

**Report 08-207, Commercial jet boat Kawarau Jet No. 6, roll-over, Confluence of the Kawarau
and Shotover Rivers, 25 September 2008**

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Report 08-207

**commercial jet boat
*Kawarau Jet No.6***

roll-over

Confluence of the Kawarau and Shotover Rivers

25 September 2008



Photograph courtesy of Kawarau Jet

Kawarau Jet No.6 fully loaded with passengers

Executive Summary

At about 1400 on 25 September 2008, a tour group of 22 non-English speaking overseas tourists, with a driver, departed the Queenstown Main Town Pier on what was intended to be a typical one hour jet boat excursion on the Shotover River. During the return journey the jet boat touched a sand bar at the meeting of the Shotover and Kawarau Rivers and rolled over coming to rest upside down. One passenger was trapped and drowned under the upturned boat, one other passenger suffered moderate injuries, while five other passengers suffered minor injuries. The boat received superficial damage.

Boats often travelled across the bar when enough water was available to do so. The experienced driver of the accident craft had done so on 2 trips earlier the same day, and the practice was taught during driver training. As the driver approached the bar he saw what he thought was clear water ahead of the boat but as he adjusted his helm to turn the boat upstream the bar appeared in front of the boat. The boat touched the bar as it was in a sliding turn to the right with the momentum causing it to flip and came to rest upside down.

Another jet boat travelling up stream parallel and close to the sand bar at the confluence had crossed ahead of the accident boat. It is highly likely that interaction between the hull of the passing jet boat and the river bank caused the water over the sand bar to recede into the main channel. This effect had not been considered in safety planning or driver training.

The passenger who remained trapped and undetected under the upturned hull highly likely drowned before rescuers could reasonably determine that one was missing. There was sufficient space beneath the upturned boat created by the roll bar for the driver and passengers to escape. Reasons for the deceased not escaping could have been entrapment, disorientation, inhalation of water owing to gasping reflex, flotation from lifejacket forcing the passenger up under the hull, or a combination of these.

The operator has made a number of operating changes to reduce the risk of a recurrence including no longer crossing the bar involved, and requiring drivers to steer straight on to any bars or banks that cannot be avoided to minimise the risk of flipping or rolling over.

Safety recommendations have been made to the Director of Maritime New Zealand to address a number of safety factors identified during the investigation that did not contribute to this accident or its outcome. These recommendations were to:

- address the coverage limitations of emergency back-up radios
- bring to the attention of the reviewers of adventure tourism in New Zealand the lessons learned from this accident, and in particular, how to deal with informing potential commercial jet boat passengers of the risks inherent in the activity
- address with the commercial jet boat industry:
 - the issue of delivering meaningful pre-trip safety briefings to passengers, particularly where understanding of the English language is an issue.
 - the issue of accounting for passengers when multiple boats are involved during emergency response.

(Note: this executive summary condenses content to highlight key points to readers and does so in simpler English and with less technical precision than the remainder of the report to ensure its accessibility to a non-expert reader. Expert readers should refer to and rely on the body of the full report.)

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Abbreviations

°	degrees
Commission	Transport Accident Investigation Commission
cumecs	cubic metres per second
GPS	global positioning system
Kawarau Jet	Kawarau Jet Services Limited
<i>K-Jet 6</i>	<i>Kawarau Jet No.6</i>
<i>K-Jet 7</i>	<i>Kawarau Jet No.7</i>
Kph	kilometre(s) per hour
m	metre(s)
mm	millimetre(s)
NIWA	National Institute of Water and Atmospheric Research
Police	New Zealand Police
UTC	universal co-ordinated time
VHF	very high frequency

Glossary

emergency code 1	a Kawarau Jet company code for a serious emergency where urgent assistance is required
seiche	a standing wave in an enclosed or partially enclosed body of water. Seiches and seiche-related phenomena have been observed on lakes, and in reservoirs, swimming pools, bays, and seas. The key requirement for the formation of a seiche is that the body of water be at least partially bounded, allowing the formation of the standing wave.

Data Summary

Vessel Particulars:

Name:	<i>Kawarau Jet No.6</i>
Type:	commercial jet boat
Class:	marine craft used in adventure tourism - jetboat
Limits:	Kawarau and Shotover Rivers
Length:	7.3 metres (m)
Breadth:	2.97 m
Construction	aluminium alloy
Built:	Bluff 1999
Propulsion:	2 x Chevrolet 350 cubic inch electronic fuel injection petrol engines each driving Hamilton 212 jet unit
Normal operating speed:	70-90 kilometres per hour (kph)
Owner/operator:	Kawarau Jet Services Limited (Kawarau Jet)
Allowable occupants:	1 crew and up to 22 passengers

Date and time: 25 September 2008 at about 1445¹

Location: Confluence of the Kawarau and Shotover Rivers

Persons on board: crew: one
passengers: 22

Injuries: crew: nil
passengers: one fatal, one moderate, 5 minor

Damage: Minor to boat.

Investigator-in-charge: Captain Iain Hill

¹ Times in this report are New Zealand Standard Time (UTC + 12 hours) and are expressed in the 24-hour mode.

