Inquiry MO-2010-206: Coastal container ship *Spirit of Resolution* grounding on Manukau Bar, Auckland, 18 September 2010

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Final Report

Marine inquiry 10-206
coastal container ship *Spirit of Resolution*
grounding on Manukau Bar, Auckland
18 September 2010

Approved for publication: July 2015

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (Commission) is a standing commission of inquiry and an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and causes of occurrences with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

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Important notes

Nature of the final report

This final report has not been prepared for the purpose of supporting any criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

Ownership of report

Citations and referencing

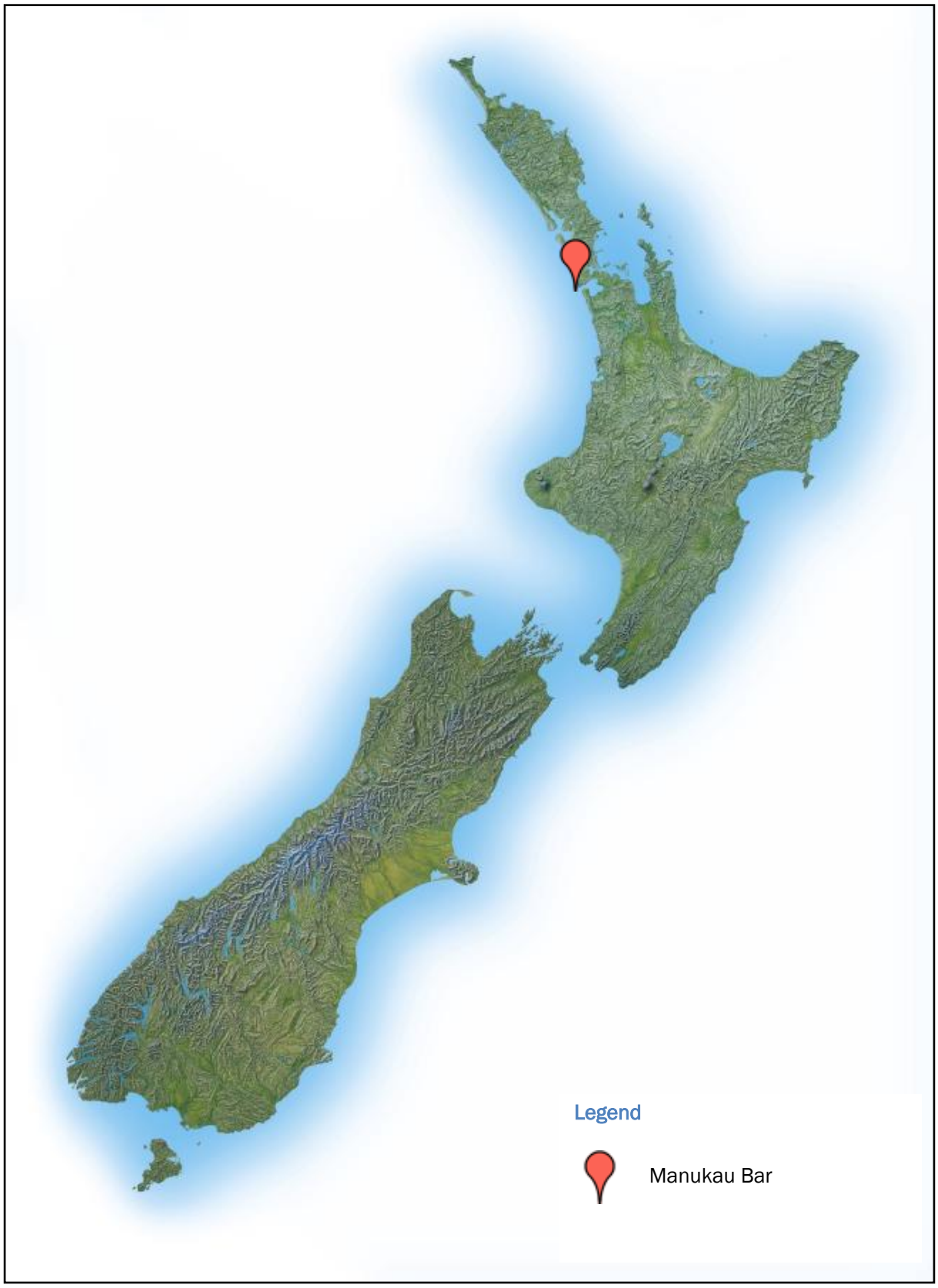
Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1980 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publicly available are cited.

Photographs, diagrams, pictures

Unless otherwise specified, photographs, diagrams and pictures included in this final report are provided by, and owned by, the Commission.

The *Spirit of Resolution* in transit on Manukau Harbour

(Photograph courtesy of John Regan)



Source: mapsof.net

Location of accident

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Abbreviations

AIS	automatic identification system

Glossary

bow thruster	a propeller contained in an athwartships tunnel near the bow of a ship, used to push the bow sideways when manoeuvring
bulwarks	railings made from solid steel plate
draught	the depth to which a ship floats in the water
hove to	lying with the bow to the sea, using only sufficient engine power to maintain position
pintle	a pin or bolt used as a vertical pivot or hinge on a rudder
significant wave height	significant wave height is defined as the average height of the highest one-third of waves
squat	a peculiarity that causes a ship to sink deeper in the water when it is moving through the water. The effect is more pronounced in shallow water where there is only a small distance between the keel and the seabed

Data summary

Vehicle particulars

Name:	*Spirit of Resolution*
Type:	container vessel
Class:	Germanischer Lloyd 100 A5 MC E AUT
Limits:	unrestricted
Length:	100.51 metres (overall)
Breadth:	16.5 metres
Gross tonnage:	3,850 tonnes
Built:	1997 by Estaleiros Navais, Portugal
Propulsion:	single 3,520-kilowatt MaK 8M 32 diesel engine driving a single variable-pitch propeller
Service speed:	15 knots (loaded)
Owner/operator:	Harren & Partner Bremen/Pacifica Transport Group
Port of registry:	Lyttelton, New Zealand
Minimum crew:	11

Date and time 18 September 2010 0830[1]

Location Manukau Harbour entrance, Auckland

37° 05's 174° 27.6'e

Persons involved 12

Injuries nil

Damage rudder lost, wave damage to bow and containers on deck

[1] All times in this report are New Zealand Standard Time and expressed in the 24-hour format.

1. Executive summary

1.1 At about 0530 on Saturday 18 September 2010, the coastal container ship *Spirit of Resolution* departed its berth at the port of Onehunga in Manukau Harbour and took about 1.7 hours to reach the Manukau Bar at the harbour entrance.

1.2 The sea conditions were forecast to exceed the four-metre maximum permissible observed wave height over the Bar and remain so for at least another two days. The master decided to proceed to the harbour entrance, knowing that he had the option of anchoring inside the entrance and awaiting more favourable conditions.

1.3 The signalman located on South Head above the entrance had reported to the master that the observed wave height was 3.5 to four metres and increasing, but that the Bar was still open. When the ship arrived inside the Bar, the master observed the wave conditions and began the crossing.

1.4 The crossing was uneventful for the first 20 minutes until the *Spirit of Resolution* was about to clear the Bar, when the wave height suddenly increased and the ship's speed over the ground dropped to almost zero. Unable to make any outward progress, the ship was carried sideways by the current out of the main channel and into shallower water. There the ship's rudder struck the sea bed and most of the rudder sheared off and was lost to the sea. The ship sustained wave damage to its bow and to a number of containers on deck. No-one was injured.

1.5 With the aid of the ship's bow thruster, the master was able to manoeuvre the ship clear of the Bar and into deeper water, where it lay for about two days awaiting a tow. The ship was eventually towed to the port of New Plymouth and then on to Lyttelton, where it underwent permanent repair.

1.6 The Transport Accident Investigation Commission (Commission) found that there was sufficient information available to the master for him to determine that crossing the Bar when he did would risk operating the ship in wave conditions beyond what the port company had deemed safe.

1.7 Since the accident the *Spirit of Resolution* has been returned to its owner and the Pacifica Transport Group has stopped operating into Manukau Harbour.

1.8 The Commission considered whether more real-time information on wave heights over the Bar would have made any difference, but considered that unless the shipping using the harbour significantly increased, or more cost-effective technology for predicting and measuring wave heights is developed in future, the current information and technology available are sufficient to maintain maritime safety for Manukau Harbour. Consequently the Commission has not made any safety recommendations.

1.9 The key lesson arising from this accident is that:

- Bar harbours are notoriously hazardous for vessels of all sizes. Crossing a Bar in deteriorating sea conditions that are already at the margins of what has been deemed safe is a high-risk activity that should not be contemplated.

2. Conduct of the inquiry

2.1. The accident happened on Saturday 18 September 2010. Maritime New Zealand notified the Transport Accident Investigation Commission (Commission) of the accident on Monday 20 September 2010. In the following nine days the Commission gathered information and monitored the salvage operation to tow the *Spirit of Resolution* to the port of New Plymouth.

2.2. On 29 September 2010 the Commission opened an inquiry into the accident under section 13(1)b of the Transport Accident Investigation Commission Act 1990 and appointed an investigator in charge.

