Report 98-213

jet boat *Terminator*

rollover on to shingle bar

Dart River, Glenorchy

2 October 1998

and

Report 98-215

jet boat *Helijet 7*

collision with rock face

Kawarau River, Queenstown

12 November 1998

Abstract

At about 1610 on Friday, 2 October 1998, the jet boat *Terminator* was proceeding at a speed of about 65 km/h down one of many secondary channels on a braided section of the Dart River, when the driver was confronted with an obstacle partially blocking a left hand turn in the channel. As the driver attempted to make the turn around the obstruction, his boat struck it, the driver lost control and the boat skidded sideways into a shingle bank and flipped, trapping some of the passengers beneath the boat. The 11 passengers plus the driver suffered minor to serious injuries.

At about 0945 hours on Thursday, 12 November 1998, the jet boat *Helijet 7* was travelling down the main channel of the Kawarau River at a speed of about 65 km/h when the driver lost control of his boat in a back eddy near the true river left bank. The boat veered left and struck a rock face. The 5 passengers and driver suffered minor to serious injuries.

Safety issues identified were the adequacy of training for jet boat drivers required under current legislation, and the fitting of a roll bar or similar device to jet boats operating on braided rivers.

Recommendations were made to the director of maritime safety, the chairman of the Commercial Jet Boat Association and the general manager of Shotover Jet Limited to address the safety issues.

Contents

Figures

Glossary of abbrevations

cc	cubic centimetre
cm	centimetre
GRP	glass reinforced plastic
km	kilometre
km/h	kilometres per hour
kW	kilowatt
m	metres
MSA	Maritime Safety Authority
QLDC	Queenstown Lakes and District Council
UTC	universal time (co-ordinated)

Glossary of terms

ballast	weight, usually sea water, put into a ship to improve stability
class	category in classification register
chine	the join between the sides and the bottom of a vessel
gunwale	the upper edge of the side of a vessel
mayday	radiotelephone distress signal requesting immediate assistance
strake	a continuous line of plating or planking extending along a hull from forward to aft

Transport Accident Investigation Commission

Marine Accident Reports 98-213 and 215

	98-213, *Terminator*	98-215, *Helijet 7*
Boat Particulars:		
Type:	Dart Craft commercial jet boat	Dart Craft commercial jet boat
Class:	Passenger (under 6 m)	Passenger (under 6 m)
Limits:	Lake Wakatipu and Dart River	Lake Wakatipu, Shotover, Kawarau and Dart Rivers
Allowable occupants:	13 (including driver)	At driver's discretion (usually 8 including driver)
Length:	5.2 m	5.5 m
Construction:	Aluminium monohull	Aluminium monohull with GRP deck
Propulsion:	One 5735 cc 230 kW Chevrolet petrol engine driving a series 211 2-stage Hamilton jet unit	One 5735 cc 225 kW Chevrolet petrol engine driving a series 770 3-stage Hamilton jet unit
Normal operating speed:	Up to 75 km/h	Up to 70 km/h
Owner:	Shotover Jet Limited	Shotover Jet Limited
Operator:	Dart River Jet Safari Limited	Helijet Limited
Location:	Lower Dart River, near Glenorchy, Queenstown	Kawarau River, Queenstown
Date and time:	Friday, 2 October 1998, at about 1610[1]	Thursday, 12 November 1998, at about 0945
Persons on board:	Crew: 1 Passengers: 11	Crew: 1 Passengers: 5
Injuries:	Crew: 1 (serious) Passengers: 11 (minor to serious)	Crew: 1 (serious) Passengers: 5 (minor to serious)
Nature of damage:	Superficial to hull and topsides	Substantial to hull and topsides
Investigator-in-Charge:	Captain Tim Burfoot	Captain Tim Burfoot

[1] All times in this report are New Zealand local time (UTC + 12 or 13 hours depending on daylight saving, which started on 3 October) and are expressed in the 24-hour mode

Figure 1
***Terminator*, shortly after the accident**

1. Factual Information (98-213, *Terminator*, on the Dart River)

1.1 History of the trip

1.1.1 Shortly before 1300 on Friday, 2 October 1998, a group of passengers gathered at the Glenorchy base of Dart River Jet Safaris Limited, some having travelled from Queenstown by company bus, others by private vehicles. They were about to embark on a 2½-hour jet boat safari up the Dart River.

1.1.2 Each passenger was provided with additional warm clothing, waterproof jackets and gloves as required, and a lifejacket.

1.1.3 The passengers were divided into 3 groups and assigned to one of 3 boats that were to make the trip in convoy. The group assigned to *Terminator* comprised 6 adults and 5 children, making a total of 12 including the driver.

1.1.4 The driver of *Terminator* briefed the passengers on the nature of the trip, the details of the boat, its safety equipment, and the signals he would use to warn them when he was about to perform certain manoeuvres. The driver told the passengers to:

- remain seated at all times,
- keep wholly inside the boat,
- steady themselves by holding on to the rails,
- brace themselves with their feet,
- ensure clothing and lifejackets were properly secured, and
- tell him if anyone was having difficulties.

1.1.5 The convoy of 3 boats left Glenorchy shortly after 1300, crossed the northern part of Lake Wakatipu and entered the mouth of the Dart River. The drivers were in radio contact with each other and the base. They had each reported to the base their departure time and number of passengers on board.

1.1.6 The safari consisted of a return trip to Sandy Bluff (see figure 2), a total of about 76 km. The upriver ride was made at slower speed, typically about 40 km/h, partly because of the opposing river flow and partly because of the 150 m climb from the lake to Sandy Bluff. The upriver ride was considered to be the scenic part of the trip and included several stopping points where the driver made commentaries on the scenery and history of the area.

1.1.7 The downriver ride was made at higher speeds, typically 65 km/h. As well as the river flow and down gradient contributing to the higher speed, this part of the trip was considered to be that on which drivers demonstrated the capabilities of the jet boat; its high speed in shallow water and high manoeuvrability.

1.1.8 The 3 boats kept in loose formation on the ride upriver, keeping far enough apart so as to not interfere with each other, yet close enough to render assistance should it have been required.

