



Report 00-207

commercial jet boat *Discovery*

collision with rock face

Shotover River, Queenstown

29 June 2000

Abstract

On Thursday 29 June 2000 at about 1505, the jet boat *Discovery* was approaching Tyrees Cut on the Shotover River with the driver and 15 passengers on board. The driver had reduced speed approaching the cut, and as he attempted to accelerate to maintain control of the boat the left side of his boot momentarily caught on the accelerator surround, preventing him from applying optimum power for the manoeuvre, causing the boat to drift to the right of the intended track. The stern of the boat clipped the canyon wall, causing it to spin towards a recess in the wall. The driver managed to apply power and avoid the recess but the starboard bow of the boat collided with the rock face immediately downstream. The driver and 13 passengers suffered minor injuries and 2 passengers suffered moderate injuries. The boat was extensively damaged.

Safety issues identified included:

- the suitability of footwear worn while driving jet boats
- the lack of co-ordinated radio communication procedures for emergency services in the Queenstown area
- the non-reporting of hazards and incidents
- a speed restriction placed on the area of the accident potentially compromising safety.

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Discovery

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List of Abbreviations

cm	centimetre
km	kilometre(s)
km/h	kilometres per hour
m	metre(s)
mm	millimetre(s)
OSH	Occupational Safety and Health
QLDC	Queenstown Lakes District Council
UTC	co-ordinated universal time
VHF	very high frequency

Glossary

gunwale	the upper edge of the sides of a boat or ship
knot	one nautical mile per hour
mayday	radiotelephone distress signal requesting immediate assistance
port	left-hand side when facing forward
starboard	right-hand side when facing forward
track	the path intended or actually travelled by a ship
true right	the right-hand side of a river looking downstream

Data Summary

Boat particulars:

Name:	<i>Discovery</i>
Type:	commercial jet boat
Class:	passenger (under 6 m)
Limits:	Shotover River - Deep Creek to Skippers Bridge
Allowable occupants:	driver plus 18 passengers (at driver's discretion)
Length:	5.9 m
Construction:	aluminium
Built:	1996
Propulsion:	a single Chevrolet 502 engine powered by aviation fuel driving a series HJ-212 Hamilton water jet unit
Normal operating speed:	55 km/h
Operator:	Skippers Grand Canyon Limited

Location: Tyrees Cut, Shotover River

Date and time: Thursday 29 June 2000 at about 1505¹

Persons on board:

crew:	1
passengers:	15

Injuries:

crew:	1 minor
passengers:	2 moderate 13 minor

Nature of damage: substantial to hull on starboard side and minor to trim tabs and bottom plates

Investigator-in-charge: Captain W A Lyons

¹ All times in this report refer to New Zealand Standard Time (UTC +12 hours) and are expressed in the 24 hour mode.

1. Factual Information

1.1 History of the trip

- 1.1.1 On the morning of Thursday 29 June 2000, the driver of the *Discovery* for the accident trip arrived at work at 0830. He conducted the daily safety checks on the boat, launched it, warmed the engine through and took it for a short test run. He was then engaged in maintenance work for the rest of the morning while another driver took the *Discovery* on a passenger trip.
- 1.1.2 At about 0900 the driver accessed the automatic flow meter by telephone to obtain the height of the river. At the time the river level was 1600 mm, which was within the company's safe operating limit of 2600 mm.
- 1.1.3 At about 1340 a group of 15 passengers arrived at the jet boat base. They had booked a "grand slam" package that included a 4-wheel drive trip, a ride on a flying fox, the jet boat trip and a bungy jump.
- 1.1.4 The passengers were fitted out with life jackets and spray jackets and boarded the *Discovery*. Once seated they were given a safety briefing by the driver who instructed them to hold on tightly, keep their arms inside the boat and brace themselves with their feet. They were also shown the hand signal the driver would use to indicate he was about to put the boat into a spin².
- 1.1.5 The 8 km trip upstream went without incident. The driver periodically gave the passengers information regarding the history of the area and pointed out places of interest.
- 1.1.6 On the return trip downstream the *Discovery* passed under the Pipeline Bungy Bridge and was approaching Tyrees Cut, a man-made cut through the rock wall of the canyon about 30 m long and 4 m wide dating back to the gold rush period (see Figure 1). The driver lifted his foot off the accelerator to reduce the speed of the boat as it approached the entrance to the cut. When about 6 to 7 m from the entrance he tried to accelerate but the left side of his boot, alongside the ball of his foot, became momentarily caught on the left-hand extended plate of the accelerator surround, preventing him from applying the power he wanted.
- 1.1.7 With a jet boat, the rate of a turn is governed by a combination of steering nozzle deflection and jet unit thrust. Because the driver of the *Discovery* was not able to achieve the level of thrust he wanted, the boat drifted to the right of his intended track, causing the starboard aft side to strike the rock face at the entrance to the cut. The impact caused the boat to sheer towards a recess in the true right canyon wall about 15 m downstream. To minimise the impact and avoid the boat becoming wedged in the recess the driver immediately put the helm to port, adjusted the position of his foot and applied power (see Figure 2).
- 1.1.8 The *Discovery* passed the recess but the starboard bow struck the rock face immediately downstream, causing all the passengers to slide towards the starboard side of the boat and the engine to stall. The boat then drifted clear of the cut.
- 1.1.9 The driver immediately transmitted a mayday call on channel 60 on the very high frequency (VHF) radio. The call was received at the home of the operator's general manager. The general manager's wife then alerted the emergency services by telephoning 111. She told them the accident had occurred just downstream of the Pipeline Bungy Bridge.
- 1.1.10 With the aid of the paddles the driver and some of the passengers were able to manoeuvre the boat out of the fast water and beach it on an area of shingle about 100 m downstream of the cut (see Figure 3).