2.3. The *Spirit of Resolution* was subsequently towed from New Plymouth to Lyttelton, where it underwent repairs. One investigator travelled to Lyttelton to observe the damage incurred in the grounding.

2.4. The Commission engaged R & D Consultancy (2007) Limited, a specialist in metallurgy, to analyse and report on the nature and cause of the fracture across the vessel's rudder.

2.5. The Commission also engaged the Meteorological Service of New Zealand to provide the weather forecasts issued in the days leading up to and including the day of the accident, as well as a hind-cast of the actual weather conditions experienced.

2.6. Another investigator travelled to Auckland to interview: the relevant crew on board at the time of the grounding; representatives from Pacifica Transport Group's (the operator) shore-based management; representatives from Ports of Auckland Limited; and the signalman based at the South Head signal station overlooking the Manukau Bar.

2.7. Port company policies and procedures for operating Manukau Harbour were reviewed along with the operator's policies and procedures for entering and departing Manukau Harbour.

2.8. Historical and post-accident reports on depth soundings taken for the Manukau Bar were obtained and reviewed. The automatic identification system (AIS) data showing the *Spirit of Resolution*'s track as it transited the Manukau Bar was obtained and referenced to the depth sounding taken over the Manukau Bar after the grounding.

2.9. An early analysis of the facts known at the time revealed no urgent safety issues that would normally result in the Commission making recommendations. Owing to the Commission's heavy maritime caseload and its resources available at the time, a decision was made to prioritise other inquiries ahead of this inquiry.

2.10. In October 2011 the container ship *Rena* ran aground on Astrolabe Reef near Tauranga, consuming most of the Commission's maritime resources for the following three years.

2.11. On 12 October 2012 the operator returned the *Spirit of Resolution* to its owner and ceased operating into Manukau Harbour.

2.12. On resumption of completing this inquiry, a final analysis of the evidence revealed no significant safety issues that would result in the Commission making any recommendations.

2.13. On 28 May 2015 the Commission considered a draft final report and approved it to be sent to interested persons for consultation.

2.14. Submissions were received from the master, the operator and the Ports of Auckland Limited.

2.15. On 29 July 2015, the Commission considered these submissions, made amendments to the draft final report as appropriate, and approved the final report for publication.

3. Factual information

3.1. Narrative

3.1.1. The *Spirit of Resolution* provided a weekly coastal container service between the ports of Onehunga (in Auckland's Manukau Harbour), Lyttelton, Nelson and New Plymouth. Manukau Harbour is a Bar harbour, meaning ships had to cross the Manukau Bar at the harbour entrance to enter. Once inside the harbour ships had to transit a narrow tidal channel to reach the port of Onehunga.

3.1.2. At about 0730 on Thursday 16 September 2010, the *Spirit of Resolution* had crossed the Manukau Bar and anchored off Lawry Point near the harbour entrance to await the incoming tide. This was in order to have sufficient depth in the channel for the vessel to make for Onehunga wharf (see Figure 1).

3.1.3. The *Spirit of Resolution* berthed at Onehunga at about 1600 the same day and exchanged containers until the early morning of Saturday 18 September.

3.1.4. The weather forecast for the Raglan sea area outside Manukau Harbour was for westerly winds rising to 45 knots with a southwest swell rising to four metres on Friday evening and rising to six metres during Saturday 18 September (see Appendix 1 for the full weather situation).

3.1.5. High tide for Manukau Harbour was predicted for about 0600 on Saturday 18 September. The master had calculated the latest time that the ship could depart Onehunga wharf and have sufficient underwater clearance to pass over the shallowest point in the Waihopi Channel (known as the pipeline) on the way to the Manukau Bar.

3.1.6. The master also calculated the maximum permitted draught[2], making the appropriate allowance for squat[3] and dynamic increase in draught based on the ship pitching as it encountered waves when crossing the Bar[4]. The *Spirit of Resolution* departed Onehunga in the dark at 0530 on Saturday 18 September. Sunrise was at 0618.

3.1.7. Ports of Auckland maintained a manned signal station that overlooked the Manukau Bar. One of the signalman's responsibilities was determining the (actual observed) wave height over the Manukau Bar. If the observed wave height reached four metres or more, he would close the Manukau Bar and inform the relevant parties. There was no wave-rider buoy[5] located off Manukau Harbour, so the signalman made day-time visual assessments of the wave conditions using the observed wave heights in relation to local shoreline features. He had been the signalman for many years and was therefore experienced in making these assessments.

3.1.8. A wave-rider buoy was located about 120 kilometres south of Manukau Harbour off the port of Taharoa. Normally the signalman could access readings from this buoy, which gave him an indication of the wave trend when a weather system was approaching from that direction (south). However, data had become sporadic then recording had ceased at about 2120 on the previous day (Friday 17 September). The buoy did not resume receiving until about 1540 on the Saturday (after the ship had run aground).

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[2] Draught is the depth to which a ship floats in the water.

[3] Squat is a peculiarity that causes a ship to sink deeper in the water when it is moving through the water. The effect is more pronounced in shallower water where there is only a small distance between the keel and the seabed.

[4] A ship's draught is calculated for when it is resting in still water. When a ship begins to pitch and roll in waves, this has the effect of dynamically increasing its draught, increasing the risk of it striking the sea bed when in shallow water.

[5] A wave-rider buoy is a buoy fitted with a wave-measuring system that is moored to the seabed. Wave data is transmitted to and stored in a receiver on shore.

3.1.9. At 0700 the *Spirit of Resolution* was still transiting Manukau Harbour. The master called the signalman and asked about conditions over the Manukau Bar. The signalman said that the waves were 3.5 to four metres and that the Manukau Bar was still open.

3.1.10. At 0712 the *Spirit of Resolution* rounded Puponga Point, at which time the wave conditions over the Manukau Bar became visible to the master. At that time the master had the option of anchoring in the vicinity if he thought the conditions were unsuitable to make a crossing. The bridge team studied the conditions as the ship approached Ninepin Rock. Once past Ninepin Rock the ship would be committed to crossing the Bar. The conditions looked suitable to them, so the master decided to proceed across the Manukau Bar, passing Ninepin Rock at 0739.

3.1.11. For the next 20 minutes progress across the Manukau Bar was uneventful. The ship had almost reached the 10-metre contour, where the depth begins to increase, when it encountered a series of large waves. The large wave pattern did not abate and consequently the ship's speed across the ground dropped to almost zero as it struggled to make any headway to clear the Bar[6].

3.1.12. For the next 30 minutes the ship drifted southwards into shallower water under the influence of a strong southerly set[7] across the Manukau Bar. Figure 2 shows the progress of the *Spirit of Resolution* with Automatic Identification System (AIS) position fixes overlaid on the then recent soundings diagram, initially at two-minute intervals and then at one-minute intervals as it was reaching shallower water.

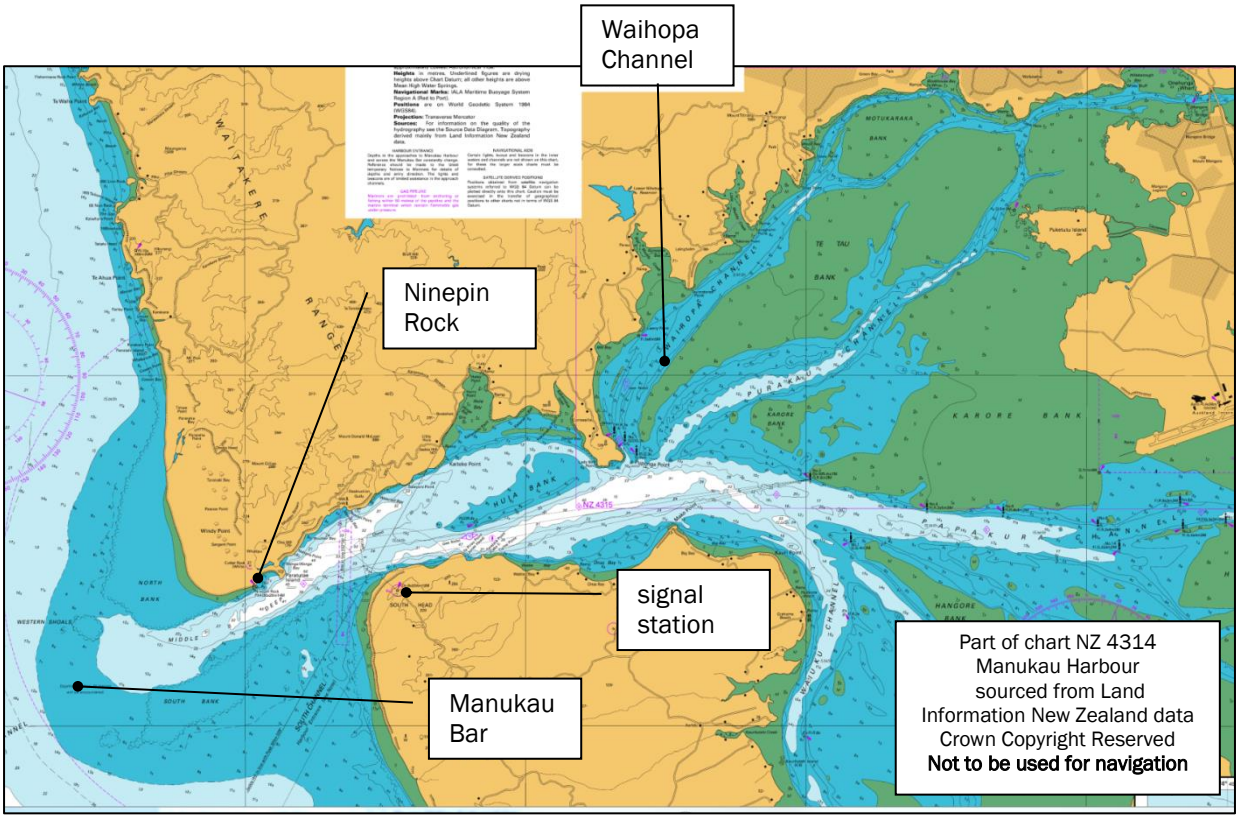

Figure 1
Part of Chart NZ 4314, Manukau Harbour
(Courtesy of Land Information New Zealand)

[6] The track and speed of the ship were available from AIS records.
[7] A southward combination of tide and current.

