Design and feasibility of wash-down stations for boating equipment entering the Rotorua Lakes

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ABSTRACT

Biological diversity in the Rotorua Lakes, New Zealand, is under threat from aquatic pests, in particular pest fish species and various lake weeds. This report considers possible solutions to both out-of-district contamination and cross-contamination of the Rotorua Lakes. A network comprising ten decontamination facilities is proposed, with facilities located on public land: specifically, land managed by the Department of Conservation and road reserves. A number of decontamination methods are considered. The two methods that are recommended for further investigation are high-pressure, multi-nozzle water blasting, and a combination of dipping and ultrasonic irradiation. Incentives to use the decontamination facilities and construction and operational costs are considered. As a case study, a facility located at the southern entrance to Rotorua is considered. Possible costs to establish this case-study facility are also provided. It is proposed that a single case-study facility be established initially, and monitored for operational and strategic success.

Keywords: Rotorua Lakes, wash-down facilities, pest fish, aquatic pests

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1. Introduction

The introduction of exotic species to New Zealand ecosystems has had dramatic consequences for native biological diversity. With 35 species of introduced mammals (Aktinson 1989) and more than 50% of New Zealand's flora (Webb et al. 1988) naturalised, many native species now have only restricted and fragmented distributions (Towns & Daugherty 1994). Freshwater systems have not escaped damage, with the introduction of primarily sports fish (McDowall 1990) suspected to be a significant contributing factor in the diminished native biological freshwater values. In the Rotorua Lakes, the introduction of further exotic pest fish species and invasive aquatic plant pest species has the potential to significantly impact on biological diversity.

The Rotorua Lakes are a major visitor attraction for both the domestic and international markets. They comprise 18 named lakes in a relatively small geographic area. Thus, the area has traditionally been known as the 'Lakes District'. Practically all activities undertaken by the 700 000 domestic and 600 000 international visitors that come to Rotorua each year are either directly or indirectly associated with the lakes. A number of the lakes are world-renowned for trout fishing. Due to their natural beauty and unique geology, a world heritage status is currently being investigated (Environment Bay of Plenty 2003).

These lakes are currently free of wild populations of some of the potentially more damaging of the pest fish species, such as koi carp (*Cyprinnus carpio*), catfish (*Ictalurus nebulosus*), rudd (*Scardinius erythophthalms*), tench (*Tinca tinca*), and perch (*Perca fluviatilis*), and invasive plant pest species such as *Hydrilla verticillata*. However, these aquatic 'pest' species are present in surrounding regions and have the potential to be inadvertently transferred to the Rotorua Lakes via boating equipment as fish, larvae, eggs or weed fragments. Furthermore, several highly invasive aquatic plant pests, such as hornwort (*Ceratophyllum demersum),* oxygen weed *(Lagorosiphon major)* and elodea (*Elodea canadiensus*), are already present in some Rotorua Lakes but not others. Given that there is considerable movement of boats and boating equipment between regions and among lakes, the spread and establishment of aquatic pest species presents a serious concern.

The impact of pest fish species in the nearby Waikato lakes has been well documented. For example, the decline and loss of submerged vegetation in several lakes has been attributed to high population densities of pest fish (Clayton & Champion 2004). Rudd feed directly on submerged plants, while other species (e.g. koi carp) are known to disrupt bottom sediments either directly through their feeding activities or through other behaviours (e.g. breeding). This has resulted in turbid and devegetated lakes, which contain reduced biodiversity and possess highly compromised prospects for ecological restoration (Clayton & Champion 2004).

Similarly, the impact of invasive plant pests has been well documented for the Rotorua Lakes (Atkinson 1989). Exotic macrophyte species have displaced indigenous species, with a resulting loss of biodiversity, increased nutrient cycling and sediment build-up. This has also been followed by devegetation of the lake as water quality has declined (Atkinson 1989).

To date, there has been no successful accidental or deliberate introduction of any pest fish species to the Rotorua Lakes (Lander 2004), and some lakes (e.g. Lake Rotomahana) have managed to stay free of invasive aquatic plants (Wells et al. 2001). However, there is considerable boat movement between Waikato waterbodies (including Lake Taupo) and the Rotorua Lakes, and among the Rotorua Lakes themselves (Crump 2004). Thus, the carriage of weeds, fish or fry on boat propellers, trailers and anchors provides an ongoing risk of accidental transfer of aquatic pest species from infested waterbodies.