² A spectacular manoeuvre unique to jet boats where the boat is turned at relatively high speed almost within its own length. A spin is used when a rapid stop or change in direction is required in narrow sections of the river but is often used by commercial jet boat drivers to enhance the thrill of the trip.

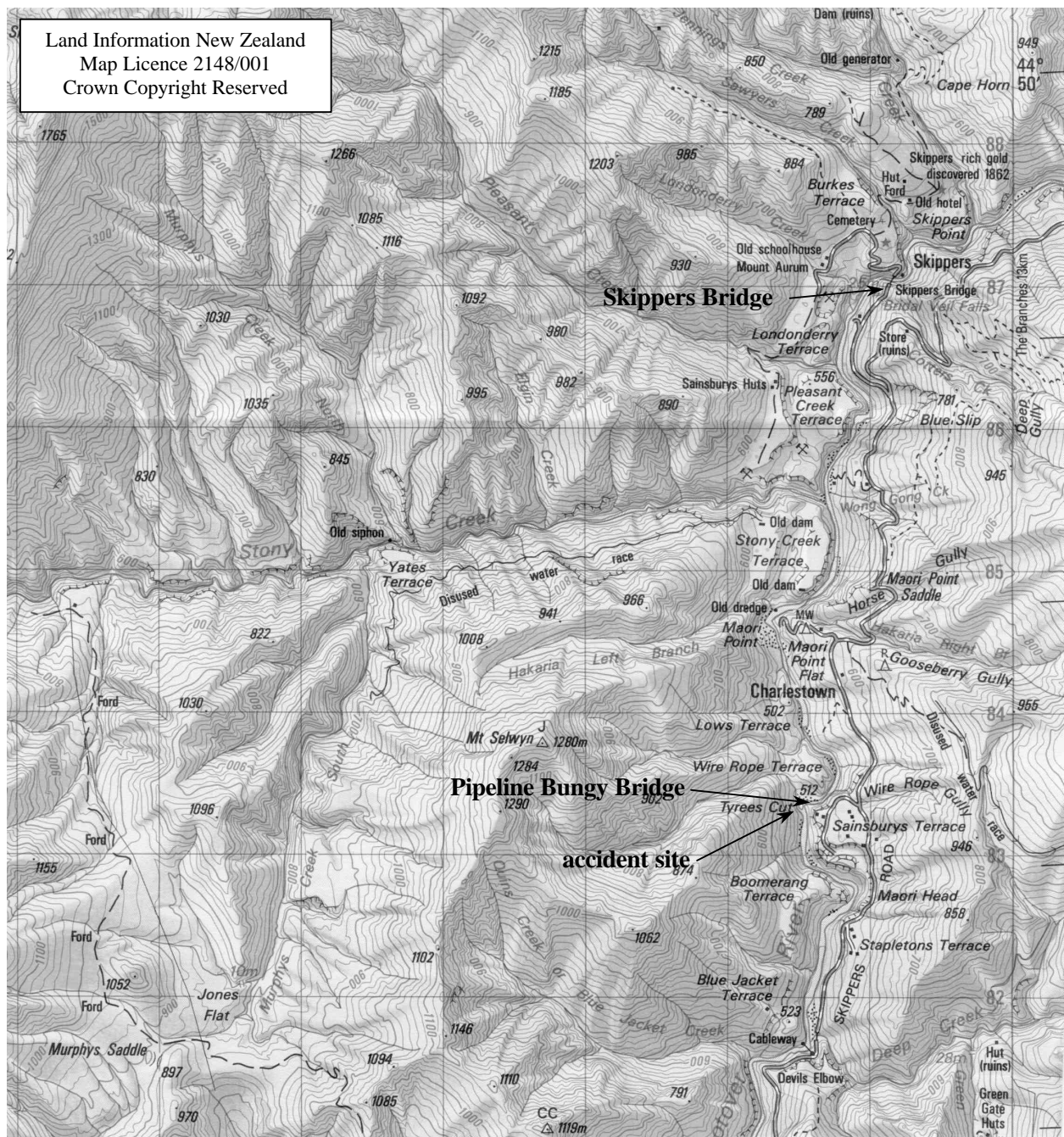


Figure 1
Location map showing the area of the accident

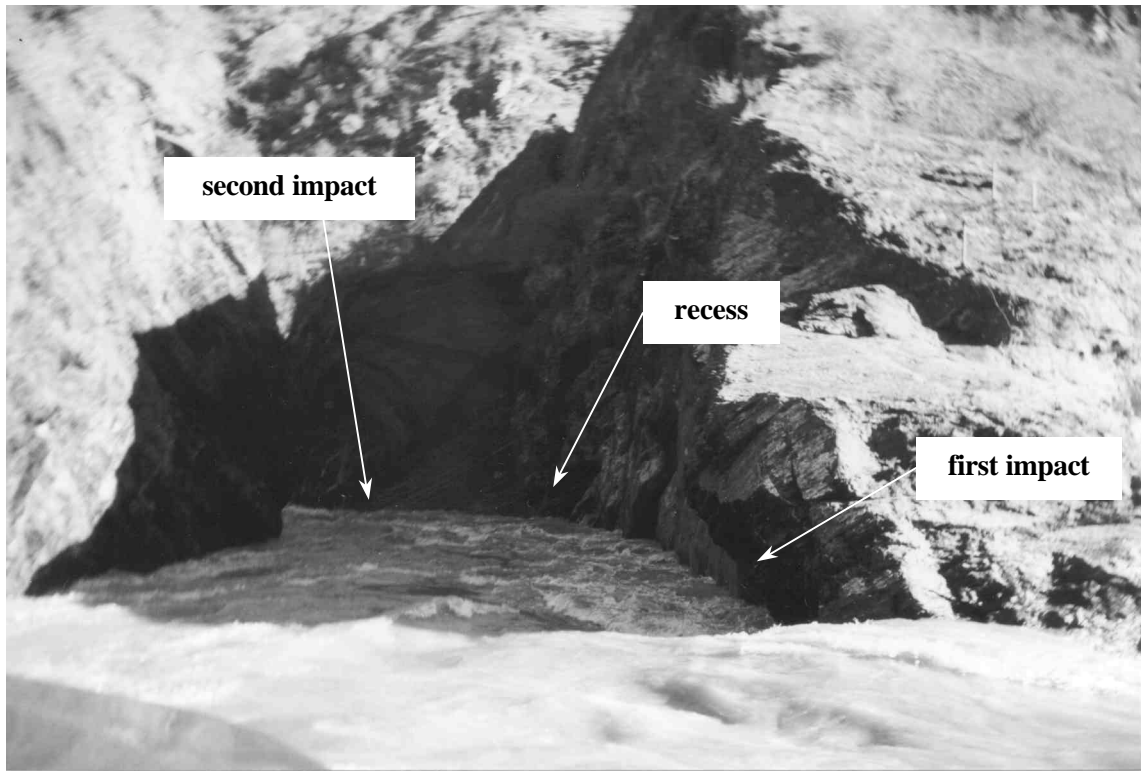


Figure 2
Entrance to Tyrees Cut

- 1.1.11 Once on shore, the driver checked the passengers for injuries. The 2 passengers sitting on the starboard side of the first 2 rows of seats were suffering from moderate injuries to the pelvic area, the rest were shaken and had minor bruising.
- 1.1.12 On the starboard side of the boat the gunwale extended down into the boat, stopping about 25 cm short of the base of the seats. The space under the gunwale was used for running steering and electrical cables. When the *Discovery* struck the rock face the second time, the weight of the other passengers sliding across the seat forced the hip region of the 2 outside passengers in the front 2 rows of seats into this space. The deceleration of the collision resulted in one receiving a broken hip and the other severe bruising. The driver had a cut above his right eye which he thought had been caused by the frame of the glasses he was wearing.
- 1.1.13 Shortly after the *Discovery* was beached, the pick-up boat for the Pipeline Bungy operation arrived at the scene to assist, having heard the mayday call.
- 1.1.14 A helicopter with a paramedic on board was dispatched from Queenstown by the St Johns Ambulance control centre but was instructed to proceed to the Skippers Canyon Bridge instead of the Pipeline Bungy Bridge. On the way to the Skippers Canyon Bridge the helicopter overflew the accident site. When it could not find the accident site it turned around and headed down river. The distance between the 2 bridges was about 6 km.
- 1.1.15 The driver saw the helicopter when it flew past the accident site but did not attempt to make radio contact with it. About 4 minutes later it landed at the site and took the 2 passengers with hip injuries to the hospital.
- 1.1.16 The remainder of the passengers were taken by 4-wheel drive vehicles to complete the bungy jump before being transported back to Queenstown.