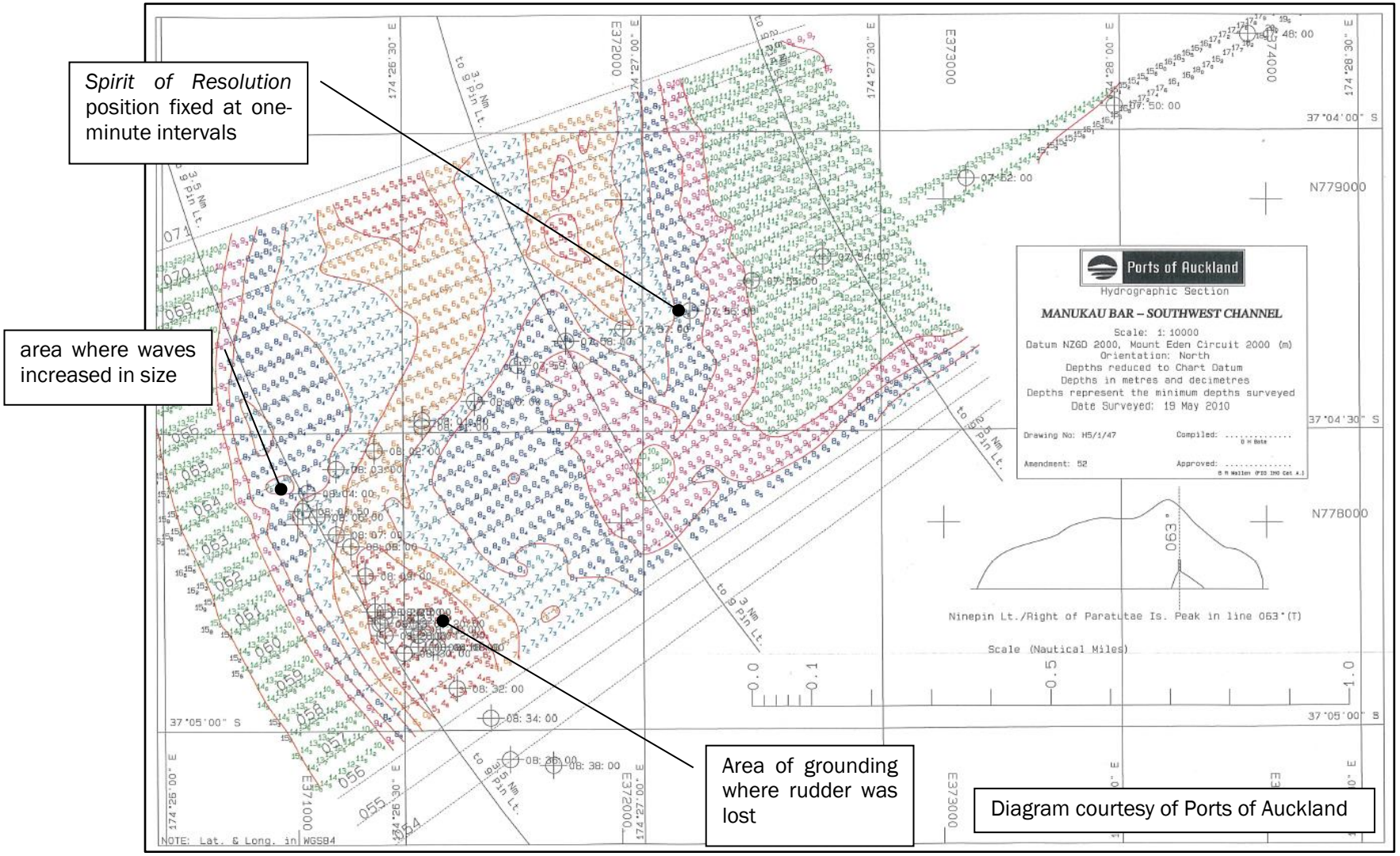

Figure 2
Diagram showing latest depth survey of the Manukau Bar – southwest channel with *Spirit of Resolution* AIS data overlaid

3.1.13. At about 0830 the crew felt the *Spirit of Resolution* striking the sea bed as it struggled to make any headway against the sea. During this period the bottom three-metre section of the rudder was sheared off. The master soon realised that he had lost directional control of his ship.

3.1.14. For the next 15 minutes he continued to drive the ship against the sea, using the ship's bow thruster[8] to maintain limited directional control. He eventually was able to drive the ship clear of the Manukau Bar and head out to sea, still using the bow thruster for limited directional control.

3.1.15. The ship remained hove to[9] off the coast for about two days awaiting a harbour tug to arrive from the port of New Plymouth. The tug *Rupe* arrived at the *Spirit of Resolution* on Monday 20 September and began towing it towards New Plymouth. However, progress was slow so the more powerful off-shore support vessel *Farfosna* was engaged to take over the tow. The *Farfosna* arrived at the *Spirit of Resolution* on 21 September and took over the tow from the *Rupe*.

3.1.16. The *Spirit of Resolution* was towed to the anchorage off the port of New Plymouth. After spending about three days at anchor then two days in the port of New Plymouth, the ship was towed to Lyttelton, where it underwent repairs.

3.2. Damage

3.2.1. The *Spirit of Resolution*'s rudder sheared off near the bottom pintle[10], with the bottom three metres and the trailing flap being lost to the sea.

3.2.2. A number of containers that were carried on deck were damaged or displaced by waves, with one refrigerated container breached.

3.2.3. The 'soft nose' structure at the bow of the *Spirit of Resolution* was damaged, with the bulwarks[11] being pushed in.

Figure 3
Rudder stock and remaining top part of rudder after removal from ship
(Photograph courtesy of Pacifica Transport Group)

[8] A bow thruster is a propeller contained in an athwartships tunnel near the bow of a ship, used to push the bow sideways when manoeuvring.
[9] Hove to means lying with the bow to the sea, using only sufficient engine power to maintain position.
[10] A pintle is a pin or bolt used as a vertical pivot or hinge on a rudder.
[11] Bulwarks are railings made from solid steel plate.

Figure 4
Damage to bulwarks and containers
(Photograph courtesy of Pacifica Transport Group)

Figure 5
Damage to containers on starboard side
(Photograph courtesy of Pacifica Transport Group)

3.3. Personnel

3.3.1. The master had started his sea career in 1978, obtaining his Second Mate Foreign-going Certificate in 1982, his First Mate Certificate in 1986 and his United Kingdom Captain Foreign-going Certificate in 1989.

3.3.2. He had been sailing as master with the operator for seven years and had held a pilot exemption certificate for Manukau Harbour since 2008. He had made about 120 crossings of the Manukau Bar as a pilot-exempt master.

3.3.3. The first mate who was on the bridge during the Bar crossing had been at sea for about 20 years. He held a New Zealand Captain Foreign-going Licence and had sailed as master in the South Pacific prior to joining the operator. He had worked for the operator for about three years, all of that time on the *Spirit of Resolution*. He estimated that he had crossed the Manukau Bar about 50 times.

3.3.4. The signalman at the South Head signal station had been in that role for 25 years. He held New Zealand small boat qualifications and a radiotelephony licence.

4. Analysis

4.1. The presence of a Bar across the entrance to a harbour creates special challenges and additional risks for shipping in comparison with more conventional harbours. A Bar usually forms when debris carried by rivers and strong tidal flows is deposited where the waterway meets the sea, thus forming an area of shallower water with deeper, more navigable channels scoured by the current. The position of these channels is nearly always changing in response to floods, strong tides and severe sea conditions outside the Bar.

4.2. The wave conditions over a Bar can be unpredictable and treacherous. When surface waves move towards shallow water they slow down, their wave height increases and the distance between waves decreases. This behaviour is called shoaling. The waves may or may not build to the point where they break, depending on how large they were to begin with and how steep the slope of the Bar is. For this reason, navigating over a Bar requires extreme caution.

4.3. The existence of a Bar limits the type and size of ship that can enter the harbour. Ships must be relatively shallow in draught to avoid grounding. They also need sufficient propulsion to drive through shoaling waves. A ship's ability to cross a Bar safely is a fine balance between the size and nature of the waves over the Bar and not driving the ship so hard as to cause it damage.