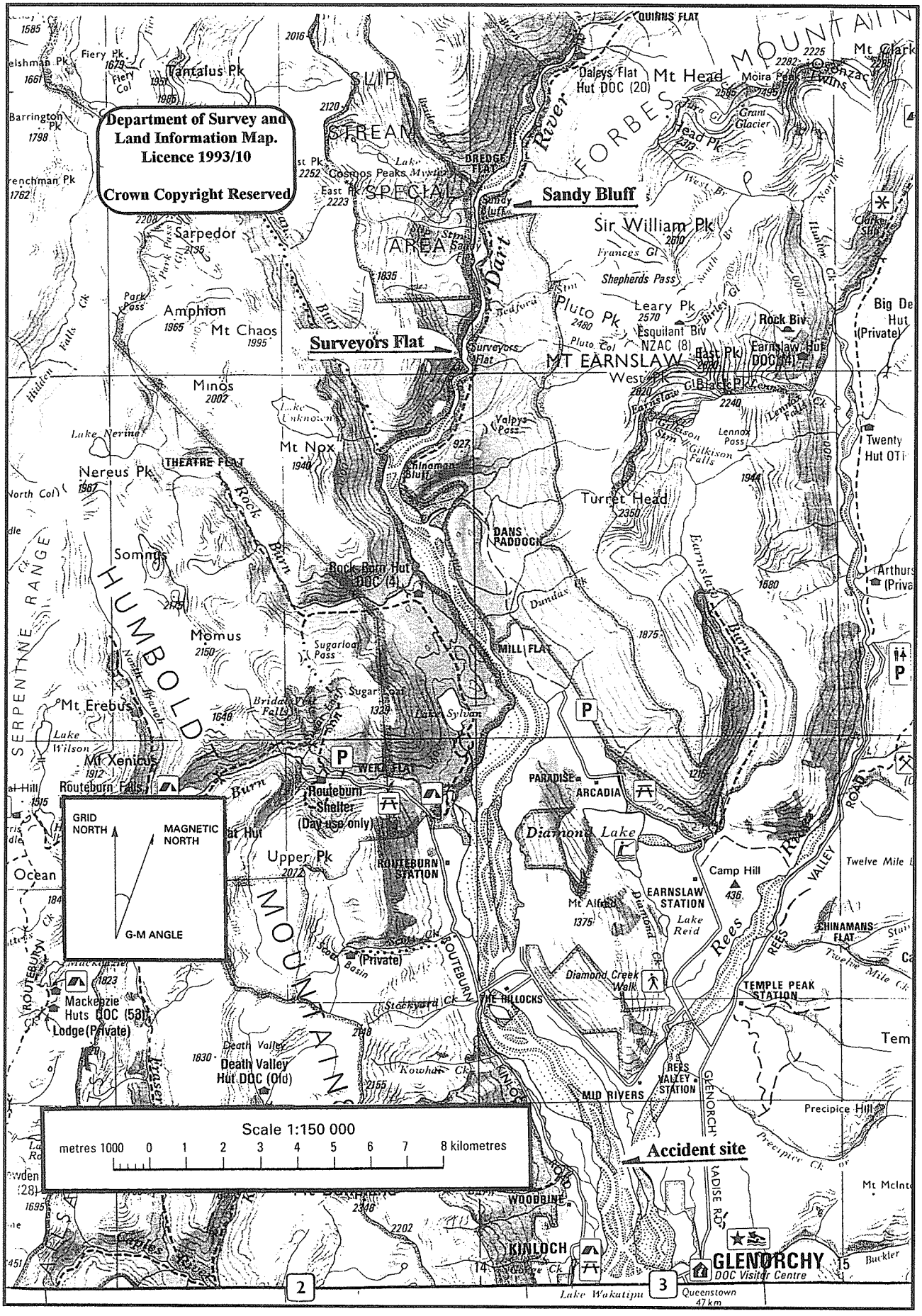

Figure 2
Location map showing key points

1.1.9 During each stop, the driver assessed the passengers' reaction to the ride, paying particular attention to the children. He also asked the passengers if they were comfortable with the trip; all said that they were. The ride upriver went without incident.

1.1.10 On the slower upriver part of the trip, the driver of *Terminator* was continually making an assessment of the river. In its lower reaches the river was braided, with the main flow often branching into several tributaries. The form of the river could change in a short time, especially when the river level was rising or falling. The driver's assessment of the river on the slower upriver journey allowed him to broadly pre-plan his downriver route.

1.1.11 At Sandy Bluff, the boats turned around and started back down the river, again keeping a safe distance apart. The drivers performed several spins[2] on the way. The driver of *Terminator* made several stops to check the passengers' reaction to the faster speed and manoeuvres. None of the passengers said to the driver that they felt uncomfortable. Further downriver the *Terminator* stopped at The Beans Burn, where the passengers disembarked and went for a short forest walk. The driver used this opportunity to talk to the passengers and gauge their response to the nature of the ride, in particular the spins. All of them except one of the children were happy, but after the child was reassured by his parents, all agreed to continue the trip downriver in a similar fashion[3].

1.1.12 After the forest walk, the passengers re-embarked *Terminator* and the driver resumed the trip downriver, which was uneventful as far as the Dart River Bridge. There the driver stopped and offered to contact the base using the radio and relay any orders for hot food, which would be available at the lodge facilities at the end of the trip.

1.1.13 Several passengers placed an order for food and while the driver was relaying the orders to the base, the third boat in the convoy arrived. Few on the third boat wished to order food; consequently both boats departed Dart River Bridge at the same time, *Terminator* taking the true-river-right side and the third boat taking the left side. At that time, the first boat in the convoy was further downriver, almost back at the base.

1.1.14 The drivers of *Terminator* and the third boat weaved their boats down their respective sides of the river until they were adjacent to Midrivers, where the two main channels converged. At that point the driver of the third boat wanted to cross to the right side of the river so that he could enter Woodbine Channel. Seeing that both boats were converging, the driver of the third boat flared[4] his boat to bleed off speed and signalled to the driver of *Terminator* to proceed first.

1.1.15 The third boat fell in about 150 m behind *Terminator*, and followed it for about 200 m before veering right and entering Woodbine Channel. The driver of *Terminator* looked at the entrance to the Woodbine Channel and, noting how little water was running into it, decided to veer left and run with the main flow. Woodbine Channel was considered by drivers to be a little challenging at times. The driver of *Terminator* had been on rostered time off for the previous two days and he felt that he was not current with the conditions in Woodbine Channel.

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[2] A spectacular manoeuvre, unique to jet boats, where the boat is turned at relatively high speed, almost within its own length. The manoeuvre is normally used when a rapid stop or change in direction is required in narrow sections of the river. It is often used by commercial jet boat drivers to enhance the degree of excitement of the trip.

[3] After the accident, some of the passengers stated that they felt the trip through the upper reaches (Cathedral Rocks) was made too fast.

[4] Swing the stern of the boat out, as if to turn, to create drag. Like most water craft, inducing a turn will create drag and result in a loss of speed.

1.1.16 Between Woodbine Channel on the right, and the main river flow on the left was a network of smaller tributaries. The driver of *Terminator* had noted on the way upriver that there appeared to be sufficient water flowing out of the network at the bottom and sufficient water entering it from the top, so he decided to pass through it to provide the passengers with a variety of jet boating and navigation. This section of the river was later reported to have changed considerably over the previous 2 days.

1.1.17 As *Terminator* entered a smaller channel, the driver stood up to raise his height of eye to enable him to better read the water ahead; a common practice among drivers. Confident that the channel ahead was navigable, the driver sat back down and began to pick his way down the channel at close to full speed (about 70 km/h).

1.1.18 The channel that *Terminator* was following veered left as it converged with another channel; however, a clump of earth blocked part of the confluence of the two channels. The driver noted that the main water flow was to the right of the clump, so he began to line the boat up for that point, first flaring the stern of the boat out to the left to reduce boat speed to facilitate the hard left turn that would be required to avoid a shingle bank after passing the clump (see figure 3).