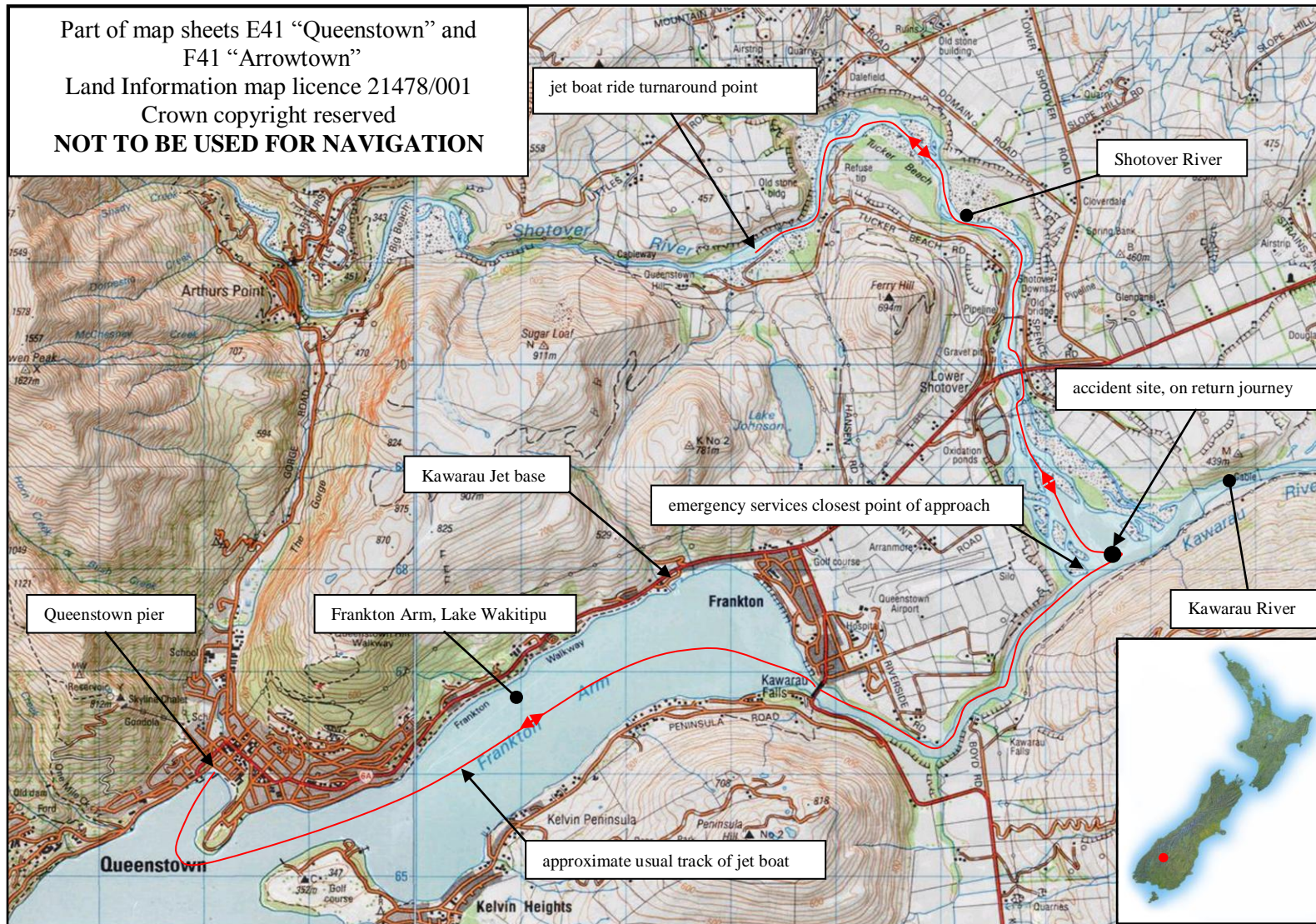
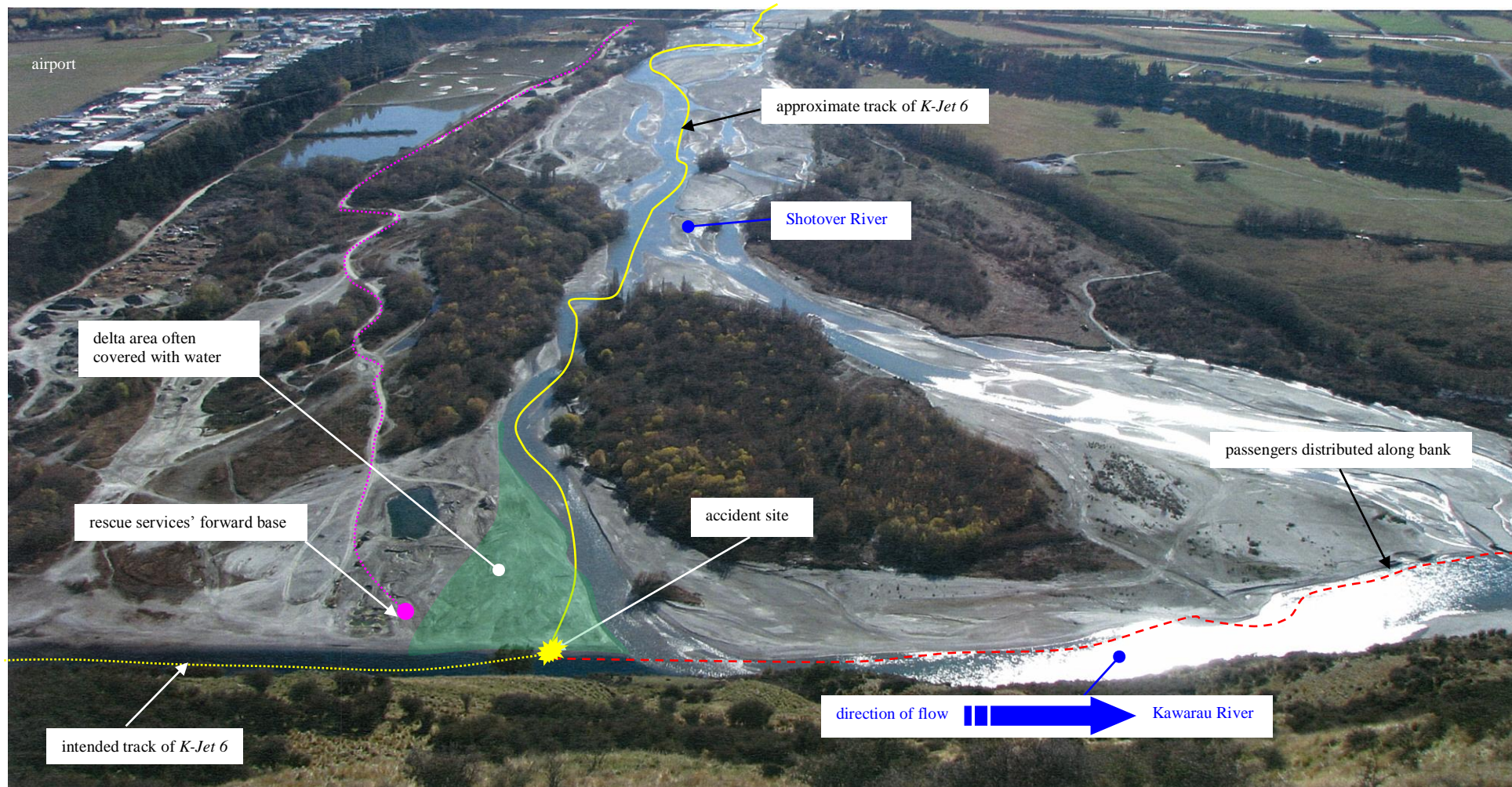