The Department of Conservation (DOC) currently utilises public awareness programmes to encourage boat owners to clean and inspect their boating equipment for weeds, fish and fry prior to launching in any of the Rotorua Lakes. While this approach has been effective in reducing the risk of accidental introduction of weed and pest fish species to date, DOC now considers that an operational arm is required to strengthen the public awareness message and further reduce the risk of accidental introduction. Recent surveys have shown that 'wash-down' facilities have been requested by the boating public at large (Crump 2004). Therefore, there is a need to investigate the design and feasibility of constructing and operating wash-down stations for cleaning boating equipment en route to the Rotorua Lakes.

This report evaluates methods for removing pest organisms from boats prior to launching, and possible designs and locations of wash-down facilities. Information in this report is current as of June 2004. Therefore, some information and proposed solutions, particularly regarding the most important threats to biosecurity in the Rotorua Lakes and technological solutions, may now have changed and/or been advanced. The report is divided into three parts: part one considers the means to decontaminate boats and equipment; part two considers the requirements, placement and configuration of wash-down facilities; and part three undertakes a case study for implementation. It is envisaged that the results from this study will also have national application for the minimisation and reduction of risks of accidental transfer of aquatic plant pests and pest fish species between waterbodies.

2. The problem

2.1 PEST SPECIES

Various aquatic plant species (macrophytes) are potential pest species. They include *Egeria densa*, *Lagarosiphon major* and *Ceratophyllum demersum*, all of which are present in the Rotorua District, but not in all lakes. *Hydrilla verticillata* is not present in the district, but there is a risk of it being transported here. All these species can grow from small fragments and will survive for several days out of water if kept damp.

Pest fish species of greatest concern include:

- European or Koi carp (*Cyprinus carpio*). These are a major pest in Australia and some other countries. They are widely present in New Zealand, including the Waikato River system, close to Rotorua. They prefer still waters, and have a wide tolerance of environmental conditions. Koi carp may have a serious effect on water quality, due to the turbidity caused by their feeding activities. A large female may produce over 1.5 million eggs (McDowall 1990). These eggs are small (1.2–1.5 mm diameter) and adhesive.
- Catfish (*Ictalurus nebulosus*). These are natives of North America. They are also present in the Waikato River system and Lake Taupo. They have sharp spines, which may cause painful wounds to persons handling them. They are active predators, and may impact considerably on freshwater ecosystems (McDowall 1990). The females produce several hundred to a few thousand eggs, about 3 mm in diameter, and spawn several times per year. Both sexes may guard the young. Adult catfish can survive out of water for long periods if they remain moist (McDowall 1990). These characteristics greatly increase their chances of being spread from one waterway to another.
- Other introduced fish species, such as perch (*Perca fluviatilis*) and rudd (*Scardinius erythophthalms*). Both of these produce small (< 2 mm) and numerous eggs (McDowall 1990).

2.2 VEHICLES

The types of boats used on the Rotorua Lakes fall into the following categories:

- Outboard- or sterndrive-powered vessels. With a hull length ranging from about 2.5 m to several metres, these are readily transported between lakes by trailer. They vary greatly in size, layout and cost, but have the common property of portability, making them a potential means of transporting pest species.
- 'Launches'. Usually 5 m or more in length, these rely on an inboard motor with the traditional propeller and propeller shaft. They may be transported on a trailer, but their size, weight and vulnerable propulsion arrangements mean that this seldom happens. They are not considered to be a significant means of transporting pest species between lakes.

- Jet skis (personal water craft; PWC). These are small, fast and highly manoeuvrable. They are very portable, and often operated by members of the public with limited environmental awareness. They must be regarded as a potential means of transporting pest species.
- Sailing boats. Ranging from sailing dinghies to trailer yachts, these are portable, and contain potential spaces (such as centreboard cases, auxiliary outboards and trailers) in which pest species can be transported.
- Canoes and kayaks. Often made from high density polyethylene, these are light and very portable, often being car-topped. They contain few spaces in which pest species may lodge, and the slippery plastic from which they are usually made further reduces their risk factor.

Boat trailers are a significant potential means of transporting pest species. A survey of trailer structures that was carried out in a typical boat yard revealed that c. 40% of the trailers surveyed possessed a structure that had the potential to transport aquatic weed fragments, fish eggs or juvenile fish from one waterway to another (Table 1).

Outboard motors were also surveyed at the same boatyard. Yamaha and Evinrude/Johnson motors had cooling-water intake screens of 2 mm size. These are potentially capable of taking in carp, perch and rudd eggs. Mercury motors had intake screens of 5 mm, and these could also take in catfish eggs. Provided that the boats are not out of the water for prolonged periods, there seems to be no reason why fish ova could not survive in the cooling systems of these engines.