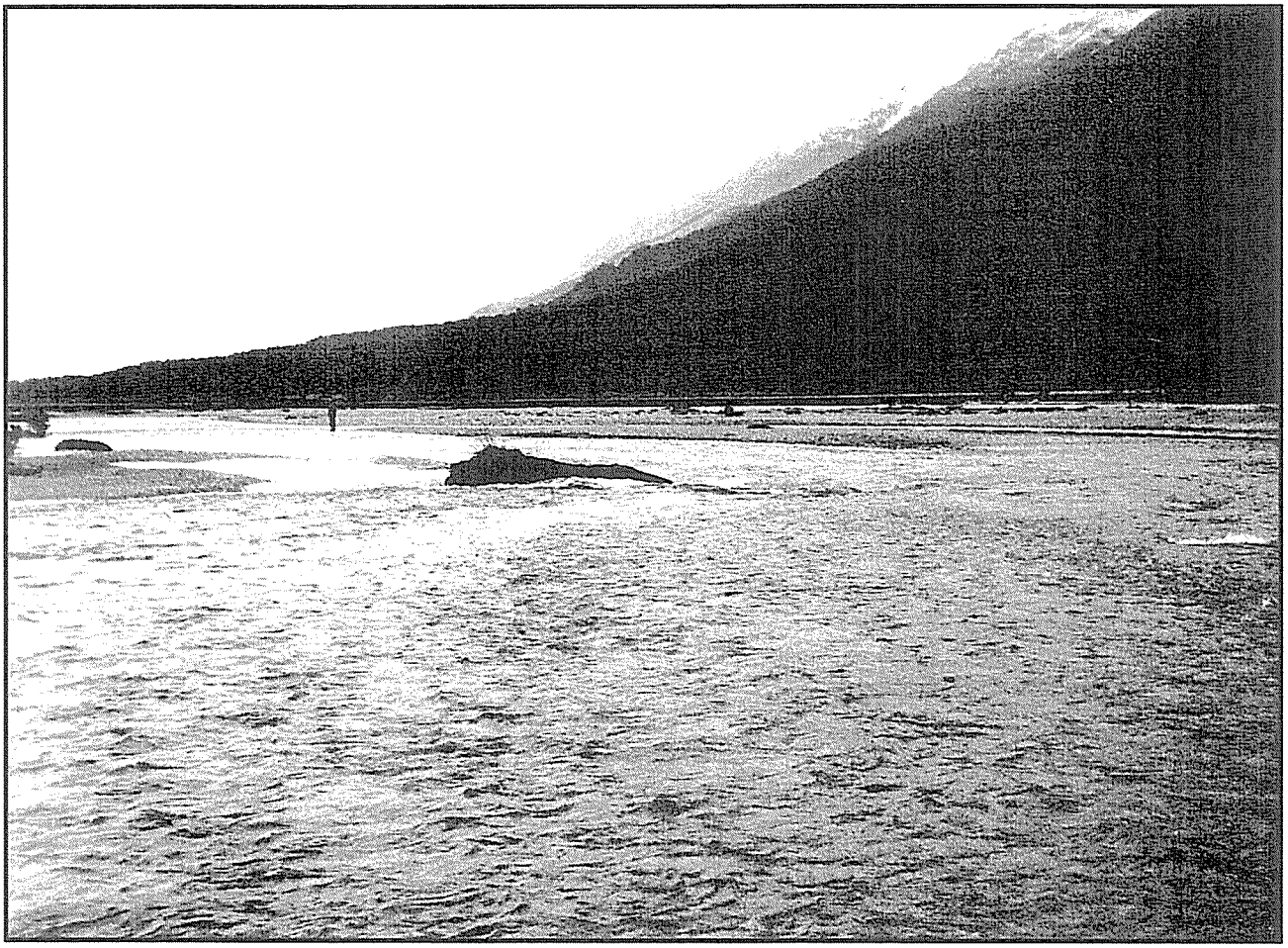

Figure 3
Driver's view of channel; note the clump and the obstruction close right of it, and the shingle bank behind.

1.1.19 As *Terminator* passed the clump, the left rear chine of the boat caught on an object extending out from the clump, just under the water surface, which caused the boat to become partially airborne and nose into the water in an induced slow left turn. The forward right chine then caught in the water and, despite the driver's attempt to keep it straight, the boat broached to the left, skimmed across the water sideways, struck the shingle bank and flipped upside down, coming to rest with its bow in the water.

1.1.20 The driver and the left rear seated passenger were thrown well clear of the boat onto the shingle bank; the centre left seated passenger was thrown just clear, with the boat gunwale landing close to where she lay unconscious for about one minute. The 2 passengers in the front seat next to the driver were able to slither out of a small gap under the gunwale before the boat settled into the soft shingle. The rest of the passengers were trapped beneath the boat.

1.1.21 The driver and 3 of the passengers who were clear of the boat were able to lift one side of the boat up and hold it long enough for the remaining passengers to be pulled clear. The driver, in spite of having a broken arm, checked the injuries of the passengers and tried to reassure them.

1.1.22 Meanwhile, the driver of the third jet boat was looking across at *Terminator* and saw the boat flip. He relayed a Code 1 emergency[5] to the base at about 1608, disembarked his passengers onto the river bank further downriver, and proceeded back upriver to assist. He could not reach the accident site without grounding, so he beached his boat and walked across to the site. He made his own assessment of the injuries to the passengers and driver, and relayed information back to the base.

1.1.23 The safety boat arrived at the scene about 8 minutes later with blankets and first aid equipment. The driver of it could not reach the accident site either. He beached his boat and after first aid had been administered to the injured, they walked across the channel to the rescue boat and were taken back to the Glenorchy. Some were treated further at the Glenorchy Medical Centre and discharged; others were taken by ambulance to Queenstown Hospital.

1.1.24 Thirty minutes had elapsed from the time of the accident to the time the rescue boat reached the base.

1.2 Injuries to occupants and damage to the boat

1.2.1 The only damage to the boat was scratched paint and a fractured hand rail. The engine had stopped when the boat rolled over. It did not show any signs of fuel leakage from being upside down and there was no fire.

1.2.2 The day after the accident, the engine of *Terminator* was tested. After removing crankcase oil from the cylinders and replacing the spark plugs, the motor ran normally. The steering worked normally. There was no evidence of mechanical failure that might have contributed to the accident.

[5] Code 1 emergency refers to that requiring the back-up safety boat and emergency services.

1.2.3 The injuries to the passengers and driver are encapsulated in Figure 4 below:

Bow

	Driver	**Adult**	**Adult**		
	Ejected from boat	Able to escape from under boat	Able to escape from under boat		**Front row**
	Broken arm, lacerations and bruising	Lacerations and bruising	Lacerations and bruising		
Adult	**Child**	**Child**	**Child**	**Adult**	
Ejected from boat	Unable to escape but had sufficient occupiable space	Unable to escape but had sufficient occupiable space	Unable to escape but had sufficient occupiable space	Upper body pinned under seat back	**Middle row**
Unconscious for about one minute, abrasions and bruising	Fractured ankle, abrasions and bruising	Abrasions and bruising	Abrasions and bruising	Fractured cheekbone, lacerations and severe bruising	
Adult	**Child**		**Child**	**Adult**	
Ejected from boat	Legs pinned under seat back		Chest pinned under seat back, difficulty breathing	Unable to escape but had sufficient occupiable space	**Back row**
Minor bruising	Bruising to legs and face		Moderate bruising	Minor bruising	

Figure 4
Diagram correlating seating position with injury

1.3 Driver training

1.3.1 The driver of *Terminator* had spent a number of years involved with recreational boating, followed by a 2-year period in the Royal New Zealand Navy. His first encounter with jet boats came in the summer of 1997 and 1998 when he worked as a beach and radio co-ordinator for Shotover Jet Limited.

1.3.2 At the beginning of the 1998 winter, the driver was hired by Dart River Jet Safaris as a trainee driver and general hand, which included duties as photographer, reservations clerk and workshop hand. The driver commenced his on-water training on 2 August 1998 and accumulated 75 hours without passengers, mostly with either of the 2 senior training drivers, but some time alone practising the skills he had been taught.