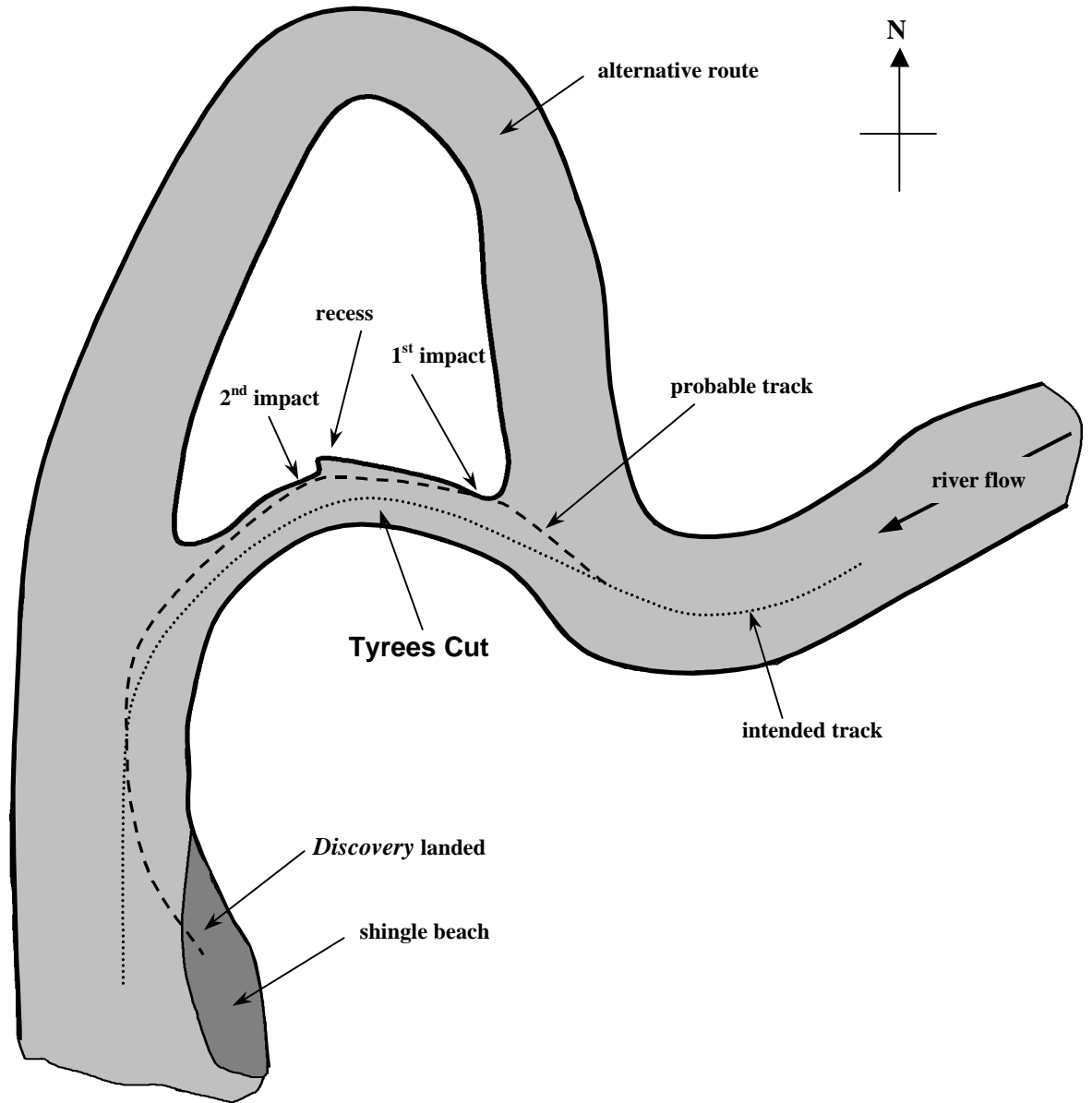


Figure 3
Path of the *Discovery* through Tyrees Cut, and the alternative route

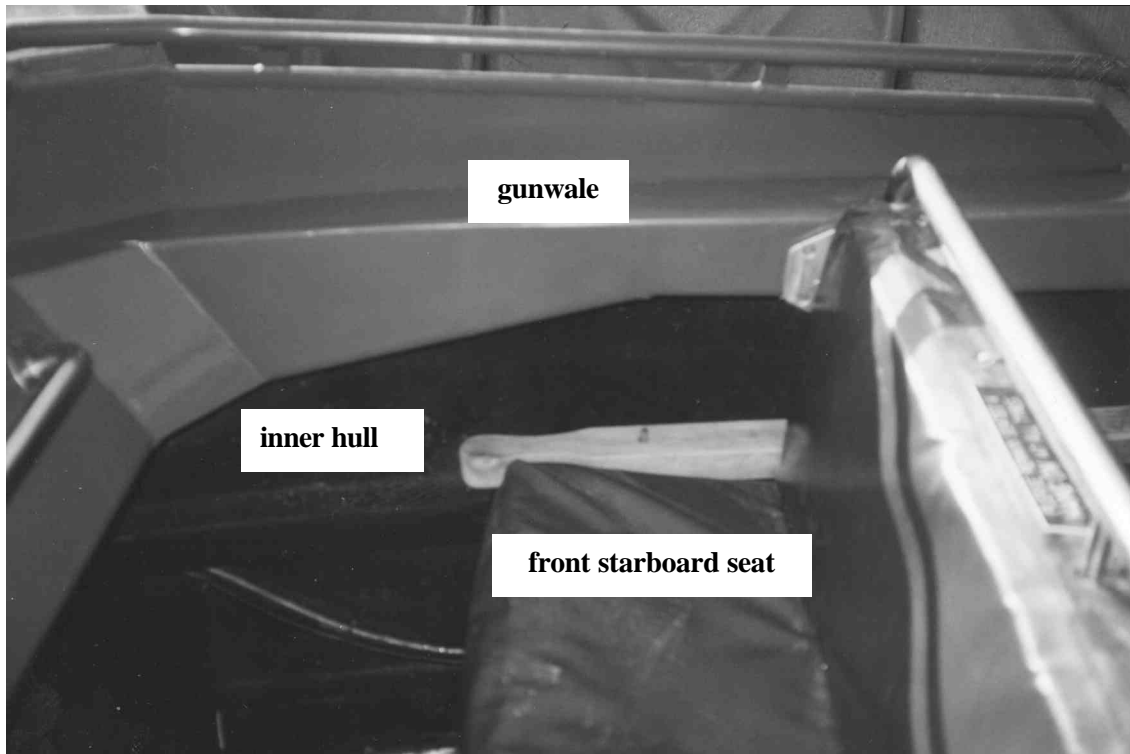


Figure 4
Gunwale on the starboard side of the front seat



Figure 5
Damage to the starboard side of the *Discovery*

1.2 Damage

- 1.2.1 In the first collision with the rock face the *Discovery* suffered scrapes and minor indenting to the starboard aft side of the boat. There were also scrapes on the bottom in an area about one metre from the stern across to the trim tab under the jet nozzle, which was bent slightly upwards.
- 1.2.2 The second collision with the rock face caused heavy indentations to the starboard bow, just forward of the windshield, and to the hull directly below this point. These indentations continued back to the stern but were not as deep as those in the forward section. There was no apparent damage to the engine or steering system.

1.3 Personnel information

- 1.3.1 The driver of the *Discovery* was 37 years old and had first been employed by the operator in 1992. He had operated jet boats on the same stretch of the river for about 6 of the previous 8 years and had a total of about 5000 hours driving experience. According to records he had not had any previous accidents.
- 1.3.2 The driver held a commercial jet boat licence for Shotover River and Skippers Canyon which was issued by the Queenstown Lakes District Council (QLDC) harbourmaster. He had also attended a swift water rescue course and a first aid course.
- 1.3.3 The driver wore tinted glasses with a prescription lens for one eye. He later stated that he was not required to wear the glasses as part of his licence but found they helped reduce the glare from the sun.
- 1.3.4 When driving jet boats in the winter the driver usually wore waterproof boots known by their trade name of Sorells. This type of boot was designed for use in snow and was lined with sheepskin, making them bigger than normal boots. The driver later stated that the Sorells provided protection from the sub-zero temperatures experienced in the area of operation.
- 1.3.5 The Sorells measured about 120 mm across the widest part of the boot. The pair the driver was wearing on the day of the accident was about 8 years old and the sheepskin linings had worn to the point where the driver had purchased replacement linings but had not fitted them; consequently, the boots were relatively loose on his feet.
- 1.3.6 The driver later stated that on a number of previous occasions his foot had lost contact with the accelerator pedal but never at such a crucial point on the river. He had not reported these incidents to the general manager. Under the Health and Safety section of the company Operations Manual it stated:

Hazard Identification and Management

All hazards are identified and recorded on an OSH [Occupational Safety and Health] Hazard Identification form. Methods of how to eliminate, isolate or minimise such hazards are discussed and procedures formed with all staff.