TABLE 1. TRAILER STRUCTURE SURVEY AT TELFER MARINE, ROTORUA, ON 18 MARCH 2004.

TRAILER STRUCTURE	NUMBER	PERCENTAGE
With open box sections (unsafe)	13	36
U-sections that could hold water	1	3
Built of ‘L’ or ‘T’ sections (fairly safe)	13	36
Closed box sections (safe)	9	25
Total number of trailers surveyed	36	100

3. Methods to remove aquatic pests from boats and trailers

Due to the structural nature of boats and trailers, several engineering challenges present themselves. Decontamination systems must be designed to remove weeds and fish eggs from the numerous nooks and crannies on both the boats and their trailers. Also, a means to decontaminate engine cooling intake reservoirs must be considered in any decontamination system design. Furthermore, the decontamination of sailing craft with a centreboard that is lowered for launch and raised prior to retrieval makes decontamination deep within the centreboard case difficult.

With these challenges in mind, the advantages and disadvantages of potential decontamination systems are discussed.

3.1 HIGH-PRESSURE WATER BLASTING

The most popular method of cleaning boats prior to launch is a high-pressure water blasting system. This is either through a hand-held wand that is used by the boat operator to systematically clean the boat, or an automatic system similar to an automatic car wash.

There are a number of weaknesses with the water blasting method, especially the automated system. While water blasting removes most weed and fish eggs from boats, heavily entangled weeds may not be completely removed, and any eggs not washed away still pose a risk. Also, those weeds and fish eggs that are successfully removed pose a risk of establishment if the wash-down pad is close to a water body, and there is also a risk of pests being transported via stormwater to a water body. Furthermore, the water blasting method uses a relatively large amount of water. The effectiveness of such a system could be considerably enhanced by using hot water: hot water would have better wetting and penetrating ability, and the high temperatures would also provide a biocidal ability. However, this method would entail extra capital and operating costs, and operator safety would need careful consideration.

Installation would require that all wash-down water be disposed of via a properly designed ground soakage system. This should incorporate suitable screen and filtration devices to avoid the in-ground soakage becoming clogged with organic debris such as aquatic plant fragments. These filters would need to be cleaned regularly.

In July 2004, an approach was received from a Cambridge-based company, Washtech Solutions Ltd, who are currently working on a boat wash station to be installed at boat ramps (N. O'Dwyer, Washtech Solutions Ltd, pers. comm.). This is primarily designed to wash salt water from boats and trailers, and is based on a number of high-pressure fan nozzles in a fixed installation. It has the advantage of being fast (20–30 seconds per boat), and has relatively low water consumption (c. 135 L per boat). It is to be marketed under the trade name of 'Inshorerinse'. Discussions with the principals of the company suggest that, with suitable modifications, this approach might be a reasonably effective and economical solution to the problem. The major modifications required would be the addition of a suitable nozzle arrangement to flush out the lower portions of outboard motor cooling systems, and a hand-held hose with suitable nozzle for flushing out hollow box sections of trailer frames.

3.2 LOW-PRESSURE WATER/CHEMICAL APPLICATION

Boats and trailers can also be washed down using a low-pressure water and chemical application. Chemicals that kill pest organisms (e.g. weeds and fish eggs) on contact are applied to the boat. While this method uses less water and has a higher success rate in eliminating pest organisms, a chemical reservoir is required near the wash-down facility and the use of chemicals poses its own risks: the effect of chemicals on people can be widely variable (i.e. some people could be extremely sensitive to a supposedly innocuous chemical). A range of organic and inorganic compounds could be used.

3.2.1 Simple organic compounds

The most obvious simple organic compound is a concentrated salt (sodium chloride; NaCl) solution, which would kill fish eggs, plant material, etc. by simple osmotic shock. This has the advantage of low cost and low mammalian toxicity. However, a prolonged exposure time would be required and it is unlikely that freshwater boat owners would relish exposing their boats to salt water. Other potential compounds include:

- Ammonium compounds, such as ammonium sulphate ($(NH_4)_2SO_4$), ammonium hydroxide (NH_4OH) and tertiary ammonium compounds. All present health and/or environmental hazards.
- Bromine compounds, such as activated bromine, sodium bromide (NaBr), bromine chloride (BrCl) and various proprietary compounds. All present health and/or environmental hazards.
- Carbon dioxide (CO_2) as a gas or as 'dry ice'. Presents health and safety issues, plus storage difficulties.
- Chlorine-based compounds, such as sodium or calcium hypochlorite (NaClO; $Ca(OCl)_2$), chlorine dioxide (ClO_2) and chloramines. All present health and/or environmental hazards.
- Copper compounds. A variety of organic (and inorganic) copper compounds and complexes. All present health and/or environmental hazards. Also may pose a corrosion hazard with metallic boat hulls, motors, trailers, etc.