1.3.3 On 9 September 1998, having completed 75 hours training, the driver completed a test drive to the satisfaction of the Queenstown Lakes District Council (QLDC) Harbourmaster, after which he was licensed to, and began carrying passengers.

1.3.4 At the time of the accident, the driver had completed some 50 hours driving solo with passengers on board, a total of about 125 hours, including training. He had been rostered off for the 2 days prior to the accident.

1.3.5 The driver was considered by his peers to have been a good student driver with a good manner with the customers, which was confirmed by the passengers after the accident trip.

1.4 River and weather information

1.4.1 The river level was slightly above what the drivers considered normal, and dropping. The water was slightly discoloured.

1.4.2 The weather was overcast with occasional fine breaks; a cool northerly wind with snow showers on the surrounding mountains.

1.5 Company information

1.5.1 Dart River Jet Safari Limited was a wholly owned and operated subsidiary of Shotover Jet Limited (Shotover Jet). Shotover Jet was established in 1970 as one of the first jet boat operators in the Queenstown area. Shotover Jet acquired Dart River Jet as a going concern in August 1996.

1.5.2 Shotover Jet was ISO 9001 accredited. Most of its safety policy and procedures had been progressively introduced to Dart River Jet and, although Dart River Jet was not ISO accredited, its policy and procedures were subject to regular audits by Shotover Jet management.

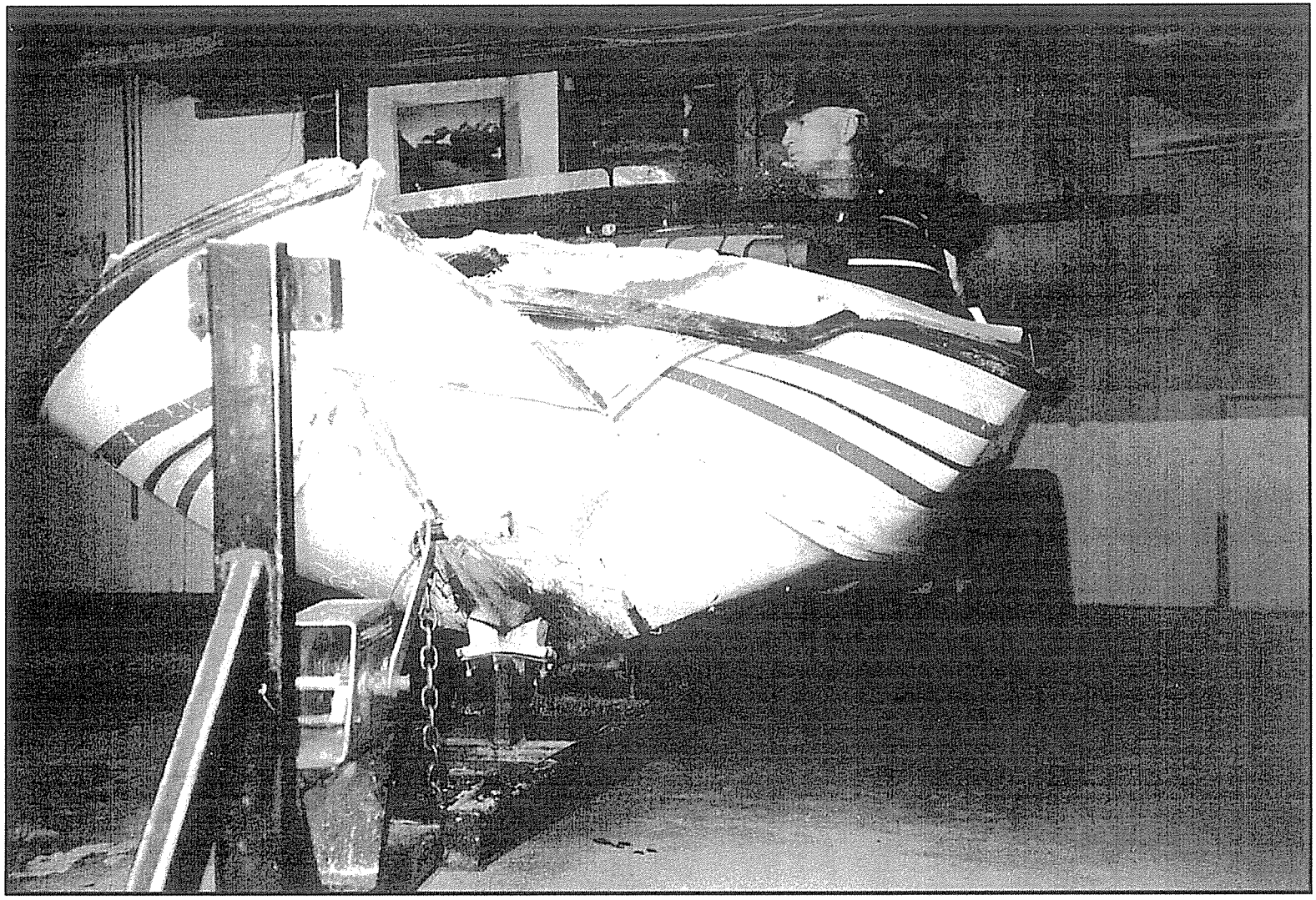

Figure 5
Damage to bow of *Helijet 7*

2. Factual Information (98-215, *Helijet 7*, on the Kawarau River)

2.1 History of the trip

2.1.1 At about 0830 on Thursday, 12 November 1998, a group of 5 adult tourists gathered at a lodge in Queenstown. They were booked on a "triple thriller" package which included a scenic helicopter ride, a jet boat ride on the Kawarau River between the Shotover River confluence and the Arrow River confluence, and a rafting trip on the Kawarau River below the Arrow River confluence.

2.1.2 The group was fitted out with wet suits, spray jackets, lifejackets and helmets before being taken by coach to the Queenstown Airport. They boarded the helicopter at about 0920 and were taken for a 10-minute scenic flight. The group disembarked the helicopter near a jetty on the bank of the Kawarau River, just upriver of the Shotover River confluence.

2.1.3 The driver of *Helijet 7* met the group and guided them to the boat. Before departing the jetty the driver gave the group a safety briefing similar to that given by the driver of *Terminator* on the Dart River Jet safari.

2.1.4 *Helijet 7* departed the jetty at about 0935 and headed down the Kawarau River. The driver performed several spins on passage downriver and was weaving the boat close to objects on the banks of the river to enhance the excitement of the trip for the passengers.

2.1.5 *Helijet 7* passed a series of rock outcrops jutting into the river from the left bank, and into a wide section of the river called Fisherman's Hole. The driver turned *Helijet 7* in Fisherman's Hole, headed back up past the rock outcrops and performed a spin ready to come back down. That section of the river was normally traversed twice as it was considered scenic, and it offered an opportunity to show the passengers the manoeuvring capabilities of jet boats.

2.1.6 The river flow formed an eddy behind the first outcrop, which created an eddy line[6] and up-welling where the eddy re-entered the main flow. The driver steered *Helijet 7* near the first outcrop at a speed of about 70 km/h, passing about 2 metres off it, heading parallel to the river bank (see figure 6).