Figure 1
General area of the accident

1 Factual Information

1.1 Narrative

- 1.1.1 On 25 September 2008, at some time during the morning the guide in charge of a tour group of Chinese nationals arranged for a jet boat excursion on the Shotover River for members of the tour group. The excursion was arranged at short notice because an intended excursion to Milford Sound had been cancelled because the road was closed owing to the weather.
- 1.1.2 The jet boat excursion was planned for 1400 the same afternoon, with the pick-up point being at the Queenstown Main Town Pier. Tour groups were usually picked up from the Kawarau Jet base at Frankton Marina as this afforded parking for the tour coach.
- 1.1.3 At about 1345, the 22 members of the tour group who had elected to go on the jet boat ride arrived at the Kawarau Jet office on the Main Town Pier where they were issued with and were helped with donning waterproofs and lifejackets.
- 1.1.4 At about 1358, another jet boat, *Kawarau Jet No.7 (K-Jet 7)* departed the Main Town Pier with 21 passengers on board. These passengers were independent travellers not associated with any particular tour group. This boat was ahead of *Kawarau Jet No.6 (K-Jet 6)* and would remain so throughout the trip.
- 1.1.5 At about 1400, the designated driver of *K-Jet 6*, returned from his lunch break, embarked the town group passengers into *K-Jet 6* and seated them to his satisfaction for trim and balance.
- 1.1.6 Once seated, the driver cast off and drove the boat around to the front of the jetty where he stopped for a close up photograph and completed a safety briefing. He then drove out into Queenstown Bay where he completed a spin to allow the photographer to capture an “action” photograph. He said that as the majority of his passengers were not English speakers, he used a safety card (see Appendix 1), which was printed in a variety of languages and graphically depicted safety advice, and demonstrated the safety instructions. The passengers were later to say that they had not understood the safety briefing, and many could not remember seeing the safety card.
- 1.1.7 After completing the photo shoot the driver headed out of Queenstown Bay along Frankton Arm towards where the Kawarau River flows out of Lake Wakatipu. As the boat passed through “the narrows” the driver executed a 360-degree (°) “Hamilton” turn followed by another 360° just after he had passed under the road bridge at the entrance to the Kawarau River. The driver said that he used the first 2 turns to gauge how much the passengers liked the turns. On this occasion he judged the majority of them had not enjoyed the experience, so he decided to modify the remainder of the trip accordingly.
- 1.1.8 *K-Jet 6* then proceeded down the Kawarau River and turned up the Shotover River as far as Tuckers Beach, which was as far as the Kawarau Jet resource consent extended. The driver stopped the boat at certain points to give a commentary. When *K-Jet 6* arrived at Tuckers Beach *K-Jet 7* was stopped in a deeper part of the river with the driver giving a commentary. *K-Jet 6* came to a stop in the same part of the river and the driver of *K-Jet 6* started to give his commentary, at which point *K-Jet 7* departed Tuckers Beach after transmitting on his very high frequency (VHF) transceiver that he was proceeding downstream. After the driver of *K-Jet 6* had completed his commentary at Tuckers Beach he also departed downstream after radioing his intentions to the base station.
- 1.1.9 The driver of *K-Jet 7* proceeded down the Shotover River without doing any 360° turns. Arriving at the confluence of the Shotover and Kawarau Rivers he took the right branch main channel and entered the Kawarau River, following the flow downstream from the confluence for a short distance before performing a 360° turn.



Unannotated photograph courtesy of Otago Regional Council 2009

Figure 2
Shotover delta and confluence with the Kawarau River

After stopping for a brief time, *K-Jet 7* proceeded upriver towards the lake. As it passed the confluence of the 2 rivers, and knowing that *K-Jet 6* would be close, the driver glanced up the Shotover River and saw *K-Jet 6* approaching at a distance that he estimated to be about 150 - 200 m away.

- 1.1.10 The driver of *K-Jet 6* recalled that as he approached the confluence of the rivers he saw *K-Jet 7* cross ahead of him. He decided to veer right and cross the bar at the confluence and return directly to Queenstown without going downstream as *K-Jet 7* had done; he had done this on his previous 2 trips that day. When he looked at the bar he saw what he thought was clear water ahead of the boat, but as he adjusted his helm to turn the boat upstream, a sand bar appeared in front of the boat. *K-Jet 6* touched the bar as it was in a sliding turn to the right, the momentum causing it to roll-over and come to rest upside down.
- 1.1.11 Many of the passengers were thrown clear of the boat and into the water when it rolled over, and started to float downriver with the current; some were able to swim towards the sand bars in the river confluence. Some of the passengers were trapped underneath the upturned boat and either managed to work themselves clear of the boat or were aided by other passengers and the driver to get free.
- 1.1.12 The driver of *K-Jet 6* said he managed to swim out from under the boat, then used his portable transceiver radio to call “emergency code 1” several times. The driver then swam around the boat and aided 4 passengers to get onto the upturned hull of the boat, then climbed up himself. Once on the upturned hull he checked both sides of the boat to see if any other passengers were still trapped underneath. He could not see any.

Rescue

- 1.1.13 Meanwhile, the driver of *K-Jet 7* continued upriver for approximately 0.5 kilometres (Km) where he completed another 360° turn. As he completed the turn he heard an unclear message on his radio. Knowing that *K-Jet 6* was the only other Kawarau Jet boat on the river, he looked back downriver where he saw *K-Jet 6* at an unusual angle and thought that the boat had grounded.
- 1.1.14 The driver of *K-Jet 7*, on seeing *K-Jet 6* at an unusual angle, turned his boat around and returned to the confluence to render assistance. As he got closer he could see that *K-Jet 6* was upside down. The driver of *K-Jet 7* made an all-stations call on Kawarau Jet’s VHF channel 1 to switch to the company’s working channel 2, which was heard at both Kawarau Jet’s base and at the Main Town Pier. The driver then relayed the information that *K-Jet 6* had overturned at the mouth of the Shotover River.
- 1.1.15 The driver of *K-Jet 7* saw people floating down the river, so he decided to drop off his passengers on one of the exposed sand bars, retaining several of the male passengers to assist him with the rescue, and started to pick up those passengers from *K-Jet 6* who were still in the water.
- 1.1.16 Kawarau Jet’s operations manager received the radio call at the Kawarau Jet base and called the emergency services. Another jet boat driver who was in the Kawarau Jet base also heard the call and responded by loading the accident emergency kit into the safety boat (*K-Jet 2*), which was tied up at Kawarau Jet base jetty, ready to respond. He then untied the boat and made his way to the accident site.
- 1.1.17 A Kawarau Jet boat driver stationed at the pier heard the call, boarded an empty boat (*K-Jet 8*), and made his way to the accident site.
- 1.1.18 At about 1445, the Southern Communications Centre received an emergency call from Kawarau Jet advising it of the accident, and then issued a “priority one” call. The New Zealand Police (Police) and St Johns Ambulance were dispatched to the scene of the accident.