1.4 Boat information

- 1.4.1 The *Discovery* was locally built in 1996 to the operator's requirements. It had 4 rows of seats with the driving position at the front left. Next to the driving position was a short bench seat capable of seating 3 passengers. The other 3 bench seats sat 4 adult passengers each. The engine compartment was at the stern.
- 1.4.2 The boat was powered by a Chevrolet 502 V8 engine, which ran on aviation fuel. Propulsion was achieved using a Hamilton HJ-212 water jet unit. An impeller housed within the jet unit tailpipe drew a high volume of water into the tailpipe through a grill-covered intake positioned near the stern of the boat. The water was then ejected near the water surface at high pressure through a restricting nozzle at the after end of the tailpipe to produce forward thrust.
- 1.4.3 The boat was steered by deflecting the efflux from the jet unit left or right through a steering nozzle at the back of the jet unit tailpipe. The steering nozzle was rotated laterally through a tiller connected to the steering wheel by a system of wires and pulleys.
- 1.4.4 At the stern of the boat under the jet unit was a trim tab which doubled as protection for the jet unit.
- 1.4.5 The accelerator pedal was a smooth aluminium plate about 130 mm long and 70 mm wide situated to the right of the driving position and angled slightly towards the driver. It was cut into a 430 mm long and 145 mm wide chequer-plate footrest with a 40 mm extended plate on the left side and an 80 mm extended plate on the right. A 25 mm diameter alloy pipe guard was fitted to the right of the accelerator arrangement to prevent the feet of the passenger sitting next to the driver from interfering with the accelerator operation (see Figures 6 and 7).
- 1.4.6 The extended plates either side of the accelerator pedal were designed to prevent the driver's foot from losing contact with the accelerator due to movement of the boat, or from slipping due to water or ice.

1.5 Communications

- 1.5.1 The company had a licence to operate a VHF radio station and had a VHF repeater strategically located to cover its area of operation. The managing director stated that the overall coverage on the river was good except for a few short blind spots.
- 1.5.2 The base station for the operation was located in the reception office and another radio was installed in the general manager's house. There were also VHF radios on each boat, at the bungy operation and in each of the 4-wheel drive vehicles. Channel 60 was used as the working channel. All the VHF sets were fitted with the international maritime distress frequency, channel 16.
- 1.5.3 All radio communications were monitored and logged at the base station or general manager's house.
- 1.5.4 The rescue helicopter was capable of communicating on VHF channel 16. There were no procedures in place that required the helicopter pilot to monitor channel 16 when engaged on a rescue flight, nor for any of the jet boat operators in the Queenstown region to use channel 16 in an emergency involving the rescue services.



Figure 6
Accelerator arrangement and a Sorell boot

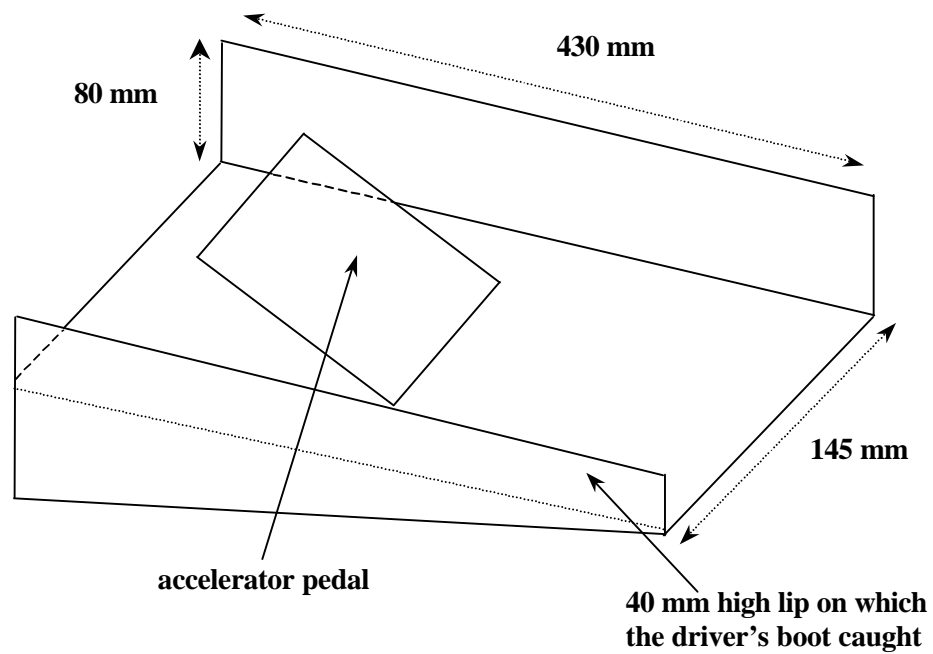


Figure 7
Dimensions of accelerator surround

1.6 Speed restriction

- 1.6.1 The operator first applied to commence commercial jet boat trips on the river in 1986. As part of the resource consent a 5-knot (9.25 km/h) through the water speed restriction was put in place in 3 areas of the river, one being Tyrees Cut. These areas were identified as being of concern with regard to safety, so under the Lakes District Waterways Authority Control By-Laws (1989), the speed restrictions were imposed.
- 1.6.2 At the time of the accident the river was estimated to be running through Tyrees Cut at between 15 and 18 km/h. By staying within the speed restriction the boat was still travelling at between 24 and 28 km/h in relation to the rock walls in the cut.
- 1.6.3 For the driver to maintain reasonable control of the boat when travelling downstream through the cut the boat needed to be on the plane, travelling at least 25 km/h through the water. This speed, coupled with the flow of the river, meant the boat was travelling through the cut at about 40 km/h relative to the rock walls.
- 1.6.4 The alternative route around Tyrees Cut was too shallow for the jet boats if the river was below 1300 mm. There was no speed restriction in force for the alternative route.