A variety of compounds that are toxic to plants and animals could be used, e.g. halogens and heavy metals. However, this property also renders them unsatisfactory candidates due to their potential effects on the operator and their environmental implications

3.2.2 Oxidising agents

Oxidising agents include materials such as ozone (O_3; which could be generated on site), various chlorine compounds, or hydrogen peroxide (H_2O_2). Many of these compounds attack living cells vigorously and they are often of relatively low cost. However, they generally require an extended period of contact (often several minutes, depending on concentration and water chemistry), and may attack boat or trailer materials, particularly rubber. Safe storage is also an issue.

3.2.3 Organic biocides

A variety of organic compounds have been used as biocides. They include organophosphorus compounds (often of high mammalian toxicity) and organohalogen compounds (now generally out of favour or illegal due to their ability to persist in the environment and to bioaccumulate). However, as yet, there are no obvious candidates for removing aquatic pests from boats and trailers. Many such materials pose both safety and environmental issues, making them undesirable.

Formaldehyde (CH_2O) has been widely used as a biocide (as formalin—a 10% aqueous solution). However, this also poses health and environmental hazards.

3.3 HIGH-TEMPERATURE STEAM CLEANING

High-temperature steam cleaning works by blowing steam at c. 110°C onto infected surfaces to kill pest organisms on contact. The advantage of this method is that it uses very little water and the steam blast displaces pooled water that collects in trailer or boat structures. The key disadvantage is the risk posed to operators and potentially to various boat construction materials:

- Aluminium hulls would be little affected. However, such hulls are increasingly being paint-coated or treated with a transparent vinyl protective coating. The sudden thermal shock of a steam jet may loosen paint coatings (aluminium is a difficult material to securely bond paints to) or soften the vinyl coat. Similar observations apply to the aluminium alloy lower units of outboard motors.
- Glass-reinforced plastic (GRP or 'fibreglass') can be expected to withstand such temperatures, but the polyester resins used in earlier fibreglass boats may pose a problem. Similar observations apply to the fibreglass engine casings of most outboard motors.
- Timber boats are unlikely to be significantly affected, but their paint coats may be at risk, depending on the type of paint used.
- Polyethylene boats are becoming increasingly popular. They are constructed from high density polyethylene (HDPE) using a rotational moulding process. HDPE starts to soften significantly at approximately 110–130°C, depending on the particular grade and formulation; therefore, localised distortion could be a problem with these craft.
- Acrylic or polycarbonate are used as windscreen materials in many boats. These materials start to soften below the temperatures used in high-pressure steam. Therefore, operators would need to take care not to steam-clean windscreens, cabin windows, etc.

3.4 DRY HEAT APPLICATION

Dry heat application uses a heat blaster, which is popular amongst organic farmers as a weed control system. This is a simple system constituting a gas source, a pipe and a sleeved flame-throwing wand. The advantage of this method is its simplicity.

Problems with certain boat materials would occur, as described in section 3.3. The use of such a system, at least in rural or semi-rural areas, would entail the bulk supply and storage of Liquid Petroleum Gas (LPG), or similar, with the numerous associated regulatory, safety and environmental issues.

3.5 DIPPING

A dipping system could be similar to the decontamination dips that are used to prevent the spread of agricultural-related pest or hazardous organisms. Here, boats are towed through a low-lying bunded area that is filled with a chemical that kills pests on contact. This method has the advantage of immersing the entire boat and trailer in chemical solution to ensure 100% decontamination. It also has the advantage of a quick turnover, as boat operators need not get out of the vehicle: they simply drive through the dip and continue on their way. There is also less chance of negative effects on humans, as no aerosol is created during the decontamination process. As with any chemical application, it would be an advantage if the chemical could also treat the raw-water cooling system, as this would create an incentive to use the facility.

There are a number of weaknesses with this system. Firstly, the use of chemicals is always problematic, though in this case they would not need to be stored on site. Secondly, there are high construction and maintenance costs. Construction costs are increased because the dip and its bunded area would need to be covered, to avoid the creation of contaminated stormwater, and a system would need to be devised that lowers the boat and trailer after the tow vehicle has passed over the pit; this is necessary because the pit needs to be deep enough to decontaminate all the required surfaces of the boat and trailer, and such a depth would create a gradient too steep for most vehicles to drive through without decontamination fluid entering the vehicle. However, the pit cannot be too deep, as this could result in boats floating off their trailer and creating a road hazard, though by law all boats should be secured to their trailers. Thirdly, residual decontamination chemicals pose a risk to the water body when the boat is launched. The problems associated with the use of chemicals as described in section 3.2 would also apply.