- 1.1.19 At about that time, a helicopter on a tourist flight, took off from Queenstown Airport and flew straight down the Kawarau River. As the helicopter flew down the river, the pilot could see an upturned yellow boat and people floating down the river. The pilot contacted Queenstown Airport air traffic control, reported what he had seen and requested clearance to land at the mouth of the Shotover River.
- 1.1.20 The helicopter pilot landed his craft and spent several minutes observing passengers in the water drifting down the river. He saw a Kawarau Jet boat plucking people out of the water, so he took off and flew his passengers to their destination. He then flew straight back, landed at the mouth of the Shotover River again and offered assistance.
- 1.1.21 At about 1448, the harbourmaster had seen *K-Jet 2* depart from the base wharf at high speed with no passengers on board. The harbourmaster walked across to the Kawarau Jet base next door to find out what was happening. He learned that a boat had overturned at the confluence, so he drove his car to the confluence, calling the deputy harbourmaster on the way for backup.
- 1.1.22 One of the Police officers who heard the “priority one” call telephoned 2 members of the Queenstown Coastguard, which was part of Royal New Zealand Coastguard Inc, but received no reply. He did not try to page them using the pager numbers listed in the emergency response plan.
- 1.1.23 As the harbourmaster drove to the scene, he linked up with an ambulance and guided it to the confluence. A few minutes later they were joined by members of the Police and the deputy harbourmaster. The emergency services were located on the western bank of the Shotover River, which was the most easily accessible bank for motor vehicles.
- 1.1.24 Meanwhile the driver of *K-Jet 7* had proceeded to pick up passengers from *K-Jet 6* who were floating down the river, starting with the passengers furthest down river and transporting them back to the sand bar where he had dropped his own passengers earlier. He then took his boat out again to resume picking up other passengers just as *K-Jet 2* and *K-Jet 8* arrived.
- 1.1.25 *K-Jet 6*'s driver, along with the other passengers on the upturned boat, were picked up by the driver in *K-Jet 2*, and transported to the sandbank where the other passengers were assembling. Once there the 2 drivers attempted to carry out a head count. They had difficulty because the passengers from the 2 jet boats *K-Jet 6* and *K-Jet 7* were mingling. The passengers were later to say that some were aware that one was missing, but had some difficulty relating that information to the drivers. From the drivers' perspective, they were faced with a number of distraught passengers and did not understand what was being said to them, so they decided to reload the passengers from *K-Jet 7* and take them back to the Kawarau Jet base.
- 1.1.26 The drivers decided to evacuate 3 of the cold and injured passengers in the helicopter that had landed. As this was being done, 2 of the drivers got into *K-Jet 2* and went to the upturned boat, but decided that it was too dangerous to go underneath it and proceeded across to where the emergency services had gathered. The drivers told the Police that all the passengers had been accounted for, then returned to the sand bar where they helped load *K-Jet 7* with its passengers. Once *K-Jet 7* had departed, the drivers made a head count and it was only then that they established one passenger from *K-Jet 6* was unaccounted for.
- 1.1.27 The 2 drivers then loaded the remaining passengers into *K-Jet 2* and *K-Jet 8* and took them to the emergency services. The drivers then told the harbourmaster and the Police that one of the passengers was unaccounted for.
- 1.1.28 The deputy harbourmaster and 2 others boarded one of the jet boats and went to the upturned boat. They knocked on the hull in case the missing passenger was alive and trapped underneath. They got no response and could not see underneath because the water was discoloured following recent rain, so they proceeded to search downriver under the overhanging willows for the missing passenger. Finding no trace they returned to the forward base. They arrived back at the forward base at about 1523. The deputy harbourmaster telephoned a local dive team and put it on standby for searching the river.



Photograph courtesy of New Zealand Police

Figure 3

Helicopter lifting *K-Jet 6* to allow divers to access under boat

- 1.1.29 The helicopter had by then returned so the harbourmaster boarded and requested the pilot to conduct a sweep downriver to search for the missing passenger. While the harbourmaster was in the helicopter, he arranged for the use of the only heavy-lift helicopter in the area to assist in retrieving the upturned boat.
- 1.1.30 At about 1540, the heavy-lift helicopter arrived at the confluence and was readied for lifting the upturned boat. At about 1600, the divers arrived at the confluence and were transported out to the upturned boat. The divers decided that it was too dangerous to go under the boat without it being lifted because of the strong current, so they attached the lifting strops from the helicopter. At about 1620, the heavy-lift helicopter made the lift and shortly after the divers located the missing passenger under the boat and transported her by boat to the forward base. The paramedics were unable to resuscitate the passenger and she was declared dead there.

1.2 *K-Jet 6* information

- 1.2.1 *K-Jet 6* was purpose built in Bluff by Mackraft for use in the tourist industry as a commercial passenger-carrying jet boat. The boat was of aluminium construction and was 7.3 m overall in length and 2.97 m overall in breadth. It was powered by 2 Chevrolet EFI 350 engines each driving a Hamilton 212 jet unit that gave an operational speed of about 90 kph. It was capable of carrying 22 passengers and one driver.



Photograph courtesy of Maritime New Zealand

Figure 4
K-Jet 6

- 1.2.2 The hull was designed with an almost flat bottom aft transforming to a shallow vee forward. This form of hull generates hydrodynamic lift as it is driven through the water, rising up on the plane when sufficient thrust is applied through the jet units. The large flat area towards the stern makes it easier for the boat to remain on the plane at lower speeds, thus maintaining a shallow draught and making it ideal for operating in shallow or braided rivers. The draught at normal operating speed of 90 kph was about 100 millimetres (mm).
- 1.2.3 The shallow operating draught when on the plane allowed the driver to follow or access shallow sections of the river, choosing deeper sections or “holes” in which to stop and restart when required.
- 1.2.4 Steering a jet boat is achieved by altering the angle of the jet nozzle through a wire and pulley arrangement between the steering wheel at the front and the jet nozzles at the back. In a twin jet installation, the nozzles are rigidly connected so that they turn together. Moving the jet nozzles to either side alters the direction of thrust to the fore-and-aft line of the boat, pushing the stern across and changing the direction in which the boat is pointing. Depending on how tight a turn is, the direction in which the boat is pointing will differ from the actual direction of travel owing to the boat side-slipping in the turn. The amount of side-slip will depend on the profile of the underwater section of the hull. Planing strakes are often fitted to cause the hull to “grip” the water better and reduce side-slip. Generally, the more planing strakes fitted, the more directionally stable the boat will be.
- 1.2.5 The flat bottom at the stern of *K-Jet 6* had the effect of allowing the craft to drift sideways when turning, although some planing strakes were fitted to the hull to improve directional stability. This feature also facilitated the driver performing spins, or what has been traditionally called “Hamilton turns”, performed to enhance the excitement of the trip for the passengers.
- 1.2.6 Following the accident *K-Jet 6* was taken to a secure facility and underwent a thorough examination by Maritime New Zealand’s Adventure Jet Boating Safety Auditor under the direction of the Transport Accident Investigation Commission (the Commission).

- 1.2.7 Apart from superficial damage to the hull and roll structure, the boat was intact. All of the control cables and linkages to the jet unit steering nozzles and reverse buckets were intact and the full range of movement was possible for all components. Both engines operated faultlessly. These findings were consistent with the driver's statement that he had not noticed any mechanical malfunction with the boat leading up to and at the time of the accident.