1.7 Weather and river conditions

- 1.7.1 Due to rain and snow in the area the river had been running high for the previous 2 weeks. From the time the driver checked the river height at 0900 until he checked it again at the end of the day the height had increased from 1600 mm to 1900 mm.
- 1.7.2 Early in the morning on the day of the accident there had been heavy rain, which had eased to showers and then cleared to sunny patches by the time of the accident. There was no significant wind and the driver reported that his visibility was not impaired.
- 1.7.3 The automatic river flow meter was accessed by telephone and gave the following information:
- the river height measured in millimetres
 - the river flow measured in cubic metres per second
 - the air temperature
 - the amount of rain that had fallen in the previous one, 6 and 24 hours.

1.8 Recorders

- 1.8.1 For about the previous 4 years the managing director, in conjunction with a transport safety company, had been adapting a computerised monitoring system, originally designed for trucks, to suit jet boats. The purpose of the system was to enable the managing director to enhance safety by monitoring driving style as well as recording the performance of the boats.
- 1.8.2 The system had sensors which monitored the following:
- engine revolutions
 - steering
 - forward and reverse bucket
 - when full throttle was applied
 - radio transmissions
 - bilge pumps

- sand trap
- battery charging
- oil pressure
- ignition
- engine temperature.

1.8.3 The information was time referenced and stored by an on-board computer that could be downloaded to a laptop computer. The information could then be printed out in graph form.

1.8.4 There was also a knock sensor fitted to the boat but due to the limited number of recording channels available in the system the managing director had elected not to connect it. He planned that the next upgrade to the system would incorporate the knock sensor and the boat position by way of the global positioning system.

2. Analysis

2.1 The driver of the *Discovery* was on his first passenger trip of the day. He was adequately rested and not fatigued at the time of the accident. Although the river was running high it was within company guidelines and the driver was comfortable operating in the conditions.

2.2 The driver had operated jet boats on the same section of the river in the same footwear for a number of years and had been through Tyrees Cut on many occasions in similar conditions without incident. The short period of time that the driver had limited acceleration was enough to allow the boat to drift off its intended track and collide with the cut wall.

2.3 The driver's action in turning hard left and accelerating to avoid the recess in the canyon wall after the first impact was appropriate. If the boat had become wedged in the recess by the river flow it might have taken water and sunk instead of glancing off the canyon wall and drifting clear.

2.4 The driver had experienced similar problems with the accelerator in the past but it had never happened at a crucial point on the river, so he had not reported the incidents to the general manager or filled out an OSH hazard identification form as stipulated in the Operations Manual. The reporting of seemingly minor incidents is an important tool for reducing accidents. This accident is a good example of one that could have been avoided had the driver's previous incidents been reported and appropriate action taken.

2.5 The lining in the driver's Sorells was worn so they did not fit as tightly as when new. This would have inhibited the driver's "feel" on the accelerator and caused a delay from the time the driver moved his foot to the time the boot moved.

2.6 The extra width of the Sorell compared to a normal boot reduced the available distance between the extended plates either side of the accelerator, thus increasing the chances of the boot becoming caught on them.

2.7 The accelerator surround was designed to prevent the driver's foot from slipping or losing contact with the accelerator. When driving, the heel of the driver's right foot was in constant contact with the foot plate, while the toe of the boot was moving up and down to work the accelerator. If the extended plate on the left-hand side of the accelerator tapered off below the base of the accelerator the heel of the driver's foot would still be contained but the possibility of the forefoot becoming caught would be removed. The extended plate on the right of the accelerator was high enough not to be a problem and provided a useful guide for the driver's foot.

