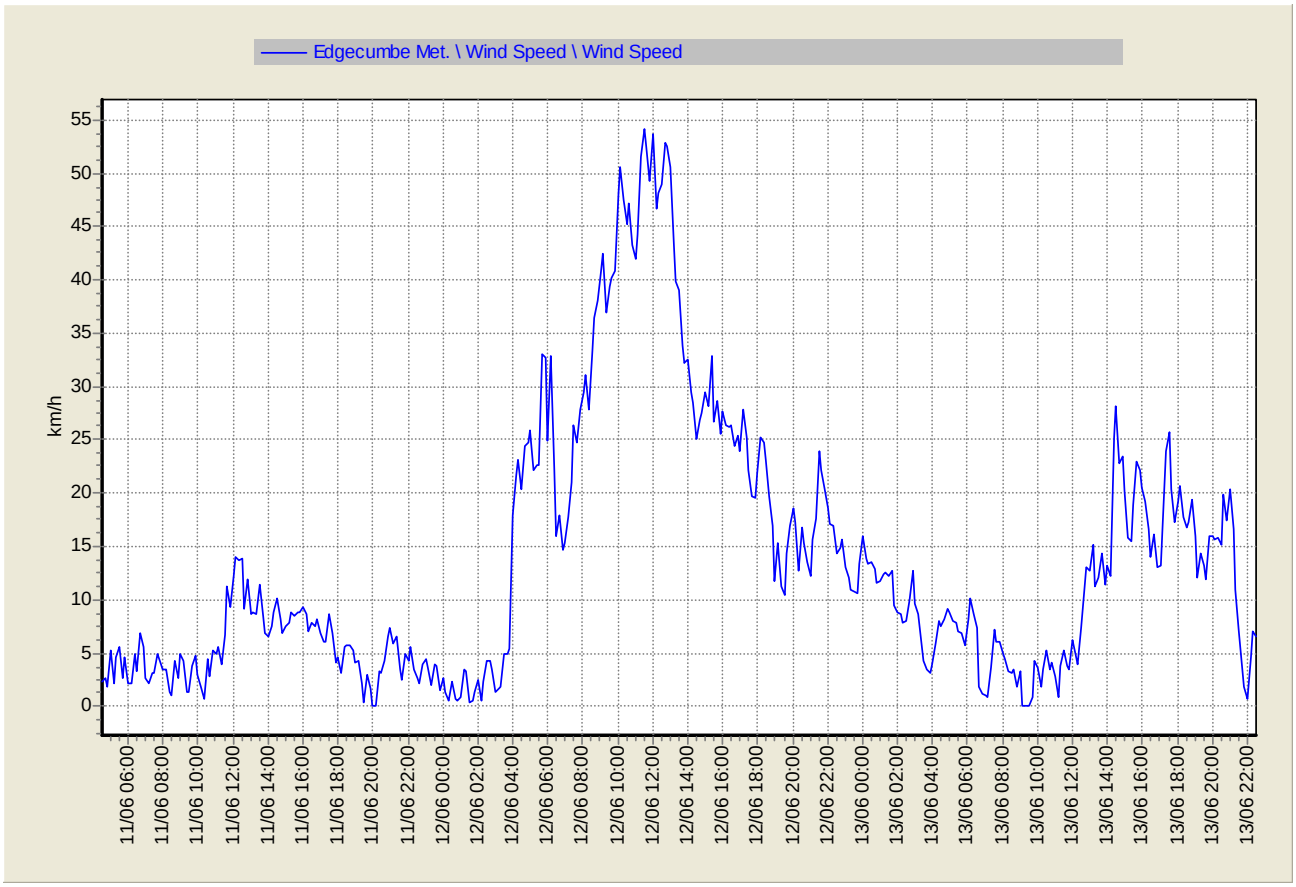
Opotiki Wharf Stage



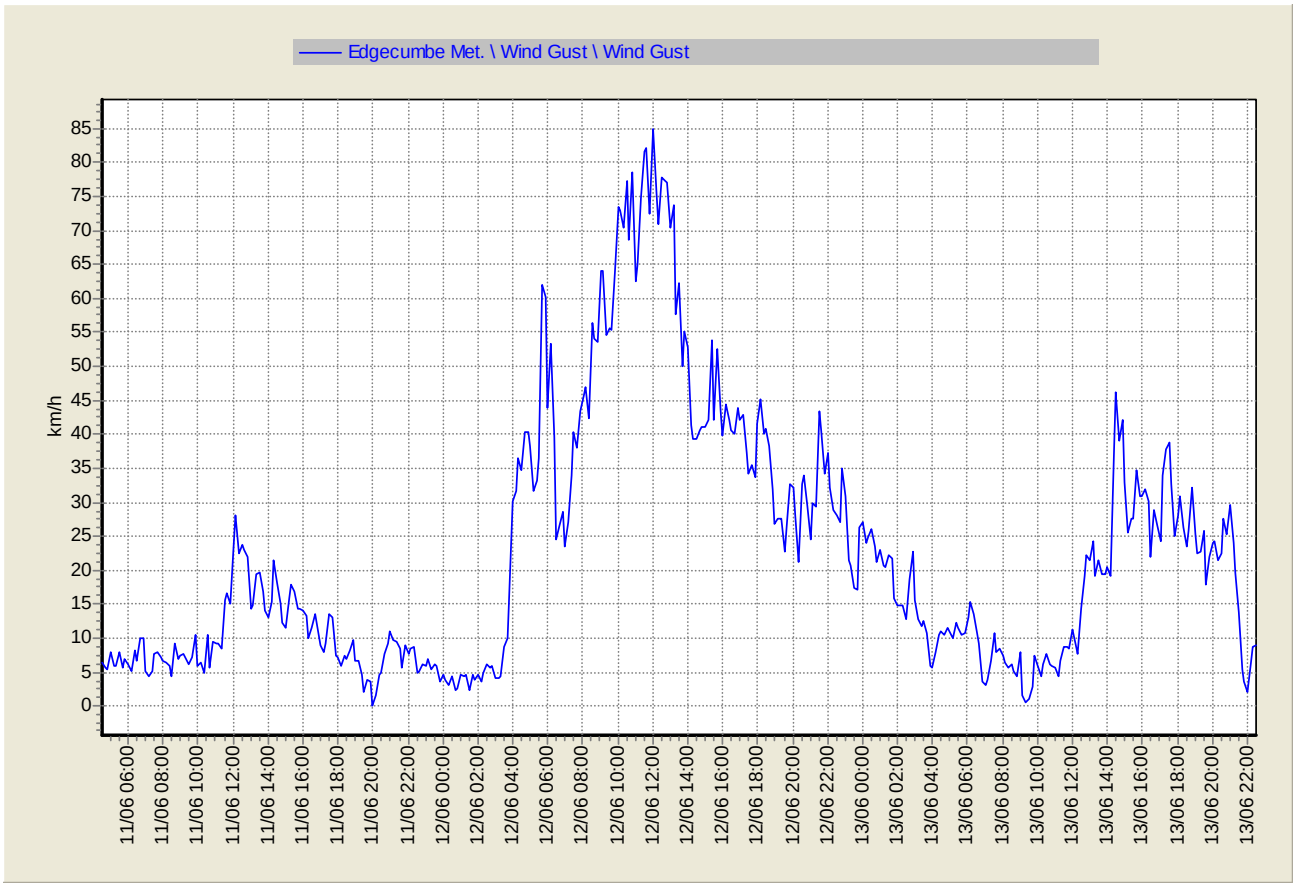
Omokoroa Barometric Pressure



Whakatane Wharf Barometric Pressure



Edgecumbe Wind Speed



Edgecumbe Wind Gust

Appendix III – Photos

Site A: Ohiwa at Harbour Sediment site 1, level = 1.34 m Moturiki Datum

Site B: Ohiwa at Harbour Road Reserve, level = 1.36 m Moturiki Datum

Site D: Ohiwa at Harbour Sediment site 2, level = 1.32 m Moturiki Datum

Site E: Ohiwa at Kutarere Jetty, level = 1.53 m Moturiki Datum

Site E: Ohiwa at Kutarere Jetty, level 1.53 m Moturiki Datum

Site F: Ohiwa at Ohiwa Loop Road Boat Ramp, level = 1.43 m Moturiki Datum

300 m SSE of Site F: Ohiwa at Ohiwa Loop Road Boat Ramp

Site G: Ohiwa at Harbour Sediment site 9, level = 1.41 m Moturiki Datum

Site H: Ohiwa at Harbour Sediment site 10, level = 1.44 m Moturiki Datum

Site I: Ohiwa at Ohiwa Motor Camp, level = 1.55 m Moturiki Datum