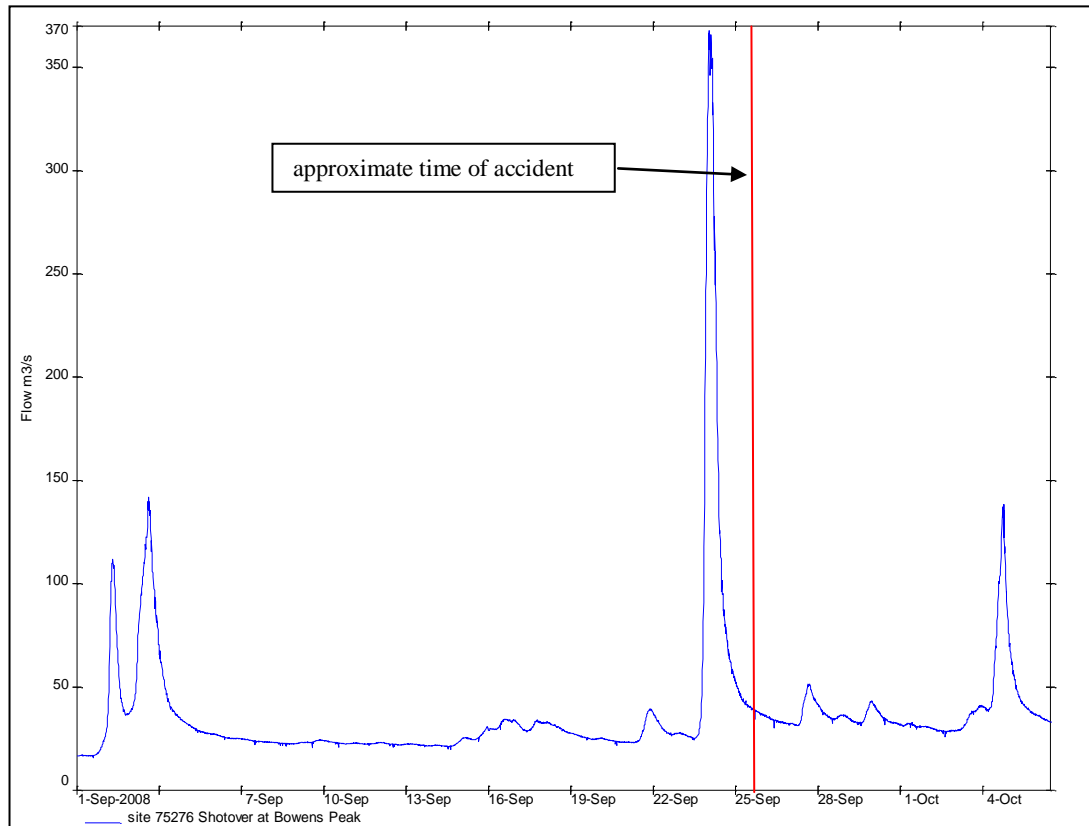
1.3 Personnel information

- 1.3.1 The driver of *K-Jet 6* was a 36-year-old male who started jet boat driving in 2000 and in that same year qualified as a commercial jet boat driver as required by Maritime Rules Part 80 Marine Craft Used for Adventure Tourism(New Zealand Government, 1998). He had been driving jet boats for 6 or 7 years, completing about 5500 individual trips. All his experience of driving jet boats had been on the Shotover and Kawarau Rivers. He had been employed for about 3 or 4 years with Kawarau Jet and had been trained by it in accordance with the company's operational training manual. The driver had undergone peer review at 6 monthly intervals. The driver was one of the most experienced drivers employed by Kawarau Jet at the time and regularly acted as driver training instructor, peer reviewer and mentor for the less experienced drivers. He had had no accidents or incidents recorded against him during his time with Kawarau Jet.

1.4 Weather and river conditions

- 1.4.1 The weather was described as cloudy and clear with near calm conditions, and an air temperature of about 7 degrees Celsius. The weather during the preceding few days had been exceptionally bad, which had caused the closure of the Milford road.
- 1.4.2 The Kawarau River drains Lake Wakatipu and as such the rise and fall in the amount of water flowing down the Kawarau River vary more slowly than those of the glacial mountain rivers that join it. Although Lake Wakatipu had a seiche of 26.7 minutes with a magnitude of about 200 mm, this did not noticeably affect the river current.
- 1.4.3 The Shotover River is fed by melt water from glaciers and also water run-off from the steep mountain slopes through which the river flows. The amount of water flowing down the river is influenced by the amount of precipitation that has fallen in the headwaters and the amount of sunshine and ambient temperature to which the surrounding snow and ice fields are subjected.
- 1.4.4 The gradient of the Lower Shotover River is less than that of the Upper Shotover River which causes the river to slow, widen and, depending on the river level, branch out into several tributaries within its banks, commonly referred to as a braided river.
- 1.4.5 As the water slows, much of the gravel and silt it carries in suspension is deposited in the river bed forming new banks and changing the nature of the river. The main channel of flow can change dramatically in a short space of time. Drivers of jet boats operating on braided rivers such as the Lower Shotover need constantly to "read" the water ahead to judge the best tributary to follow. Consequently, the route a driver takes may vary from trip to trip, especially in the period immediately after periods of high river flow.
- 1.4.6 Figure 5 shows the flow out of the Shotover River as recorded by the National Institute of Water and Atmospheric Research(NIWA, 2008) for the month during which the accident happened. The chart shows the large variations that can occur in river flows, particularly in the period immediately preceding the accident. At the time of the accident the river flow was between 52.5 cubic metres per second (cumecs) and 34.4 cumecs, which was considerably lower than the day before when the flow has been between 368 cumecs and 52.5 cumecs. This high flow the previous day had picked up considerable amounts of schist in the water that was still present making the water "milky" in colour and according to experienced jet boat drivers, difficult to "read".

- 1.4.7 At the confluence where the Shotover River runs into the Kawarau River, silt and debris carried down the Shotover River are deposited at the mouth in the form of a bar. This bar is always present but is prone to change in size and shape. When the river level is high enough, there can be sufficient water over the bar for jet boats to navigate across it. At other times of low river level, areas of the bar can become exposed, requiring the jet boats to follow the main channel out into the Kawarau River before turning upstream.



Unannotated chart courtesy of National Institute of Water and Atmospheric Research (NIWA)

Figure 5
Shotover River flow in cumecs

1.5 Damage and injuries

1.5.1 *K-Jet 6* sustained only superficial damage to the hull and roll bar.

1.5.2 Several passengers sustained injuries and one passenger died at the scene

- One passenger died from immersion in very cold water, leading to drowning
- Several of the passengers were treated for hypothermia at Queenstown hospital
- Several of the passengers were treated for minor injuries at the site and at Queenstown hospital, one passenger was treated for a dislocated shoulder
- One passenger was transferred to Dunedin hospital with chest injuries.

1.6 Organisational and management information

1.6.1 *K-Jet 6* was owned by Kawarau Jet Services Limited, which traded as Kawarau Jet.

1.6.2 Kawarau Jet had operated jet boats on the Kawarau and Shotover Rivers since 1960 when the company was bought from Lakeland Christian Camp, the originators of commercial jet boat rides on the Kawarau and Shotover Rivers. Kawarau Jet at the time of the accident operated 8 boats with 6 drivers and was one of the 2 largest jet boat operators in Queenstown. Kawarau Jet operated about 5000 departures during a year and in 2007 carried about 68 000 passengers (

Kawarau Jet Services Holdings Limited, 2009). This accident was the second accident that Kawarau Jet suffered that had been investigated by the Commission; the previous accident occurred in 1997.