2.1.7 As the craft crossed the eddy line, the driver applied a small amount of right helm to begin a right turn that was necessary to keep the boat in the main channel. *Helijet 7* did not appear to the driver to respond, so he applied more right helm, still under near full engine power. *Helijet 7* still did not respond. The driver recalled releasing the throttle pedal and moved the helm to hard left and back to hard right lock before applying full throttle again in an attempt to move the boat right. Throughout this sequence the bow of *Helijet 7* veered to the left heading for the third outcrop.

2.1.8 Seeing that his craft was going to collide with the rock face, the driver attempted to pull on full reverse bucket as he applied full throttle (see section 3.1 for description of propulsion system).

2.1.9 *Helijet 7* struck the rock face and came to a rapid stop, with the engine still running. The driver made a quick assessment of his passengers and put out a Mayday call over the radio, which was answered by another boat upriver.

[6] A line of turbulence created by the back flow of an eddy meeting with the main downriver flow.

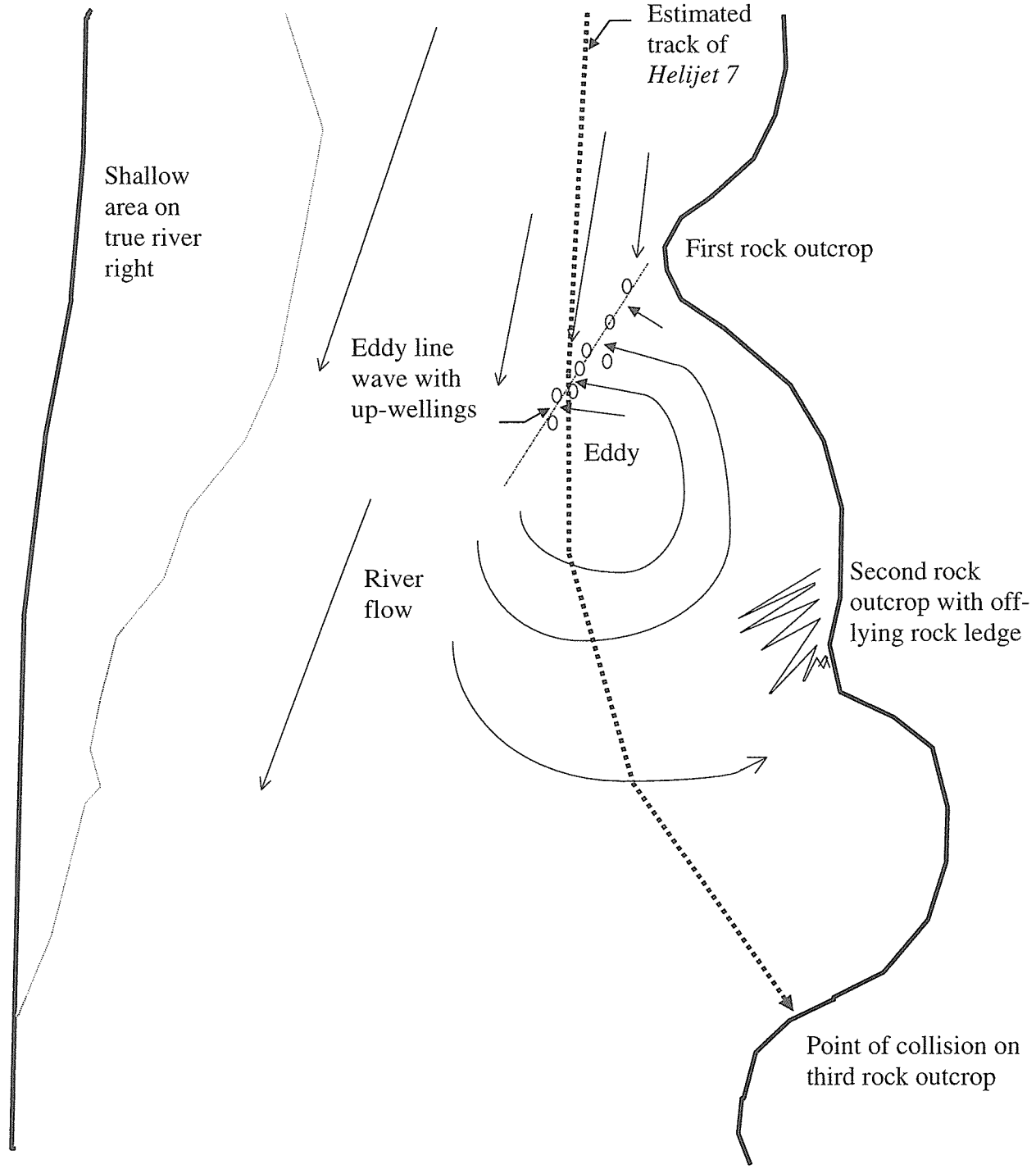

Figure 6
Schematic diagram of accident area (diagram not to scale)

2.1.10 Once he was satisfied the boat was not going to drift away, the driver switched off the engine and told the passengers to disembark onto a rock ledge. The boat had been extensively damaged and the driver was fearful that it might sink. The driver was unable to disembark as he had suffered a badly broken leg. Most of the passengers received some form of injury in the impact ranging from scrapes and bruising to lacerations and a fractured wrist.

2.1.11 After some 8 minutes the first rescue boat arrived on the scene. The passengers and driver were evacuated, initially by boat and then by helicopter and taken to hospital for treatment. The boat was towed back upriver, retrieved onto its trailer and stored in a secure location where it was later inspected.

2.2 Injuries and damage to the boat

2.2.1 The injuries to the passengers and driver are encapsulated in figure 7 below:

Bow

Driver	**Adult**	**Adult**	
Remained in boat, legs pinned under dashboard	Remained in boat, thrown forward against dashboard and windscreen	Remained in boat, thrown forward against dashboard and windscreen	**Front row**
Fractured left leg, serious laceration to right leg, severe bruising	Laceration to face and legs, severe bruising	Laceration and bruising to face, severe bruising to left side of body, fractured left wrist	
Adult	**Adult**	**Adult**	
Thrown forward into seat back	Thrown forward into seat back	Thrown forward into seat back	**Back row**
Bruising to knees and head	Bruising to knees and lower legs	Bruising to knees and lower legs	

Figure 7
Diagram correlating seating position with injury

2.2.2 *Helijet 7* was extensively damaged in the collision. The aluminium bow was pushed back about 60 cm and bowed outwards. Part of the GRP foredeck shattered and had sprung from the hull. The front seat mount sheared from the floor frame and the back of the front seat was pushed forward by the impact from the rear seat passengers, sheering the steel channel frame from the seat frame.

2.2.3 During testing the day after the accident the engine started instantly and ran smoothly. A thorough check was made of the steering system. All linkages were sound and the jet unit steering nozzle had full and free lateral movement. The jet reverse bucket operated normally.

2.2.4 Following the out-of-water inspection, *Helijet 7* was temporarily repaired, launched and extensively tested down the Kawarau River with another company jet boat in attendance. Apart from the hull porpoising at medium speeds, the hull, motor and steering performed normally.

2.2.5 Comparing the nature of the hull damage with the impact marks on the rock face, it was apparent that *Helijet 7* had struck the rock face with a bow-high attitude and with a bias on the left side, indicating that the boat might have been either starting to turn to the right, or had some residual side-slip to the left, when it struck the rock face.

2.2.6 A number of crash stop manoeuvres were made with *Helijet 7* (near full ahead to full reverse bucket). As expected with jet boats, the boat assumed a severe bow-down attitude as it came to a rapid stop.