4.4. It is not always possible to utilise the available propulsion power when a ship is pitching into waves because the ship's pitching motion into waves causes the propeller to lose immersion. In extreme cases the propeller can momentarily lift clear of the water altogether. Because the ship must have a relatively shallow draught to begin with (due to the shallow water over the Bar) this makes maintaining propeller immersion more difficult.

4.5. The size of the waves passing over the Bar is therefore the critical factor. The larger the waves, the more likely they are to be breaking and the more difficult it will be for the ship to maintain sufficient propeller immersion to use its available engine power to keep its speed whilst crossing the Bar.

4.6. Ports of Auckland had conducted a risk assessment when developing its safety management system[12]. The risk assessment confirmed past practice that had considered any waves more than four metres over the Bar to be unsafe for the typical size of ships operating into Manukau Harbour. The port company had therefore developed an agreement that set a four-metre maximum observed wave height restriction on ships crossing the Manukau Bar. The forecast for the Raglan marine forecast area was for a significant[13] wave height to build to four metres on the Friday evening before the accident, then build further to six metres during the day of the accident. Even a four-metre swell, combined with wind-generated waves and the shoaling effect over the Manukau Bar, would produce waves well in excess of the four-metre limit.

4.7. However, the Raglan marine forecast area spanned Cape Egmont in the south up to Manukau Harbour in the north. The weather pattern was building from the southwest, which meant the conditions over the Manukau Bar could have reasonably been expected to build during the latter part of the forecast period. This was consistent with what the signalman at the South Head signal station observed at first light when the *Spirit of Resolution* was en route from Onehunga to the Manukau Bar, namely observed waves of 3.5 to four metres. Also, when the *Spirit of Resolution* arrived at the entrance to Manukau Harbour, to the master and the other bridge crew the wave conditions looked to be acceptable for making the crossing.

4.8. The fact that the *Spirit of Resolution* had almost completed the Bar crossing uneventfully before encountering the first of a series of larger waves supports the master's decision. The fact that the wave conditions continued to deteriorate from that point on suggests there was

[12] A system recommended and approved by Maritime New Zealand in accordance with the New Zealand Port and Harbour Marine Safety Code 2004 (to promote good practice in the conduct of safe marine operations in ports and harbours)

[13] Significant wave height is defined as the average height of the highest one-third of waves.

an element of bad luck with the timing of the crossing and the onset of the swell generated by the approaching weather system. That aside, the ship was crossing the Bar right on the limit of maximum safe operating conditions, which were forecast to deteriorate. There was therefore a high risk of the ship becoming overwhelmed by the sea conditions during the estimated 30 minutes it would normally take to clear the Bar.

4.9. Once the ship was caught on the Bar in deteriorating wave conditions, it was captured in that fine balance between having or applying sufficient power to clear the Bar or sustaining damage to the ship and cargo. Unable to make any headway against the shoaling waves, and unable to turn around, the ship was carried by the south-flowing set out of the main channel into shallower water, where its rudder struck the seabed.

4.10. Once the ship had lost its rudder, it was extraordinary that it was able to make it clear of the Bar into deeper waters. Ships that have their accommodation block near their sterns tend to point into the wind when moving forward, which during this period was blowing on-shore, from the direction of deep water. This was likely to have been the main factor contributing to the ship clearing the Bar, aided by the master's use of the bow thruster.

4.11. A major factor contributing to the accident was the master's decision to proceed across the Bar. A point to consider is whether his decision would have been different if more information had been available to him on the actual wave conditions over and outside the Bar.

4.12. Ports of Auckland has not attempted to install a wave-rider buoy near the Manukau Bar. One reason for that is the difficulty it has had in maintaining navigation buoys and beacons in the area. A navigation buoy located on Huia Bank inside of the Bar has succumbed to the extreme tides and weather. Two attempts were made at replacing the buoy with a pile beacon, but those also succumbed to the tides and weather.

4.13. Since this accident the operator has ceased operating into Manukau Harbour and the one other regular shipping service operating into Onehunga is likely to cease operating there within the next one or two years.

4.14. Mathematical wave modelling and weather forecasting can provide a reasonably accurate warning of weather conditions. In this example the actual weather conditions for the Raglan marine forecasting area closely resembled what was forecast.

4.15. The signalman often used the wave-rider buoy off Taharoa as an indication of when conditions were likely to begin affecting the Manukau Bar. For weather systems approaching from the south he generally used a three-hour rule of thumb for when conditions at Taharoa would be experienced at the Manukau Bar. Data from the Taharoa wave-rider buoy before it stopped recording showed that the significant wave height was trending up and had reached five metres by 2100 on the day before the accident. Even though the real-time data was not available at the time the *Spirit of Resolution* was approaching the Bar, this information, together with the weather forecast, should have been enough to warn the signalman and the master that there was a high likelihood of the average wave conditions over the Bar exceeding the maximum permissible.

4.16. The issues with the Taharoa wave-rider buoy have since been resolved. The Commission is not of a mind to recommend installing more technology to measure sea conditions off Manukau Harbour unless there is a significant increase in shipping activity in the harbour to justify the expenditure, especially as in this case there was sufficient information available for the master to make an informed decision. This is however an issue that the Auckland Transport Harbourmaster will need to monitor in future as shipping trends may change and other cost-effective technology may develop.

5. Findings

5.1. The *Spirit of Resolution* grounded on the Manukau Bar when it was overwhelmed by wave conditions and was carried out of the main channel into shallow water under the influence of tidal and current flows.

5.2. The actual wave conditions over the Manukau Bar were observed by both the master and the signal station operator to be marginally within the maximum permissible parameters just prior to the *Spirit of Resolution* beginning the Bar crossing. However, there was sufficient information in the wave forecast and information from the Taharoa wave-rider buoy to assess that there was a high risk of encountering wave conditions beyond the maximum permitted criteria in the 30 minutes it would normally take to cross the Bar.

6. Safety actions

General

6.1. The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

Safety actions addressing safety issues identified during an inquiry

6.2. None identified.

Safety actions addressing other safety issues

6.3. None identified.

6. Recommendations

General

6.1. The Commission may issue, or give notice of, recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector.

6.2. In the interests of transport safety it is important that these recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

Recommendations

6.3. No recommendations identified.

7. Key lesson

7.1. Bar harbours are notoriously hazardous for vessels of all sizes. Crossing a Bar in deteriorating sea conditions that are already at the margins of what has been deemed safe is a high-risk activity that should not be contemplated.

Appendix 1: Meteorological information

METSERVICE

Manukau Heads 18 September 2010

Introduction

This report has been prepared at the request of Paul Bird, Marine Accident Investigator of Transport Accident Investigation Commission. Mr Bird is investigating the grounding of "Spirit of Resolution" on the Manukau bar at about 0800 hours on 18 September 2010.

Summary

Meteorological Situation

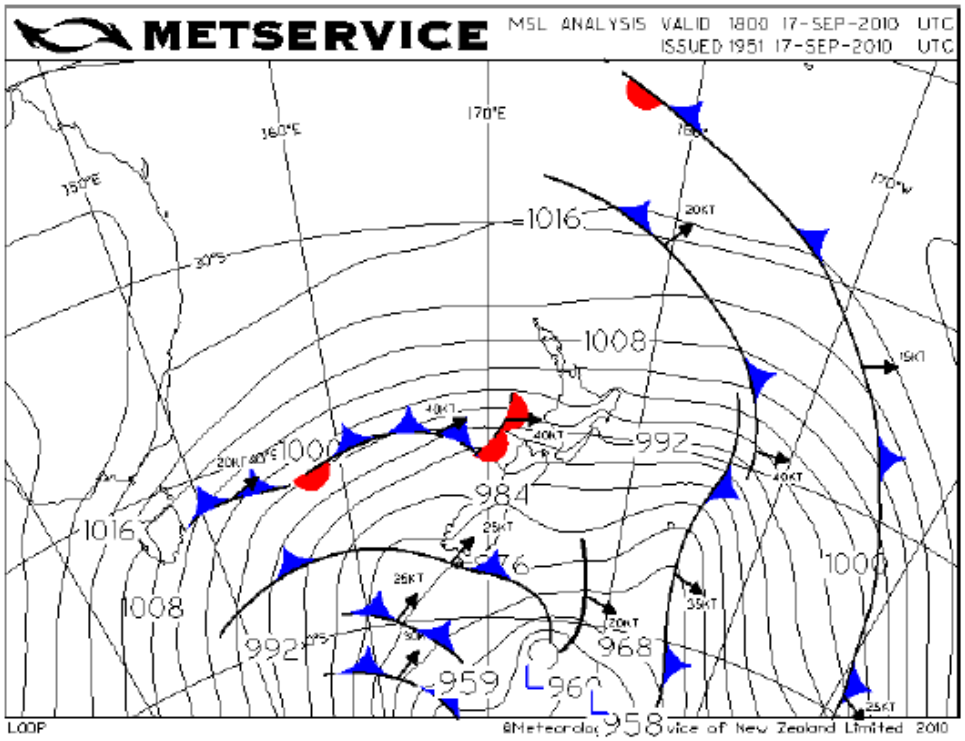

Figure 1: MetService 1800 UTC 17 Sep 2010 MSL analysis chart.

At 6am 18 September 2010 (see Figure 1 above) a very large trough of low pressure was moving very slowly eastwards across New Zealand. A broad belt of strong west to southwest wind covered the Tasman Sea. This belt of wind had been moving into the Tasman Sea area from south west of Tasmania over the previous two days.