- 1.6.3 Kawarau Jet held a certificate of compliance for commercial jet boats operating on rivers issued on 13 June 2008, by Maritime New Zealand and valid until 11 June 2009. A condition of this certificate was that the boats named on the certificate, including *K-Jet 6*, had to have been inspected and the owner's Safe Operational Plan (Kawarau Jet Service Holdings Limited, 2008) approved by Maritime New Zealand. The jet boat operation had been audited by a Maritime New Zealand authorised person on 10 June 2008 and found to be in accordance with the Code of Practice for the Safety of Jet Boats Operating on Rivers.
- 1.6.4 On 11 February 1999, Maritime Rules Part 80 Marine Craft used for Adventure Tourism (ibid), came into force. Appendix 1 of Maritime Rules Part 80 contained the Code of Practice for the Safety of Jet Boats Operating on Rivers. Kawarau Jet had developed its Safe Operational Plan (ibid) based on the requirements of the Rules.
- 1.6.5 Kawarau Jet's Safe Operational Plan (ibid) had been updated in August 2008 following a report commissioned by its directors to advise on the state of compliance with regards to Maritime Rules Part 80, and to advise on changes to the systems in place to enhance the safety and efficiency of the business.
- 1.6.6 Kawarau Jet's Safe Operational Plan (ibid) contained advice on all aspects of the operation, relevant parts of which are noted below:

Passenger Management

The safety of all passengers while travelling with Kawarau Jet is of the utmost importance to all staff members. Passenger numbers are logged at the Main Town Pier as well as recorded in the driver's log book.

It is important to check the welfare of all passengers during various stages of the trip. Additional attention must be paid to infants, children, the elderly, disabled passengers and pregnant women. At all times the driver must use their discretion whilst allowing passengers to travel with Kawarau Jet.

Number of passengers carried

Any trip from the marina where the passengers disembark before paying, the driver is to call the Operations base on departure so the passenger numbers can be recorded.

Non English speaking passengers

Safety cards in Korean, Chinese, Indian, Taiwanese and Thai are located in the life jacket shed. These must be shown prior to every trip if relevant. In the event of a passenger not speaking one of the above languages, the tour guide will be used as an interpreter for the safety briefing.

Trip safety briefing

All crew and passengers are to wear a lifejacket at all times when on board a vessel. Lifejackets are to be the correct size and properly fitted

A verbal pre-trip safety briefing is to be given on every trip.

The briefing must include the following information.

Display the safety-briefing card

Advise passengers to remain seated at all times

Advise passengers to keep body inside the boat at all times

Advise passengers to place feet on footrests

Advise passengers to hold on to handrails

Demonstrate jet boat spin signal, and advise passengers to hold on tightly

N.B. If carrying children pay special attention that both the children and his or her caregiver are aware of the importance of holding on tightly during a spin.

Trip Hazards

Trip Hazards are identified during the daily morning drivers' meeting. All trip hazards are to be discussed during this meeting including any river changes.

Also refer to Hazards Board in workshop, the daily diary, and Location Photograph in the smoko room.

Base Hazards List

Refer to Base Hazards List in the smoko room. This list identifies permanent hazards and ongoing hazards and is updated as required.

- 1.6.7 Part of the Safe Operational Plan (ibid) was the drivers' training manual. This laid out the basis of the training system, which included the minimum 50 hours training specified in Maritime Rules Part 80 (ibid) and the additional company-required training modules that increased the minimum training to about 100 hours including allied safety and operational training.
- 1.6.8 The driver's training manual (Kawarau Jet Services Holdings Limited, 2008) laid out instructions for the use of the radio communications equipment carried on board by the drivers, including protocols, call-in points and procedures. The drivers' training manual (ibid) also contained details of emergency procedures to be followed and the designated emergency codes 1, 2 and 3. Emergency code 1 meant an accident with serious injury, passengers unaccounted for or a fatality. Urgent assistance needed.

2 Analysis

The accident

- 2.1 There was nothing unusual about the trip made on the day. The weather conditions were reasonable, and although the river level had been high on the previous day, it had dropped again to an acceptable level for commercial jet boating. The river water was still clouded with schist from the recent rain, and although discoloured water can make "reading" the water ahead of the boat more challenging, drivers are aware of this and trained to take more care.
- 2.2 There were no reported problems with the performance of *K-Jet 6* on the day, and nothing obvious was revealed in the post-accident inspection of the boat that could have affected its performance.
- 2.3 The sand bar at the mouth of the river was a known feature to all the Kawarau Jet drivers. It did not appear on the trip hazard records maintained by Kawarau Jet because it did not change significantly from day to day, other than the amount of water available over it. Boats often travelled across the bar when enough water was available to do so; the driver of *K-Jet 6* had done so on 2 trips earlier the same day, and this was taught during the training through which the drivers were put.
- 2.4 What had not been considered in the company hazard identification was the effect of another boat's passage on the depth of water in shallows. *K-Jet 7* crossed ahead of *K-Jet 6* while travelling up stream parallel and close to the sand bar at the confluence. It is highly likely that the interaction between hull and river bank with the passage of *K-Jet 7* caused the water over the sand bar to recede into the main channel. Some drivers spoken to were aware of this phenomenon, and it was replicated during a post-accident re-enactment using a similar boat to *K-Jet 6*. The effect on the sand bar directly in front of *K-Jet 6* would have depended on the timing of the passage of *K-Jet 7*, its distance from the bar as it crossed ahead of *K-Jet 6* and the speed of both boats. The driver's description of the bank "appearing" in front of his boat is consistent with this theory.