2.2.7 When the crash stop manoeuvre was attempted without reducing the throttle, the test driver had to use both hands to apply sufficient reverse bucket to stop the boat effectively.

2.3 Driver training

2.3.1 Apart from a small amount of recreational water-skiing behind jet boats on Lake Wakatipu, the driver had little previous jet boat experience before joining Helijet Limited in August 1998. He completed 27 hours on-water training under the supervision of senior drivers. The training was done without passengers on board, but towards the end of his training the boat was loaded with ballast to simulate having passengers on board enabling the driver to appreciate the different handling techniques required with a loaded boat.

2.3.2 The driver then completed a test drive to the satisfaction of the QLDC Harbourmaster, after which he began making solo commercial trips. From time to time the driver was accompanied by a senior driver, whose task it was to assess his progress. The driver had accumulated a total of 80 hours driving before the accident, including the 27 hours training.

2.3.3 The driver had been on 2 rostered days off before the accident. He stated that his sleep pattern had been normal over those 2 days and that he did not feel fatigued before commencing driving duties on the day of the accident.

2.4 River and weather information

2.4.1 The river level had been above normal, but had been dropping over the previous two days before the accident. The water was relatively clear and the water surface not affected greatly by wind.

2.4.2 The weather was partly cloudy, and fine.

2.5 Company information

2.5.1 Helijet Limited was a wholly owned subsidiary of Shotover Jet Limited, having been acquired by them about 3 months before the accident.

2.5.2 Helijet Limited had its own policy and procedures in place prior to Shotover Jet acquiring the company. The process of aligning its policy and procedures with those of Shotover Jet had only just begun.

3. Factual Information relevant to both accidents

3.1 Jet boat information

3.1.1 *Terminator* and *Helijet 7* were similar in design, both having a relatively long shallow-V bow progressively transforming into relatively flat bottom stern. Both craft were fitted with planing strakes to reduce side-slip in a turn. Both craft were fitted with a raised spray dodger around the stern to prevent water entering the cockpit when spins were performed.

3.1.2 Speed and reverse thrust were achieved by a combination of foot-throttle setting and a cable-operated reverse bucket.[7] When the reverse bucket was fully open, the efflux was rearwards, thrusting the craft forward. As the bucket was closed, an increasing amount of the water efflux was deflected forward, progressively changing the resultant thrust from forward to reverse. The engine throttle was operated independent of the bucket, using a foot pedal. At full reverse thrust, with the throttle fully open, the stopping capability of a jet boat is often likened to that of a car. When applying full reverse thrust, the craft normally assumes a significant bow-down attitude.

3.1.3 Steering was achieved by a cable-operated deflector nozzle which was free to move laterally within the jet unit, deflecting the water efflux left or right depending on which direction the steering wheel was turned.

3.2 Jet boat driver training requirements

3.2.1 The draft Maritime Rules Part 80 (Marine craft used for adventure tourism) had been circulated to the jet boat industry before the time of both accidents. The draft rule specified that a driver must have not less than 50 hours experience under the supervision of an experienced driver before driving solo with passengers. The 50 hours must have included a period, acceptable to the authorised person[8], on the river on which the driver was to operate commercially.

3.2.2 Part 80 did not come into force until 11 February 1999, some months after these two accidents. The rules made no provision for a probationary period of driving following certification of a driver.

3.2.3 The QLDC required drivers to have not less than 25 hours experience as a jet boat driver under the supervision of an experienced driver, and then to have completed a practical test drive to the satisfaction of the QLDC Harbourmaster before driving solo with passengers on board.

3.2.4 Shotover Jet required their trainee drivers to have completed not less than 100 hours experience as a jet boat driver under the supervision of their senior drivers, and to have passed the QLDC practical test, before driving solo with passengers on board. A further 25-hour probationary period followed, during which a driver was kept under observation.

3.2.5 Dart River Jet had broadly adopted Shotover Jet's training procedures with some variations. The driver training was based on a weekly programme with specific skills taught each week. The total number of hours varied depending on driver ability and past experience. During the probationary period, drivers were allowed to drive solo with passengers on board, but only in tandem with another boat driven by a senior driver.

3.2.6 Helijet Limited had yet to adopt the Shotover Jet training policy at the time of the accident. They were using the QLDC criteria for training (not less than 25 hours) and followed this up by observing their drivers' performance from time to time.

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[7] A scoop which is closed into the water efflux to deflect all or some of the water forward.

[8] An authorized person is any person who holds a valid certificate of recognition issued under section 41 of the Maritime Transport Act.

4. Analysis

4.1 98-213, *Terminator*

4.1.1 The driver of *Terminator* had some 75 hours training behind him when he made his first solo trip with passengers. He had accumulated about a further 50 hours solo at the time of the accident.

4.1.2 Part of his training had included using the upriver part of a trip to establish where the main flow of the river was, and to use this information to plan his route downriver. The general rule was for drivers to not go down a channel unless they had previously driven up it, unless the whole channel was visible to a driver. There were several reasons why this practice was to be followed:

- the upriver trip was made at slower speed, affording the driver more time to assess the form of the river,
- the driver could explore tributaries at slower speed, making the consequences of turning up an impassable tributary less dire,
- the greater speed of the downriver trip left less time for the driver to read the river ahead, and
- the greater speed of the downriver trip left the driver less reaction time to avoid surprise obstructions in the water.

4.1.3 The practice was followed by drivers because, by their nature, rivers can dramatically change form over a short period, particularly when their level was rising or falling. An experienced driver may get a feel for the river flow after operating on it for several days, and get to know the small channels that are safe to pass through; nevertheless, small tributaries have a greater chance of becoming blocked by an obstacle than the main channel.

4.1.4 The driver of *Terminator* had been off the river for the 2 previous days. The accident trip was his first trip on the Dart River for that day. On the final leg back to the base, the driver made an appropriate decision to go left rather than enter the Woodbine Channel, which he knew could be marginal at times. He correctly judged that the main river flow was to the left; also, having come up the left channel, he knew it was safe.

4.1.5 The driver's decision to then branch out of the main flow and down the secondary channel in which the accident occurred was not so appropriate. He based his decision on his observation that there was good water flow into the top of the channel and good water flow out at the bottom; however, he could not see what was in between, nor had he driven up the channel on the upriver ride.

4.1.6 It is likely that the driver could have successfully driven *Terminator* down the channel had the obstruction not been there. Whether or not another driver could have successfully negotiated the obstruction without incident is not significant. What is significant is that *Terminator* should not have been in that channel heading downriver on that occasion.

4.1.7 Some of the injuries sustained by the passengers and driver were serious but not life-threatening. The severity of their injuries might have been worse had it not been for the following factors:

- that 2 of the occupants that were thrown clear of the boat were able to assist in lifting the boat,
- that 2 other occupants were able to climb from under the boat and assist in lifting the boat,

- that the driver of the third jet boat saw the accident and was able to raise the alarm and assist,
- that the jet boat rolled onto relatively soft shingle, and
- that there was no fire.

4.1.8 Of the 12 occupants of *Terminator*, 7 were trapped beneath the boat. If any one of the factors listed above had been different, there was a real chance that the injuries sustained could have been worse, possibly fatal.