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Coastal marine forecasts for Raglan

The area covered by the coastal marine area Raglan extends from Muriwai in the north to Cape Egmont in the south, and extends approximately 60 nautical miles seaward from the coast.

The coastal marine forecasts for Raglan issued between 0000 hours 17 September and 1200 hours 18 September 2010 are reproduced below. The coastal marine forecast bulletin includes a situation statement. For each issue of the bulletin, the situation statement and the forecast for the Raglan area are reproduced.

Note that swell height may be forecast a low, moderate or heavy, and may also be specified in metres when it is expected to be higher than 4 metres. Low means significant wave heights up to 2 metres, moderate means wave heights of 2 to 4 metres, and heavy swell means significant wave heights greater than 4 metres. Sea wave conditions are forecast using the widely understood Beaufort terms such as "heavy" and "high". A specific height for the combined (swell and sea) waves is not given in marine forecasts. It is expected that users would infer this from the forecast swell and sea state.

Issued: 17-SEP-2010 00:31

Valid to: 17-SEP-2010 23:59

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SITUATION AT 0000 NZST ON 17 Sep 2010~
A gale westerly flow spreads over the country today, containing a number of
embedded fronts, and accompanied by heavy west or southwest swells. Winds
may ease for a time on Sunday.

RAGLAN
*GALE WARNING IN FORCE*
Westerly 25 knots, rising to northwest 35 knots this morning, then to
westerly 45 knots this evening. Sea becoming high. Southwest swell
rising to 4 metres. Poor visibility squally and thundery showers
developing this morning.
OUTLOOK FOLLOWING 3 DAYS: Westerly 40 knots easing Sunday 25 knots,
before rising Monday 35 knots. Sea very rough at times. Southwest
swell becoming very heavy Saturday, then slowly easing.
```

Issued: 17-SEP-2010 04:42

Valid to: 17-SEP-2010 23:59

```
SITUATION AT 0300 NZST ON 17 Sep 2010~
A disturbed gale westerly flow spreads over the country today, and is
expected to persist throughout the forecast period. The flow contains a
number of embedded fronts, and is accompanied by heavy west or southwest
swells. Winds may ease for a time on Sunday.

RAGLAN
*GALE WARNING IN FORCE*
Northwest rising to 35 knots this morning, then to westerly 45 knots
this evening. Sea becoming high. Southwest swell rising to 4 metres.
Poor visibility squally and thundery showers.
OUTLOOK FOLLOWING 3 DAYS: Westerly 40 knots easing Sunday 25 knots,
before rising Monday 35 knots. Sea very rough at times. Southwest
swell becoming very heavy Saturday, then slowly easing.
```

Issued: 17-SEP-2010 13:05

Valid to: 18-SEP-2010 23:59

```
SITUATION AT 1200 NZST ON 17 Sep 2010~
A disturbed gale westerly flow covers the country, and is expected to
persist throughout the forecast period. The flow contains a number of
embedded fronts, and is accompanied by heavy west or southwest swells. Winds
may ease for a time on Sunday with a brief ridge.

RAGLAN
*GALE WARNING IN FORCE*
Northwest 35 knots, rising to westerly 45 knots this evening then
easing to 35 knots Saturday afternoon. Sea becoming high for a time.
Southwest swell rising to 6 metres. Poor visibility in squally and
thundery showers today.
OUTLOOK FOLLOWING 3 DAYS: Easing Sunday afternoon southwest 25 knots,
tending northwest early Monday and rising later to westerly 40 knots
with very rough sea. Heavy southwest swell easing for a time Monday.
```

Issued: 17-SEP-2010 15:57

Valid to: 18-SEP-2010 23:59

```
SITUATION AT 1500 NZST ON 17 Sep 2010~
A disturbed gale westerly flow covers the country, and is expected to
persist throughout the forecast period. The flow contains a number of
embedded fronts, and is accompanied by heavy west or southwest swells. Winds
may ease for a time on Sunday with a brief ridge.

RAGLAN
*GALE WARNING IN FORCE*
Northwest 35 knots, rising to westerly 45 knots this evening then
easing to northwest 35 knots in the afternoon. Sea becoming high for
a time. Southwest swell rising to 6 metres. Poor visibility in
squally and thundery showers today.
OUTLOOK FOLLOWING 3 DAYS: Easing Sunday afternoon southwest 25 knots,
tending northwest early Monday and rising later to westerly 40 knots
with very rough sea. Heavy southwest swell easing for a time Monday.
```

Issued: 18-SEP-2010 00:09

Valid to: 18-SEP-2010 23:59

```
SITUATION AT 0000 NZST ON 18 Sep 2010~
A disturbed gale westerly flow covers the country, and is expected to
persist throughout the forecast period. The flow contains a number of
embedded fronts, and is accompanied by heavy west or southwest swells. Winds
may ease for a time on Sunday with a brief ridge.

RAGLAN
*GALE WARNING IN FORCE*
Westerly 45 knots easing to northwest 35 knots this afternoon.High
sea easing. Southwest swell rising to 6 metres. Poor visibility in
squally, possibly thundery showers.
OUTLOOK FOLLOWING 3 DAYS: Easing Sunday afternoon southwest 25 knots,
tending northwest early Monday and rising later to westerly 40 knots
with very rough sea. Heavy southwest swell easing for a time Monday.
```

Issued: 18-SEP-2010 04:41

Valid to: 18-SEP-2010 23:59

```
SITUATION AT 0300 NZST ON 18 Sep 2010~
A disturbed gale westerly flow covers the country, and is expected to
persist throughout the forecast period. The flow contains a number of
embedded fronts, and is accompanied by heavy west or southwest swells. Winds
may ease for a time on Sunday with a brief ridge.

RAGLAN
*GALE WARNING IN FORCE*
Westerly 45 knots easing to northwest 35 knots this afternoon.High
sea easing. Southwest swell rising to 6 metres. Poor visibility in
squally, possibly thundery showers.
OUTLOOK FOLLOWING 3 DAYS: Easing Sunday afternoon southwest 25 knots,
tending northwest early Monday and rising later to westerly 40 knots
with very rough sea. Heavy southwest swell easing for a time Monday.
```

Issued: 18-SEP-2010 12:26

Valid to: 19-SEP-2010 23:59

```
SITUATION AT 1200 NZST ON 18 Sep 2010~
A disturbed westerly flow should cover New Zealand until at least Wednesday.