- 2.8 On the day of the accident the river was estimated to be running at between about 15 and 18 km/h. For the driver to adequately control the boat he required a minimum boat speed through the water of about 25 km/h, this being the minimum speed to keep the boat on the plane. Combining these speeds meant that the boat was travelling past the cut wall at about 40 km/h. This was about the speed the boats had been travelling each time they passed through the cut for a number of years.
- 2.9 The 5-knot speed restriction was derived from the Water Recreation Regulations (1979) which imposed a 5-knot speed restriction on vessels when they were within 200 m of the shore or any structure. While setting a speed restriction for boats transiting the cut was appropriate, the 5-knot restriction was not a practical solution and may have compromised safety had the operator adhered to it.
- 2.10 The QLDC harbourmaster was aware that in order to maintain safe control of their boats the drivers routinely exceeded the speed restriction through Tyrees Cut. This acceptance by a regulatory authority of a routine breach of a regulation did not set a good example for other operators in the Queenstown area, who might adopt a similar attitude to other regulations. The setting of practical speed restrictions for such areas needs to be addressed by the local authority responsible for granting resource consent.
- 2.11 The rescue helicopter over-flew the accident site due to a misunderstanding over the location. The helicopter was equipped with VHF radio channel 16, as was the *Discovery*, but there were no procedures in place for either to keep a listening watch on a common channel. It would be beneficial if in the event of an emergency all jet boats involved, their base, and any rescue helicopters, used a common channel so they could communicate with each other. A safety recommendation was made to the QLDC to address this issue.
- 2.12 The outcome of any rescue operation is dependent on the timeliness and efficiency of the response. In this case the 4-minute delay was not critical but in the event of an accident involving serious injury it could well have been. If procedures were in place for all parties to be monitoring the emergency frequency the helicopter could have been contacted when the driver saw it fly past the accident site.
- 2.13 The computerised monitoring system fitted to the *Discovery* was a useful tool for monitoring the performance of the boat and driver. It was also useful during this investigation for determining the driver's actions and the boat's performance immediately prior to the accident. Such systems have the potential to greatly enhance safety in the jet boat industry through boat and driver monitoring and incident investigation.

3. Findings

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

- 3.1 The driver of the *Discovery* was suitably qualified and experienced for his position.
- 3.2 The driver was fit and not suffering from fatigue at the time of the accident.
- 3.3 The river and weather conditions were within acceptable operating limits on the day of the accident.
- 3.4 The *Discovery* collided with the canyon wall when the driver's boot momentarily caught on the extended plate to the left of the accelerator, preventing him from applying the required power at a critical point of his approach to Tyrees Cut.
- 3.5 The driver's actions to recover the situation after the first impact were appropriate.

- 3.6 If the driver had reported earlier incidents of his boot losing contact with the accelerator, the appropriate action could have been taken to avoid this accident.
- 3.7 The speed restriction placed on Tyrees Cut had the potential to decrease, rather than increase safety had the operator complied with it.
- 3.8 The lack of a co-ordinated communication system between jet boats and rescue helicopters in the Queenstown region caused a 4-minute delay in the recovery of injured passengers which could have been critical in the event of more serious injury.
- 3.9 The jet boat and helicopter both had an emergency radio channel on which they could have communicated, but there were no procedures in place that required them to monitor it.

4. Safety Actions

- 4.1 Immediately after the accident the operator's general manager:
- banned drivers from wearing Sorells while driving the boats or the 4-wheel drive vehicles
 - diverted the trip through the alternative route around Tyrees Cut if the river height was above 1300 mm.
- 4.2 When repairing the boat the following modifications were made:
- the gunwales were padded on the *Discovery* and the other boats in the fleet used for jet boat trips
 - the front seat passenger's foot rests were extended
 - the gunwale around the driver's seat was padded.

5. Safety Recommendations

- 5.1 On 15 January 2001 the Commission recommended to the Queenstown Lakes District Council harbourmaster that he:
- 5.1.1 liaise with rescue helicopter and jet boat operators to develop a plan to introduce the use of a common radio frequency by all parties during rescue operations (129/00)
- 5.1.2 introduce appropriate and practicable speed restrictions through Tyrees Cut and other similar areas of concern on the river. (130/00)
- 5.2 On 10 February 2001 the Queenstown Lakes District Council harbourmaster replied, in part:
- 5.2.1 We are working with all parties concerned to improve radio communications and procedures, it is an on going process. With regard [to] the recommendation that practical speed restriction be implemented in Tyrees cut and other similar areas. I do not agree that there should be any speed restrictions as in areas like Tyrees cut, it should be up to the skipper on the day as he is the one who is best qualified to assess what is the best speed for his vessel ie it could depend on river flow, type of boat, loading of boat etc. Both points are addressed in the Companies SOP, ie cutoff levels are in the SOP for Tyrees cut.

Neither recommendation is going to be implemented at this time.

- 5.3 On 15 January 2001 the Commission recommended to the general manager of Skippers Grand Canyon Limited that he:
- 5.3.1 remove or alter the extended plate to the left of the accelerator to prevent the driver's forefoot from catching on it (131/00)
 - 5.3.2 modify either the gunwale or the passenger seats to prevent passengers sliding into the gap under the gunwale. (132/00)

Approved for publication 24 January 2001

Hon. W P Jeffries
Chief Commissioner