4.1.9 An appropriately placed roll bar, or similar device, would have afforded sufficient occupiable space for those trapped under the boat, and allowed them to have escaped without relying on those outside having to lift the boat. Their injuries would have been less severe and the survivability of this accident would have been increased.

4.1.10 If seat belts had been worn by the occupants of *Terminator*, the survivability of this accident may have been reduced.

4.2 98-215, *Helijet 7*

4.2.1 The driver of *Helijet 7* had some 27 hours training behind him when he made his first solo trip with passengers and since then he had accumulated about a further 50 hours before the accident.

4.2.2 The reason for the driver losing control of his boat is not clear. All components of the propulsion and steering system functioned normally after the accident.

4.2.3 It has been known for jet boat drivers to experience steering lock-ups caused by debris lodging in the steering nozzle of the jet unit. In such an event the driver turns the wheel from side to side until it clears; however, the driver's recollection was that he was able to turn his steering wheel to the right, but that the boat simply did not respond.

4.2.4 The driver was passing close enough to the first rock outcrop for *Helijet 7* to have crossed the wave of turbulent water created by the eddy line. The jet unit could have ingested aerated water, or the hull lost its grip on the water momentarily as the boat passed over the wave. Either circumstance could lead an inexperienced driver to believe he had lost steering.

4.2.5 From the time *Helijet 7* passed the first rock outcrop to the point of impact with the rock face, the craft travelled about 40 m. At 70 km/h this equates to about 2 seconds in time.

4.2.6 Within that 2 seconds the driver recalled:

- turning the wheel further right,
- turning the wheel hard left and then hard right again while backing off the throttle,
- Re-applying full throttle with the wheel hard right,
- backing off the throttle again,
- pulling on reverse bucket, and
- re-applying full throttle.

4.2.7 During the above sequence *Helijet 7* veered to the left and struck the rock face in a bow-up attitude. It is unlikely that the whole sequence in 4.2.6 could have been achieved within the 2-second time frame.

4.2.8 The boat probably veered left as a result of the driver turning the wheel to the left in an instinctive move to clear what he perceived to be a steering lock-up or failure. The release of

the throttle would not have been instantaneous, so the boat was probably still under some power throughout the sequence.

4.2.9 The veer to the left may have been accentuated by the bow entering the eddy. When the driver realised his boat was going to strike the rock face, he probably tried to pull on reverse bucket at near full throttle.

4.2.10 During the post-accident tests conducted on *Helijet 7*, with near full throttle on, the test driver had to use both hands to pull on the reverse bucket lever to close the bucket into the efflux.

4.2.11 The driver of *Helijet 7* may have neutralised the resultant thrust of the jet unit, and the craft may have been coming off the plane, which would account for the bow-high attitude of *Helijet 7* when it struck the rock face. Had he attained reverse thrust, the boat should have struck in a bow-down attitude.

4.2.12 Most of the injuries to the passengers in this accident would have been minimised if they had been wearing effective lap seat belts. The deceleration force was sufficient to propel all 3 rear-seat passengers into the back of the forward seat, which failed at its base. The 3 rear-seat passengers all sustained bruising to their knees and lower legs.

4.2.13 The 2 front seat passengers were propelled forward, their lower bodies sustaining injury on the dashboard; their head and upper body sustaining injury from the wind dodger.

4.2.14 The driver, who was big in stature, fared worse. His driving position was cramped, with little leg room under the dashboard; consequently, when he was thrown forward he sustained a fracture and lacerations to his legs.

4.2.15 The design and construction of the interior of *Helijet 7* offered little protection for the passengers from injury.

4.3 On-going safety issues

4.3.1 The Commission has investigated 4 previous accidents involving commercial jet boats and commented in the previous 2 reports on the trend that, in each case the drivers have had limited experience, typically less than one year. The Commission has not previously made any recommendations regarding jet boat driver training; however, the trend continues with these last 2 accidents.

4.3.2 Jet boats are classed as marine adventure tourism craft. The size and people-carrying capacity of jet boats has grown with the industry, and so too has the potential risk to the public when a single accident occurs. There will always be a certain degree of inherent risk involved with jet boating; however, with the numbers being carried, it is paramount that the risk be kept to a minimum.

4.3.3 Adequate driver training is the first defence against accidents; however, no matter how well trained drivers are, the inherent risks mean that from time to time accidents will occur. When they do, the boat design must be such that injury to occupants is kept to a minimum.

4.3.4 Part 80 of the Maritime Rules goes some way to regulating standards for driver training and boat construction, but could do with some improvement. A safety recommendation has been made to the director of the Maritime Safety Authority (MSA), the chairman of the Commercial Jet Boat Association and the general manager of Shotover Jet Limited regarding driver training and performance monitoring.

4.3.5 Shotover Jet and Dart River Jet have set training standards for their own drivers which exceed those specified by Part 80 and the QLDC. What is now required by them, and the industry in general, is recognition that inexperienced drivers require frequent follow-up training and observation, and that experienced drivers need to be subject to some form of peer review in order that high standards be achieved and maintained.

4.3.6 The Commission has previously made recommendations to the MSA and the Commercial Jet Boat Association regarding the fitting of roll bars or similar devices to jet boats operating in braided rivers, and the fitting of quick-release lap belts in all commercial jet boats.

4.3.7 The recommendation regarding the fitting of quick-release lap belts was rejected on the grounds that lap belts may in some cases cause drowning and prevent passengers reacting swiftly in an emergency. Both the MSA and the Commercial Jet Boat Association favoured improving the interior design of jet boats to guard against injury in impact type accidents. The issue of roll bars was not addressed by either party. The sections of Part 80 of the Maritime Rules relevant to internal design and construction have been included as Appendix 1.

4.3.8 The occupants of *Helijet 7* would have benefited had they been wearing lap belts; however those in *Terminator* would probably have fared worse.

4.3.9 The occupants of *Terminator*, however, would have benefited from the boat being fitted with a roll bar or similar device. A further safety recommendation has been made to the director of the Maritime Safety Authority, the chairman of the Commercial Jet Boat Association and the general manager of Shotover Jet Limited regarding the fitting of roll bars or similar devices to commercial jet boats operating in braided rivers.

5. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

5.1 The drivers of both *Terminator* and *Helijet 7* held the required licence to conduct their respective trips.

5.2 Both the *Terminator* and *Helijet 7* met the construction and maintenance standards required under the legislation in place at the time of the accidents.

5.3 Neither accident was caused by mechanical failure.

5.4 The driver of *Terminator* was faced with a situation that exceeded his driving capabilities when he ventured out of the main river flow.

5.5 *Terminator* flipped onto a shingle bar when the driver lost control of his craft after it hit an obstruction in a narrow channel.

5.6 The decision of the driver of *Terminator* to leave the main river flow and proceed down a channel he had not been up, without being able to see the whole channel, was not appropriate and placed his passengers at unnecessary risk.

5.7 The driver of *Terminator* had probably received sufficient initial training to drive solo with passengers on board; however, the follow-up guidance and training provided by the operator was not adequate. Consequently the passengers were exposed to more than an inherent level of risk.

5.8 An appropriately installed roll bar, or similar device, on *Terminator* would have been acceptable as *a last defence* for preventing injury to the occupants.

5.9 Had the occupants of *Terminator* been wearing quick-release lap belts when the craft flipped, their injuries may have been significantly worse under the circumstances.