- 2.5 It is a phenomenon well known to mariners and owners of property that border on narrow waterways that when a vessel travels along a narrow waterway, it pushes a wave ahead of it and leaves a “hole” in the water behind it. Water flows past the vessel at an accelerated rate as nature tries to restore the balance in water level and in doing so draws water away from the shallows at the edge of the channel. The severity of the effect is dependent on how large the underwater volume of the transiting vessel is in relation to the volume of water in the channel. The speed of the transiting vessel and how close it is to the bank are also factors.
- 2.6 Had *K-Jet 6* been travelling in a straight line with no helm applied, the boat would likely have simply grounded on the bank, or possibly glanced and ridden over the top into deeper water. With the boat in a right turn however the boat would have had a left-hand sideways component to its direction of travel relative to the boat’s heading. When the fore or mid part of the hull struck the sand bar, it is likely that the planning strakes caught or dug into the sand, and with the jet nozzles still thrusting the stern forward and to port, a high-speed capsizing couple would have resulted, causing the boat to roll-over.
- 2.7 With the boat decelerating on contact with the sand bar and rolling-over to port, there was a tendency for the passengers seated on the right side of the boat to be thrown clear, with those on the ports side remaining and being trapped under the boat. Fortunately the roll device across the stern allowed sufficient occupiable space under the boat for people to escape, some unaided and others with the assistance of those who had been thrown clear.
- 2.8 Why the passenger who died did not escape could not be determined. She was sitting on the port side behind the driver where occupiable space would have been smaller. She could have been caught on the surrounding structure of the boat, or become disoriented or involuntarily inhaled water owing to the gasping reflex on being instantly and unexpectedly submersed in cold water.
- 2.9 There were a number of factors that coincided to create the opportunity for *K-Jet 6* to flip:
- The river level was high enough for the boat to cross the sand bar, but only just
 - The driver decided to not go down river and perform a spin because his passengers were not enthusiastic about the manoeuvre, so he turned right as he had twice before that day
 - The 2 jet boats were close enough so that interaction caused water to draw off the sand bar just as *K-Jet 6* was traversing over it
 - *K-Jet 6* was in a right hand turn when it touched the sand bar.
- 2.10 The driver of *K-Jet 6* was an experienced driver who had a good driving record and was considered by his employers to be risk averse. He was not suffering from illness or fatigue. What this accident demonstrates are the inherent risks associated with high-speed jet boat operations on braided rivers.
- 2.11 Since 1995, the Commission has investigated 19 occurrences and published 16 reports involving commercial jet boats, the most recent being in 2004. Of these 19 occurrences, 2 involved high speed roll-overs, one in 1997 (Marine Occurrence 97-211, Jet boat *K-Jet 3*, rolled on a shingle bar, Lower Shotover River Queenstown, 26 December 1997), the other in 1998 (Marine Occurrence 98-213 Jet boat *Terminator*, roll-over on to shingle bar, Dart River, Glenorchy, 2 October 1998). After these occurrences the Commission made safety recommendations covering the fitment of roll bars on jet boats operating on braided river systems and the need for accurate recording of passenger numbers on boats to assist emergency services (Transport Accident Investigation Commission, 1998).
- 2.12 These 2 roll-over accidents resulted in 4 serious injuries and 3 minor injuries. Another roll-over accident occurred on 25 February 2009, which is currently under investigation (Investigation 09-203, *DRJS 11*, grounding and subsequent roll-over, Dart River, near Glenorchy, 20 February 2009, in which 2 passengers received minor injuries). Together with this accident, that makes one fatality and 5 serious and 5 minor injuries in a period of just over 11 years.

- 2.13 All 4 roll-over events were primarily caused by human factors rather than by design or maintenance issues. What this demonstrates is that no matter how reliable the jet boats are mechanically, there will always be an inherent risk of an accident of this type occurring when jet boats travel at high speed, down braided rivers, where the correct path to follow along an ever-changing river is reliant on the skill and judgement of the driver. The speed in relation to the river bed will be a factor. Travelling up river should allow more reaction time on the part of the driver because the boat is travelling against the river flow at a lower speed across the ground. Travelling down river, however, requires a faster reaction time on the part of the driver because the boat is travelling with the river flow with a higher ground speed. All 4 of the rollover events described above occurred when travelling downstream.
- 2.14 Earlier recommendations around the fitting of roll bars to commercial jet boats operating on braided rivers were made in acknowledgement that the risk of roll-over will always be present and that both the likelihood and the consequences could be high, as has been proven in this case. The dilemma the industry faces is what else can be done to mitigate the risks and how much the travelling public should be told of those risks before deciding to undertake the activity. Some guidance will be required from the regulator on that issue, because there will be a competing interest in how much to tell prospective customers at the risk of losing that patronage in what has become a multi-million-dollar tourist activity.
- 2.15 The New Zealand Government has recently launched a major review of adventure tourism in New Zealand. Maritime New Zealand is participating in that review, so a recommendation has been made to the Director to have this safety issue addressed.

Safety briefing

- 2.16 Giving a safety briefing to non-English-speaking passengers poses some challenges to the operator, particularly if there are several different languages spoken on board. There was some feedback from passengers that they had not understood the safety briefing and that they were not assisted that well in how to fit their lifejackets.
- 2.17 Whether the passengers understood the safety briefing or not did not contribute to or directly affect the outcome of this accident; nevertheless, the fact that giving a meaningful safety briefing is still posing a challenge to operators is a concern. Ensuring every passenger's lifejacket is the correct size and properly fitted should not be an insurmountable challenge; neither should making passengers understand the safety briefing card. An effective safety briefing should be achievable if all passengers are provided with a briefing card and the driver takes the time to engage with the passengers meaningfully, rather than performing the briefing in a robotic fashion without taking time to gauge their comprehension.

Rescue and survivability

- 2.18 The driver and other passengers did what they could to assist those trapped under the boat. The boat was large and its position made it difficult to dislodge or roll over. The current flowing past the boat would have made it perilous to attempt to dive under the boat and search for others. Those who had been thrown clear were floating down river, made it to other sand bars, or climbed on top of the upturned hull. The driver had no way of knowing if anyone was still trapped under the hull. By the time help arrived and with it the first opportunity to make a headcount, it is highly likely the deceased had already succumbed. This is supported by the pathologist's report in which the cause of death was put down to drowning by immersion in cold water.
- 2.19 Notwithstanding the cause of death, it is useful to review the search and rescue aspects for future lessons that might help save others under different circumstances in future.
- 2.20 The driver of *K-Jet 6* used his hand-held VHF transceiver to broadcast a message as soon as he was able after swimming from underneath the boat. He used this radio because the boat's main radio was inaccessible in the upturned boat. This message was heard only by the driver of *K-Jet*

7 a short distance away. Had *K-Jet 6* been the only boat on the river, or had the driver of *K-Jet 7* not heard the call from *K-Jet 6*, it would possibly have taken considerably longer for the alarm to be raised.

- 2.21 The inbuilt VHF radio transceiver equipped with its own aerial has a greater range than a hand-held radio owing to power considerations and aerial siting. Maritime Rules Part 80 states that “the driver of a jet boat must maintain radio contact with a shore base and with drivers of other jet boats to which Section 1 of Part 80 applies, which are operating on the same stretch of river”.
- 2.22 While the fixed radio installations on board comply with the Rules, it would be beneficial for operators to test the use of the smaller, less powerful radios along the entire route so that at least drivers’ will be aware of any areas of reduced radio reception between boat and base. A safety recommendation has been made to the Director of Maritime New Zealand to address this issue.
- 2.23 The driver of *K-Jet 7*’s dropping the majority of his passengers off on the sandbank was successful because it allowed him to rescue a number of the passengers in the water in his first sweep with the boat downriver. However, once the passengers from *K-Jet 7* were on the sandbank it was natural for them to mingle with the rescued passengers, providing comfort and support. This mingling made it harder for the driver’s, who were trying to do a passenger head count. The drivers could have simply taken a total head count, knowing the total number on each boat, and that might have identified that someone was missing earlier. If it was essential for them to know who was from which boat, some system of a distinguishing mark to associate each passenger with a particular boat, such as a coloured wristband for example, might have proved useful.
- 2.24 Once the relayed radio call was received by Kawarau Jet base the rescue services were alerted and Kawarau Jet implemented its own emergency response. Rescue services arrived at the scene in good time, but were hampered by being on the western bank of the Shotover River with the deepest river channel between them and the scene. Communications were established shortly afterwards between the rescue services and the Kawarau Jet employees at the scene and the Police took over the co-ordination of the rescue at that point.
- 2.25 The rescue services relied on information from Kawarau Jet staff that all persons had been accounted for, and they started to scale down their operation and move back to the Kawarau base only to have to scale up their operation again once they were informed that one person was missing. This highlights the need for accurate and timely information to be supplied to the rescue services in the event of an emergency.
- 2.26 The Police tried to contact the local Coastguard by telephone instead of by pager but were unable to contact them. However, the Queenstown Coastguard had then only recently been formed and at the time of the accident had not operated on the Kawarau or Shotover Rivers, confining itself to operations on Lake Wakatipu itself. Since this accident the Queenstown Coastguard has trained on the Kawarau River and has been effectively involved in another search and rescue on it.