RAGLAN
*GALE WARNING IN FORCE*
Northwest 45 knots, easing to westerly 35 knots overnight and to 25
knots Sunday afternoon. High sea easing. Southwest swell 6 metres
easing. Poor visibility in squally, possibly thundery showers, easing
Sunday evening.
OUTLOOK FOLLOWING 3 DAYS: Rising Monday westerly 40 knots with very
rough sea, easing Wednesday 30 knots. Heavy southwest swell.
```

Observations

Wind

Wind observations at the entrance to Manukau Harbour are represented by those recorded by the automatic weather station at Manukau Heads. Hourly observations for 17 and 18 September are listed in the Appendix.. Based on those observations, and considering the exposure and location of the station; The direction was from northwest or west, and the wind speed was strong to near gale for most of 17 September and increased to gale force in the evening. On 18 September the wind speed eased somewhat about 0400 and 0500 hours, but was increasing again in the hours following. At 0800 hours the wind speed was about 35 knots in the vicinity of the Manukau Bar.

Sea state and swell waves

Observations

There is a wave buoy at Port Taharoa that records many ocean wave parameters at 1-minute intervals. Figures 2 and 3 are graphs of significant wave height and maximum wave height every 10 minutes as recorded by the wave buoy.

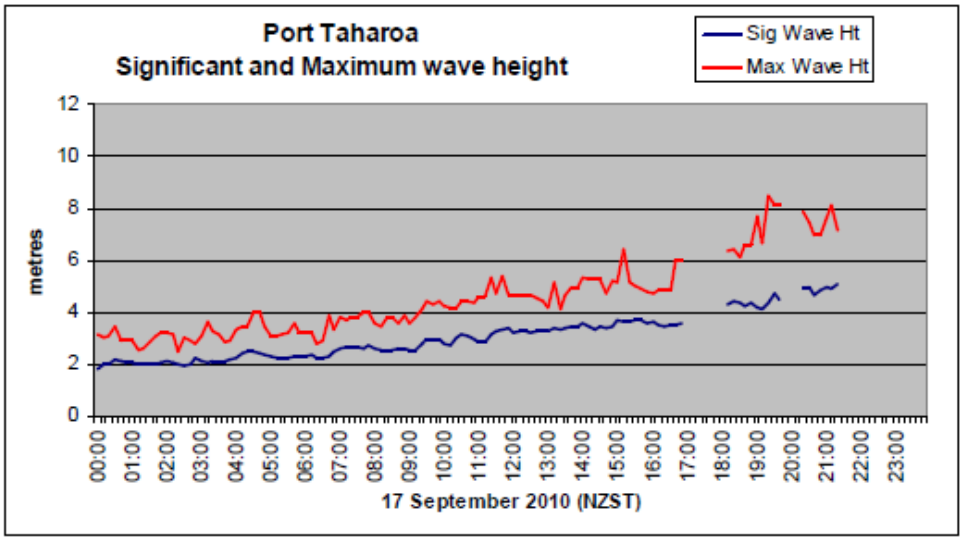


Figure 2: Significant and maximum wave height recorded at Port Taharoa on 17 September 2010. Data stopped recording at 23:24.

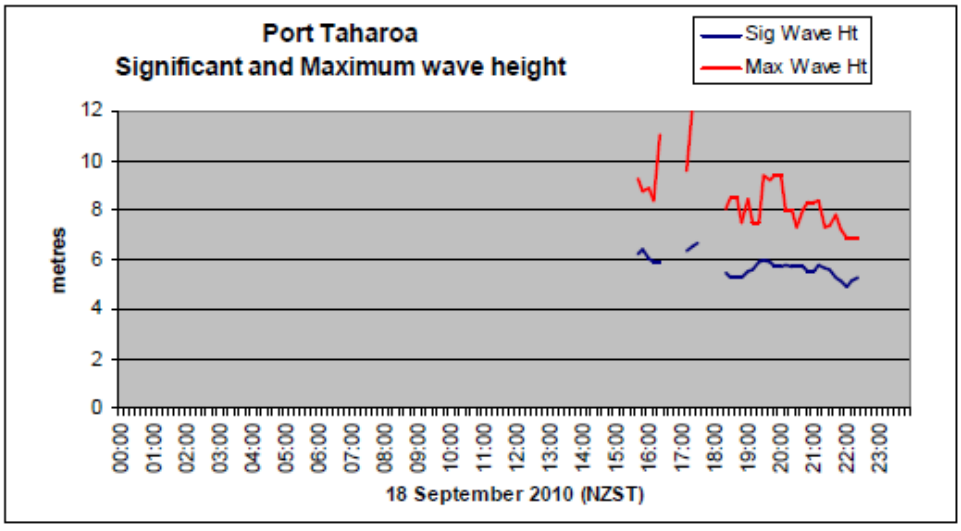


Figure 3: Significant and maximum wave height recorded at Port Taharoa on 18 September 2010. Data recommenced recording at 14:49.

"Significant wave height" is defined as the average height of the highest 1/3 of the waves.

The 10 minute data from which these graphs were constructed are listed in the Appendix. There are periods of suspect data; this is likely to be the result of impaired radio signal between the buoy and shore as the buoy is swamped by breaking waves. In the graphs and the data listings, the suspect data has been removed.

Based on the Port Taharoa wave buoy data, the significant wave height of combined waves (consisting of both swell waves and locally generated sae waves) was about 5 metres at 21:00 hours on 17 September and rising. Maximum waves were about 7 metres. At about that time reliable wave data ceased to be recorded. Between 16:00 and 20:00 hours on 18 September when reliable wave data recording recommenced the significant wave height of combined waves was about 6 metres and maximum waves were 7.3 to 9.3 metres. Between the periods of reliable data at 08:00 hours on 18 September 2010 it is reasonable to suggest conservatively that the significant wave height of combined waves was between 6 and 7 metres, and the maximum waves were 8 to 10 metres.

As is suggested by the modelled wave data, the wave field was broadly uniform in the area west of the North Island in the vicinity of Port Taharoa and Manukau Heads. Therefore, in my opinion combined waves (swell and wind waves) in the vicinity of Manukau Heads had a significant height of between 6 and 7 metres, possibly higher. The maximum wave height was 8 to 10 metres, possibly higher.

Computer Modelled Data

Global sea and swell wave spectra are routinely modelled by several centres, and the analyses and forecasts are made available to national meteorological offices for the preparation of marine weather forecasts.

The 6-hour forecast charts, from the analysis time at 1200 UTC 17 September 2010, for 1800 UTC (06:00 hours 18 September) of wind waves, swell waves, and the combined waves are in the Appendix. These show, as far as can be read from the charts, that the significant wave height of combined waves from swell and wind waves was about 7 metres at 06:00 hours on 18 September. Most of the wave energy was contributed by swell waves which had travelled from further west in the Tasman Sea.

The above meteorological information has been retrieved from our records. To the best of my knowledge, the information is correct.

For and on behalf of Meteorological Service of New Zealand Ltd

Ross Marsden

Consultant Meteorologist

04 November 2010

Appendix