5.10 The driver of *Helijet 7* was faced with a situation that exceeded his driving capabilities.

5.11 *Helijet 7* appears to have encountered a wave and eddy pattern which affected the performance of the craft. In his attempts to correct the path of *Helijet 7*, the driver might have exacerbated the situation.

5.12 In spite of having met the training requirements of the QLDC, the driver of *Helijet 7* had not received sufficient training under observation; consequently the passengers were exposed to more than an inherent level of risk.

5.13 In spite of the draft Maritime Rules Part 80 having been in circulation during the period of his training, the driver of *Helijet 7* only received the lesser amount of training required by the QLDC.

5.14 Had the occupants of *Helijet 7* been restrained with quick-release lap belts, their injuries would have been significantly reduced.

5.15 The design and construction of the interior of *Helijet 7* did little to protect the occupants from injury in a sudden impact accident.

6. Safety Actions

6.1 The General Manager of Dart River Jet Safari advised the following:

- Since the accident, Dart River Jet Safari has introduced a system using a large map of the Dart River displayed in the operations room at the base. Channels are marked "open" or "closed" along with any cautionary notes.
- Each day a senior driver is designated trip leader. The trip leader is responsible for closing or opening the various channels depending on the varying level and flow of the river. The map is continuously updated as new information comes to hand. The drivers use the map to assist in planning their route for the day.
- The trip leader is responsible for overseeing new drivers and ensuring they are paired with senior drivers on days when the river level is high, and changes in flow are likely.
- The driver of *Terminator* on the day of the accident had completed a further 30 hours of training, plus 25 hours probationary driving commercial trips with loadings of no more than 8 passengers.
- The 25-hour probationary period with light loads, followed by another check trip will be adopted for all training in the future.

7. Safety Recommendations

7.1 On 12 April 1999, it was recommended to the Director of Maritime Safety that he amends Maritime Rule Part 80 to:

7.1.1
- raise the minimum hours of training for jet boat drivers to 100 hours,
- set a standard for drivers to reach before they can be certified as senior drivers, and
- require operators of commercial jet boats to have a system of on-going guidance and training for new drivers, and a system of peer review among senior drivers.
- require drivers to undergo a further 50 hour training on any new river they intend to operate on. (032/99)

7.1.2 require a roll bar, or similar device, to be fitted on all new commercial jet boats intended to be operated in braided rivers, and recommend to owners of existing craft to, where practicable, fit such a device to their craft. The roll bar or similar device should allow sufficient occupiable space under the boat for its full compliment, should it roll. (033/99)

7.2 On 28 May 199, the Director of Maritime Safety responded as follows:

7.2.1 **032/99**
This is not accepted. Rule Part 80, developed after extensive industry consultation and full cost-benefit evaluation, was not in force at the time of these accidents and will not be fully implemented until July of this year. It would appear premature to amend the Rule at this stage, not least since it addresses each of the issues raised by your recommendations.

In that particular context, we should stress that the Rule requires a **minimum** number of hours of training for jet boat drivers, while overall standards and ongoing guidance and monitoring are matters we would expect to see covered in any company's Safe Operational Plan, approved by an expert Authorised Person.

We shall, however, draw your report and its recommendations to all such persons.

7.2.2 **033/99**
The issue of retro-fitting is far from easy and may be impractical (See MSA response to previous TAIC reports 97-211 and 98-205). We shall, however, raise the issue and encourage the industry to fit roll bars, or similar devices, on all new jet boats intended to operate on braided rivers.

7.3 On 12 April 1999, it was recommended to the chairman of the Commercial Jet Boat Association that the Association:

7.3.1 support the recommended changes to Maritime Rule Part 80, and begin a programme of compliance with the changes as a matter of urgency. (034/99)

7.4 On 30 May 1999 the chairman of the Commercial Jet Boat Association responded as follows:

7.4.1 The Association supports the proposal of drivers having 100 hours of training however we believe this is not achievable across the whole industry given that the majority of operators are only small and the fact that training is the responsibility of the operator.

During the 1980's the Code of Practice driver training hours was 100 hours, this was subsequently reduced to 50 hours in consultation with the Industry by the Queenstown Lakes District Council when the Bylaws were adopted. The reason for this was it was not accepted by the industry hence the Council adopted 50 hours in the Bylaws when they were adopted, before a full license was issued.

The recommendation that drivers obtain a standard before they can be certified as Senior drivers and that drivers have on going guidance/training is supported, however as Rule 80 stands there is not requirement for any operator to ensure his staff is given the above.

As you are no doubt aware in Queenstown jetboat drivers are issued with a full license, it seems somewhat ridiculous that once Rule 80 becomes law on July 14 the Council will not be able to issue licenses.

The [Association] totally supports drivers under going 50 hours of training on each river they intend to operate on.

The [Association] does not support the recommendation of fitting Roll Bars in commercial jetboats, as they could cause a jetboat to roll a second time thus exposing passengers to even greater risk. A foil/ducktail would be more practical but this also would need to be designed around the jetboat and is not something that could just be fitted to every jetboat.

To summarise
The [Association] supports in part the recommendations, as detailed, i.e. the 50 hour training requirement.

Further analysis is required on the other items.

At the forth coming AGM (17 July 1999, at the Waikato River Lodge) the [Association]., will be discussing these items in detail and will report back to you after this meeting.

7.5 On 12 April 1999 it was recommended to the General Manager of Shotover Jet Limited that he:

7.5.1 Implement the recommended changes to Maritime Rule Part 80 within Shotover Jet Limited and all of its subsidiaries, as a matter of urgency. (035/99)

7.6 On 27 May 1999 the General Manager of Shotover Jet Limited responded as follows:

7.6.1 1. The first four points relating to boat driver training have been adopted at all our jetboat subsidiaries with the relevant changes made to Operations and Safety Plans.

2. Dart River Safaris is our only subsidiary that operates on a shallow braided river. We are looking at a boat replacement programme over a period of one to five years. When designing the new boats your recommendation regarding roll bars or similar device will be considered.

Approved for publication, 26 May 1999

Hon. W P Jeffries
Chief Commissioner

Appendix 1

Maritime Rules Part 80 (Marine craft used for adventure tourism)

1.3 Construction

(a) A new jet boat's construction must be to standards appropriate to the material of construction and its intended use, and be acceptable to the authorised person undertaking the inspection.

(b) An existing boat will be considered satisfactory for the purposes of 9.1(d) if it is in a good state of repair and built to standards appropriate to the materials of construction and its intended use, and is considered fit for its intended purpose by the authorised person undertaking the inspection

1.4 Specific requirements

(a) A full engine cover must be fitted and be secured to the jet boat.

(b) Provision must be made for adequate natural ventilation of the engine.

(c) The engine cover and any insulation of the engine space must be of fire retardent material.

(d) Seating must be:

(i) arranged so that the persons are facing forward, and
(ii) securely fixed and have back rests, and
(iii) be so situated that the persons' upper thighs are blow the level of the side deck or coaming of the boat, and
(iv) well upholstered and constructed without any sharp edges which a passenger's body may come into contact with as a result of any motion or sudden stopping of the boat.

(e) Adequate and appropriately sited handholds must be provided for all passengers.

(f) The inside of the passenger compartments must be free of projections and sharp edges which a passenger's body may come into contact with as a result of any motion or sudden stopping of the boat. Where practicable, hard surfaces which may be subject to passenger body contact must be padded.

(g) Windscreens (where fitted) must be securely fixed and must be of safety toughened glass or a plastic acceptable to the authorised person.