3 Findings

Findings are listed in order of development, not in order of priority.

- 3.1 While making a high-speed turn, *K-Jet 6* glanced over an exposed shingle bar at the confluence of the Shotover and Kawarau Rivers, causing it to roll-over and come to rest upside down in the water.
- 3.2 The depth of water over the sand bar was marginal for the safe passage of the fully-loaded *K-Jet 6*. The effects of interaction between the shingle bar and another fully-loaded jet boat nearby caused water to be drawn from the shingle bar, exposing it in front of the turning *K-Jet 6*.
- 3.3 The passenger who remained trapped and undetected under the upturned hull of *K-Jet 6* highly likely drowned before rescuers could reasonably determine that she was missing.
- 3.4 There was sufficient occupiable space beneath the upturned boat created by the roll bar for the driver and passengers to escape. Reasons for the deceased not escaping could have been entrapment, disorientation, inhalation of water owing to gasping reflex, flotation from lifejacket forcing her up under the hull, or a combination thereof.
- 3.5 Although in this case the delivery of the pre-trip safety briefing did not affect the outcome of the accident, enhancements in the way safety briefings are conducted by the operator are needed if passengers are going to be fully briefed in future.
- 3.6 There were unnecessary delays in accounting for all of the passengers, and although that did not affect the outcome of this accident, enhancements in the way passengers are accounted for will be needed if emergency responses are going to be effective in future.

4 Safety Actions

4.1 After the accident Kawarau Jet:

- amended its training manual to:
 - include in the Kawarau Jet Driver Rules of Compliance the Queenstown Lakes District Council's requirement for boats on the Kawarau River are to give way to boats entering or exiting the Shotover River
 - include in the intermediate training section 3.0.03 that:
 - if the driver finds themselves in a position where a "touch" or grounding is imminent, the vessel must be kept travelling on a straight line. Do not attempt to turn the vessel around in shallow & narrow water. The issue of having a boat run aground is far less than the potential of what can happen (rollover's, etc) if the vessel was the hit a sand bar & run aground while travelling in a sideways (turning) direction
 - include section 3.0.03 about entering and exiting the Shotover River that states:
 - All Kawarau Jet commercial boats are to enter the Shotover River from downstream on the Kawarau River, avoiding the risk of crossing the naturally occurring sandbar on the upstream side of the confluence. When exiting the Shotover River follow the naturally occurring main flow (wave train). During periods of high water where the exit appears flat and no wave train is obvious exit in a straight line and reduce speed.
 - All Kawarau Jet commercial boats are to exit the Shotover River heading downstream into the Kawarau River; again, avoiding the risk of crossing the naturally occurring sandbar on the upstream side of the confluence. This is to be performed in conjunction with the Shotover river exiting procedure, Which involves the exiting boat making a radio call & other K-jet vessels travelling on the Kawarau River in the vicinity of the confluence

responding to this call & stopping & giving way to the exiting boat.
This is to avoid any wash / wake from the passing vessel affecting the shallow water that the exiting vessel passes over as it exits the Shotover into the Kawarau river

- amended its operational policies to ensure that the safety briefing is given once the passengers have boarded the boat and before the boat is cast off to ensure everyone's attention. The briefing is given with the aid of the safety cards in the appropriate language and in the case of large tour groups, with the assistance of the tour leader or guide translating
- has been scoping the functionality of a new radio system and repeater location to give more effective coverage and to integrate global positioning system (GPS) technology. The repeater site was expected to be established early in 2010, and the GPS transponders phased in on each boat in the fleet afterwards
- has initiated meetings with the emergency services and other commercial jet boat operators which have resulted in:
 - standardisation of the emergency log reports
 - recording of passengers post event
 - familiarisation of the emergency services with the operations of local jet boat operators, with help in understanding terrain, access points and details of specific locations.

5 Safety Recommendations

Safety recommendations are listed in order of development, not in order of priority.

5.1 On 25 February 2010 it was recommended to the Director of Maritime New Zealand that she:

5.1.1 Address the safety issue whereby in the event of an accident or incident, the emergency back-up radios are not capable of being used for communicating with either the rescue authorities or the boat's home base. (001/10)

5.1.2 Bring this report to the attention of the reviewers of adventure tourism in New Zealand, and ask them to consider how to deal with informing potential commercial jet boat passengers of the risks inherent with the activity. (002/10)

5.1.3 Address with the commercial jet boat industry that in spite of the requirements under Maritime Rules Part 80 and other safety initiatives taken by Maritime New Zealand:

- the issue of delivering meaningful pre-trip safety briefings to passengers, particularly where understanding of the English language is an issue, still remains. (003/10)
- the issue of accounting for passengers when multiple boats are involved during emergency response still remains. (004/10)

5.2 On 15 March 2010 the Director of Maritime New Zealand replied to the safety recommendations:

001/10 Draft rule 'Part 82 — Commercial Jet Boat Operations' introduces a requirement whereby back up arrangements must be in place in case the primary means of communication fails. We consider the proposed rule change will address the intent of the recommendation.

- 002/10** Draft rule 'Part 82— Commercial Jet Boat Operations' introduces a requirement that passengers be advised, before departing on any trip, of the specific risks they may experience during the trip. MNZ has also recommended to the 'Review of Risk Management and Safety in the Adventure and Outdoor Commercial Sectors in New Zealand' that a pre trip risk warning is adopted as a general safety management principle across the adventure sector. We consider these two proposals will address the intent of the recommendation.
- 003/10** The issue of delivering effective pre-trip safety briefings is the subject of a focused audit campaign. MNZ has also issued Safety Bulletin 18 to the sector reminding operators of their obligations in this area. The most recent jet boating newsletter also dealt with the issue. We consider this to address the intent of the recommendation.
- 004/10** The issue of accounting for passengers when multiple boats are involved during emergency response is also the subject of a focused audit campaign. We consider this measure will address the intent of the recommendation.

Appendix 1

Kawarau Jet safety card in English



Kawarau Jet safety card in Mandarin (Chinese)



Kawarau safety card - Pictorial



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