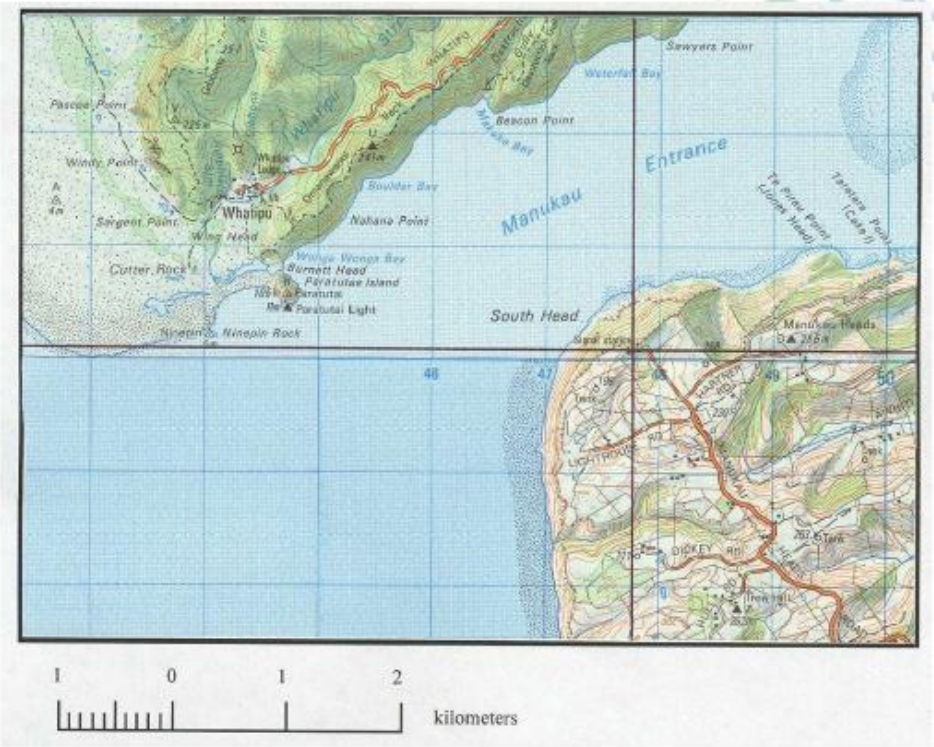
Wind observations on 17 and 18 September 2010 at Manukau Heads Automatic Weather Station.

The exposure of the anemometer at this station is far from ideal. The station note have this comment: "The anemometer is located on a pole connected to an observation platform on the roof of the station house in the southeast corner. The cups are within 2m of the roof. Due to the close proximity of the roof, large variances between the one minute average and 3 second gusts are reported in northeasterlies. In all other directions the wind is recorded satisfactorily compared to the Munro anemometer at the manual SYNOP station."

In wind from the westerly quarter, there is probably some acceleration of wind over or around the steep headland where the station is located (see map next page). Therefore wind speeds and gusts in this listing are probably higher that would have been experienced at sea level in the vicinity of the bar.

Manakau Heads Wind NZ Standard Time	Dir'n °T	Speed Knots	Gust Knots
17 Sep 2010 00:00	250	18	24
17 Sep 2010 01:00	280	16	25
17 Sep 2010 02:00	280	20	30
17 Sep 2010 03:00	290	22	31
17 Sep 2010 04:00	290	27	35
17 Sep 2010 05:00	300	27	33
17 Sep 2010 06:00	310	30	40
17 Sep 2010 07:00	310	28	40
17 Sep 2010 08:00	320	23	39
17 Sep 2010 09:00	340	22	36
17 Sep 2010 10:00	350	20	35
17 Sep 2010 11:00	340	19	42
17 Sep 2010 12:00	340	21	45
17 Sep 2010 13:00	320	32	53
17 Sep 2010 14:00	340	27	47
17 Sep 2010 15:00	340	28	50
17 Sep 2010 16:00	320	34	62
17 Sep 2010 17:00	020	15	36
17 Sep 2010 18:00	310	44	63
17 Sep 2010 19:00	300	44	57
17 Sep 2010 20:00	280	37	65
17 Sep 2010 21:00	270	38	58
17 Sep 2010 22:00	250	36	52
17 Sep 2010 23:00	250	37	62

Manakau Heads Wind NZ Standard Time	Dir'n °T	Speed Knots	Gust Knots
18 Sep 2010 00:00	280	42	74
18 Sep 2010 01:00	260	31	52
18 Sep 2010 02:00	270	35	58
18 Sep 2010 03:00	270	36	58
18 Sep 2010 04:00	270	29	51
18 Sep 2010 05:00	270	29	46
18 Sep 2010 06:00	270	28	44
18 Sep 2010 07:00	290	34	51
18 Sep 2010 08:00	290	38	53
18 Sep 2010 09:00	300	41	52
18 Sep 2010 10:00	300	43	58
18 Sep 2010 11:00	310	44	57
18 Sep 2010 12:00	300	45	60
18 Sep 2010 13:00	300	50	62
18 Sep 2010 14:00	300	43	54
18 Sep 2010 15:00	300	43	53
18 Sep 2010 16:00	300	43	57
18 Sep 2010 17:00	300	39	48
18 Sep 2010 18:00	300	41	52
18 Sep 2010 19:00	300	43	54
18 Sep 2010 20:00	300	40	52
18 Sep 2010 21:00	310	39	52
18 Sep 2010 22:00	310	41	53
18 Sep 2010 23:00	310	44	62



Location of Manukau Heads Automatic Weather Station on South Head near the Signal Station.

Wave data recorded at Port Taharoa on 17 and 18 September 2010

17 September 2010

Time NZST	Sig Wave Ht	Max Wave Ht
00:00:00	1.844	3.145
00:10:00	1.970	3.014
00:20:00	2.001	3.093
00:30:00	2.165	3.471
00:40:00	2.120	2.911
00:50:00	2.064	2.913
01:00:00	2.080	2.921
01:10:00	1.983	2.537
01:20:00	1.973	2.615
01:30:00	2.018	2.838
01:40:00	1.996	3.062
01:50:00	2.077	3.194
02:00:00	2.093	3.193
02:10:00	2.060	3.176
02:20:00	2.016	2.492
02:30:00	1.963	3.003
02:40:00	2.024	2.921
02:50:00	2.224	2.818
03:00:00	2.148	3.077
03:10:00	2.048	3.610
03:20:00	2.139	3.267
03:30:00	2.148	3.134
03:40:00	2.103	2.872
03:50:00	2.177	2.919
04:00:00	2.253	3.348
04:10:00	2.399	3.441
04:20:00	2.464	3.481
04:30:00	2.478	4.013
04:40:00	2.428	3.996
04:50:00	2.350	3.448
05:00:00	2.294	3.089
05:10:00	2.245	3.097
05:20:00	2.250	3.150
05:30:00	2.240	3.229
05:40:00	2.284	3.600
05:50:00	2.291	3.229
06:00:00	2.330	3.201
06:10:00	2.347	3.208
06:20:00	2.243	2.799
06:30:00	2.237	2.937
06:40:00	2.283	3.873
06:50:00	2.470	3.309
07:00:00	2.630	3.794
07:10:00	2.658	3.681
07:20:00	2.686	3.834
07:30:00	2.687	3.822
07:40:00	2.632	3.972
07:50:00	2.719	3.988

17 September 2010

Time NZST	Sig Wave Ht	Max Wave Ht
08:00:00	2.631	3.595
08:10:00	2.532	3.444
08:20:00	2.574	3.794
08:30:00	2.517	3.795
08:40:00	2.598	3.563
08:50:00	2.624	3.855
09:00:00	2.570	3.594
09:10:00	2.567	3.837
09:20:00	2.781	4.099
09:30:00	2.941	4.427
09:40:00	2.952	4.273
09:50:00	2.948	4.414
10:00:00	2.759	4.264
10:10:00	2.749	4.202
10:20:00	3.015	4.207
10:30:00	3.148	4.405
10:40:00	3.100	4.403
10:50:00	2.986	4.392
11:00:00	2.832	4.584
11:10:00	2.823	4.598
11:20:00	3.162	5.361
11:30:00	3.285	4.713
11:40:00	3.329	5.376
11:50:00	3.403	4.694
12:00:00	3.229	4.686
12:10:00	3.261	4.677
12:20:00	3.281	4.694
12:30:00	3.217	4.694
12:40:00	3.257	4.542
12:50:00	3.266	4.422
13:00:00	3.284	4.199
13:10:00	3.368	5.140
13:20:00	3.358	4.129
13:30:00	3.422	4.659
13:40:00	3.462	4.987
13:50:00	3.468	4.991
14:00:00	3.560	5.322
14:10:00	3.455	5.272
14:20:00	3.326	5.277
14:30:00	3.470	5.256
14:40:00	3.368	4.737
14:50:00	3.464	5.187
15:00:00	3.689	5.149
15:10:00	3.659	6.428
15:20:00	3.645	5.149
15:30:00	3.696	5.016
15:40:00	3.671	4.915
15:50:00	3.546	4.804

17 September 2010

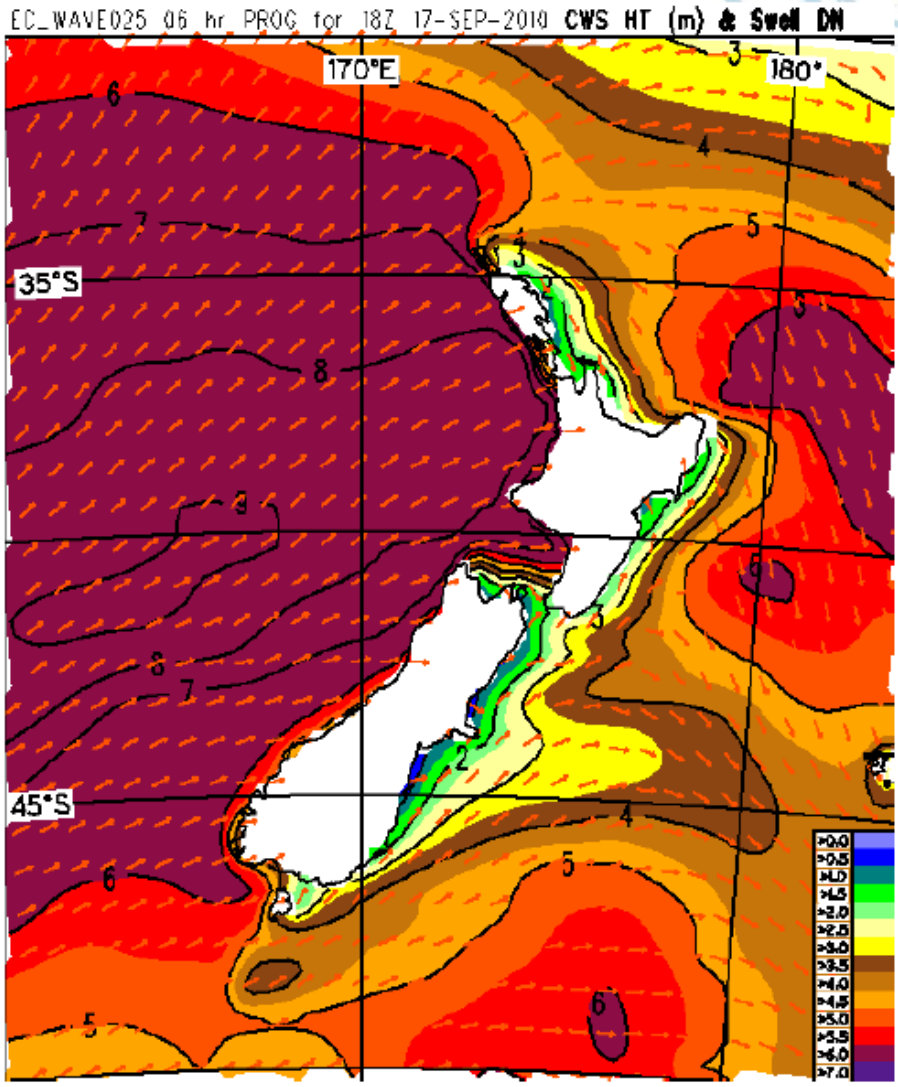
Time NZST	Sig Wave Ht	Max Wave Ht
16:00:00	3.629	4.711
16:10:00	3.509	4.865
16:20:00	3.464	4.866
16:30:00	3.527	4.867
16:40:00	3.494	6.004
16:50:00	3.561	5.979
17:00:00		
17:10:00		
17:20:00		
17:30:00		
17:40:00		
17:50:00		
18:00:00		
18:10:00	4.299	6.382
18:20:00	4.398	6.399
18:30:00	4.337	6.149
18:40:00	4.250	6.599
18:50:00	4.352	6.618
19:00:00	4.195	7.699
19:10:00	4.122	6.676
19:20:00	4.380	8.478
19:30:00	4.737	8.116
19:40:00	4.498	8.101
19:50:00		
20:00:00		
20:10:00		
20:20:00	4.972	7.882
20:30:00	4.995	7.472
20:40:00	4.684	6.988
20:50:00	4.877	6.971
21:00:00	5.000	7.607
21:10:00	4.921	8.111
21:20:00	5.063	7.134
21:30:00		
21:40:00		
21:50:00		
22:00:00		
22:10:00		
22:20:00		
22:30:00		
22:40:00		
22:50:00		
23:00:00		
23:10:00		
23:20:00		
23:30:00		
23:40:00		
23:50:00		

18 September 2010 (from 12:00)

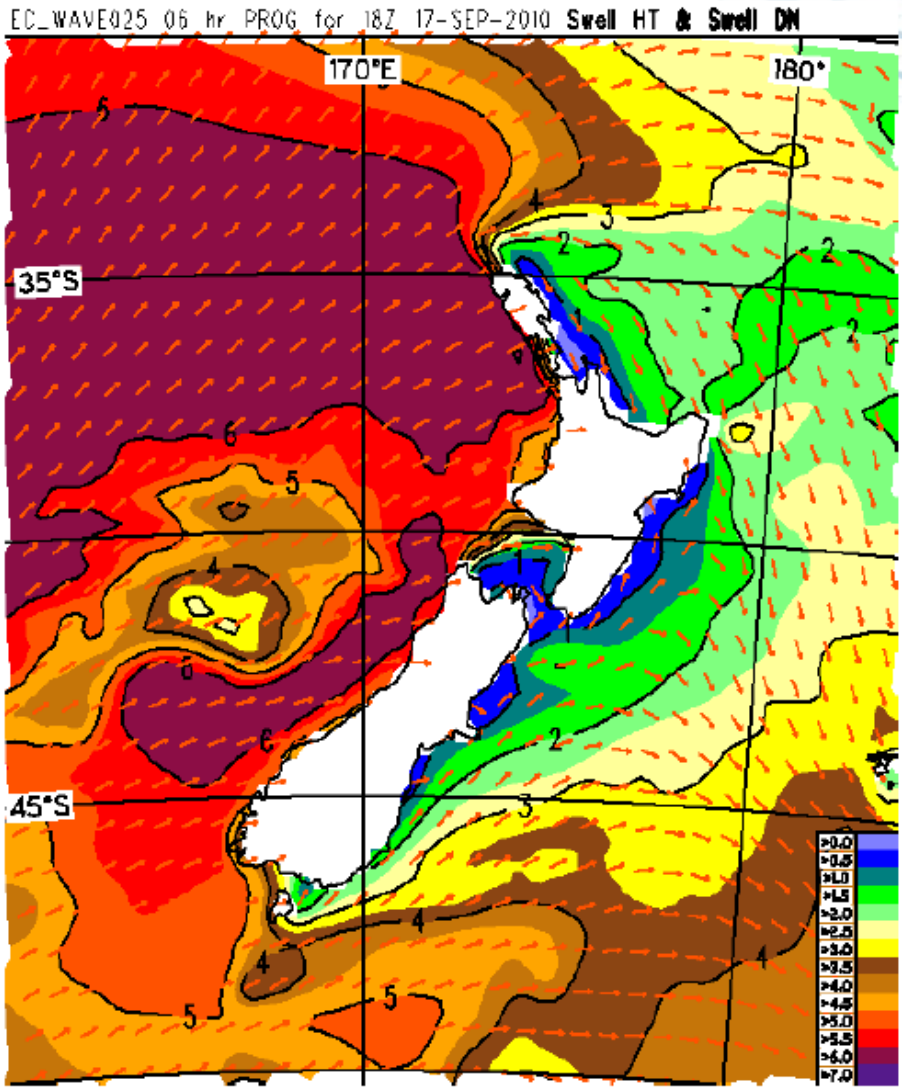
Time NZST	Sig Wave Ht	Max Wave Ht
12:00:00		
12:10:00		
12:20:00		
12:30:00		
12:40:00		
12:50:00		
13:00:00		
13:10:00		
13:20:00		
13:30:00		
13:40:00		
13:50:00		
14:00:00		
14:10:00		
14:20:00		
14:30:00		
14:40:00		
14:50:00	6.474	15.288
15:00:00		
15:10:00		
15:20:00		
15:30:00		
15:40:00	6.236	9.243
15:50:00	6.402	8.791
16:00:00	6.002	8.888
16:10:00	5.877	8.362
16:20:00	5.874	11.063
16:30:00		
16:40:00		
16:50:00		
17:00:00		
17:10:00	6.368	9.557
17:20:00	6.551	12.392
17:30:00	6.660	12.402
17:40:00		
17:50:00		
18:00:00		
18:10:00		
18:20:00	5.477	8.082
18:30:00	5.282	8.497
18:40:00	5.275	8.503
18:50:00	5.292	7.520
19:00:00	5.533	8.427
19:10:00	5.616	7.517
19:20:00	5.915	7.480
19:30:00	5.941	9.384
19:40:00	5.886	9.179
19:50:00	5.744	9.390

Time NZST	Sig Wave Ht	Max Wave Ht
20:00:00	5.718	9.417
20:10:00	5.757	8.027
20:20:00	5.739	8.015
20:30:00	5.745	7.325
20:40:00	5.746	8.013
20:50:00	5.534	8.322
21:00:00	5.497	8.324
21:10:00	5.758	8.372
21:20:00	5.672	7.331
21:30:00	5.563	7.338
21:40:00	5.266	7.820
21:50:00	5.133	7.263
22:00:00	4.881	6.865
22:10:00	5.117	6.864
22:20:00	5.246	6.864
22:30:00		
22:40:00		
22:50:00		
23:00:00		
23:10:00		
23:20:00		
23:30:00		
23:40:00		
23:50:00	5.234	7.344

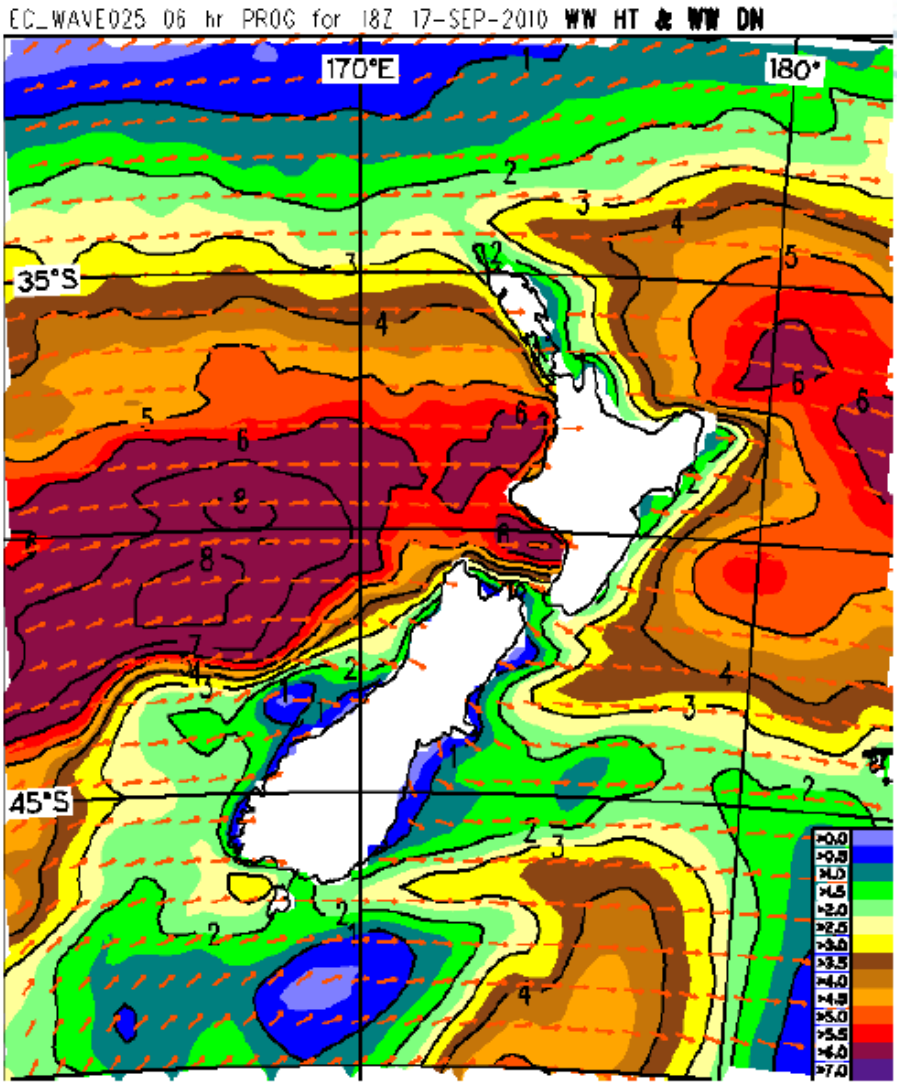
Modelled sea and swell wave charts



Combined wind and swell significant wave height forecast for 06:00 hours 18 September 2010.



Swell significant wave height forecast for 06:00 hours 18 September 2010.



Wind significant wave height forecast for 06:00 hours 18 September 2010.

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09-202	Marine Inquiry 09-202: Passenger vessel *Oceanic Discoverer* Fatal injury, Port of Napier 19 February 2009
11-201	Passenger vessel *Volendam*, lifeboat fatality,Port of Lyttelton, New Zealand, 8 January 2011
10-203	*Marsol Pride*, uncontrolled release of fire-extinguishing gas into engine room, Tui oil and gas field, 27 May 2010
09-204 and 09-207	Coastguard rescue vessel *Dive! Tutukaka Rescue* collision with rocks, Taiharuru River entrance Northland, 4 March 2009; Coastguard rescue vessel Trusts Rescue, heavy weather encounter,Manukau Bar, 31 May 2009
10-201	Bulk carrier *TPC Wellington*, double fatality resulting from enclosed space entry, Port Marsden, Northland, 3 May 2010
09-201	Collision: private jet-boat/private watercraft, Kawarau River, Queenstown, 5 January 2009
08-209	Loss of the rigid inflatable boat *Mugwop*, off the entrance to Lyttelton Harbour, 28 October 2008
11-201	Interim Factual report - Passenger vessel *Volendam*, lifeboat fatality, port of Lyttelton, New Zealand, 8 January 2011
08-205	Fishing vessel, *San Cuvier*, dragged anchor and grounded, Tarakeha Point, Bay of Plenty, 27 July 2008

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