3.6 DIPPING OR PRESSURE SPRAYING COMBINED WITH ULTRASONIC IRRADIATION

The use of ultrasonic irradiation is increasingly being investigated as a means of controlling or killing a variety of organisms. Ultrasonic sound has the ability to disrupt cell microstructure, and to collapse or implode gas vacuoles in cells, depending on the intensity and frequency of the ultrasound. To some degree, the frequency can be selected to target specific types of organisms.

Ultrasonic sound has been shown to kill and control cyanobacterial blooms under some conditions, and this approach is currently being tested on a small scale in Lake Rotoiti (Matt Bloxam, Environment Bay of Plenty, pers. comm.).

Ultrasonics have been used as a biocide in an on-land aquaculture hatchery, to kill eggs, larvae and adults of polychaete worms (Loubser & Dormehl 2000). Variable results have been obtained with plants. For example, the use of ultrasound to control the pest marine alga *Caulerpa taxifolia* was not successful (Bouderesque et al. 1996); however, high-intensity ultrasound has been successfully used *in situ* to kill plants of Eurasian milfoil (*Myriophyllum spicatum*), a major freshwater plant species (Soar 1985). To kill aquatic plant fragments and fish ova, a fairly high-powered ultrasonic source is likely to be needed, possibly radiating some hundreds of watts. This would probably need to be applied through a dipping arrangement, although ultrasonic pulses can be injected into a continuous jet of water, as in a water blasting arrangement. Such devices are made by VLN Advanced Technologies Inc., Ottawa, Canada, and are generally used in advanced surface cleaning operations. This option warrants further investigation. It could possibly be used in conjunction with the proprietary boat wash station described earlier in this report (section 3.1).

3.7 COMBINATION DIPPING/HIGH-PRESSURE WATER BLASTING

Combining the dipping system with the high-pressure water blasting system presents a number of advantages. Firstly, the dipping pit would not need to be as deep as it only needs to treat the trailer. Secondly, in addition to cleaning the boat, the high-pressure water blasting would rinse any chemical residues from the trailer. A disadvantage of this combined system is the large physical space required to accommodate both a dipping pit and a separate high-pressure wash-down area. The problems associated with the use of chemicals, as described in section 3.2, would also apply.

3.8 PREFERRED OPTIONS

When considering the various methods for boat decontamination, three key options present themselves for further investigation. These are:

- The use of ultrasonic irradiation, in a dip or pressure-washing facility
- The use of a modified version of the new (and shortly to be released) Washtech Solutions Ltd boat wash station
- A possible combination of both of these approaches

3.9 LESSONS FROM ELSEWHERE

Some use is made of boat washing stations in the USA. Most of these appear to be intended to curb the spread of the zebra mussel (*Dreissena polymorpha*) (D'Itri 1997). This species, which is originally from Europe (particularly the Caspian Sea), has spread prolifically through many North American waterways and is regarded as an invasive pest species, as it can clog water pipes and cooling intakes, and causes severe ecological damage. This organism can attach itself to boat hulls and fittings, and can invade bilges, live wells (for live bait) and engine cooling systems. Its ability to survive out of water for several days means that it can be unwittingly transported from infested waters by boat owners fairly easily (D'Itri 1997).

A number of boat washing stations have been established in an attempt to curb the spread of this pest. Most are based around a high-pressure hot-water washing system, which is claimed to be the most effective option (Rice 2004). Some jurisdictions require a sticker to be displayed, certifying that a boat has been inspected and/or washed before entering a water body. Without such a sticker, the boat is not allowed to be launched.

Recent research suggests that the zebra mussel is more likely to be spread in masses of aquatic vegetation hanging from boats and trailers (D'Itri 1997). For this reason, it has been suggested that suitable containers to deposit aquatic vegetation should be provided at launching ramps. It appears that zebra mussels only attach themselves to boats (and their fittings) that are left in the water for several weeks or more, and that weekend boaters are unlikely to spread zebra mussels by this route. It has been suggested that boat washing stations are worthless, and public campaigns are being run around this theme (FAPEL n.d.).

Hot water is an effective treatment for zebra mussels, but it is not always a practical alternative. Chlorine is probably the most popular treatment currently in use (NIMPIS 2004), but increased chlorination clearly contradicts the efforts of the Great Lakes community to reduce the amount of chlorine entering the ecosystem. Research has shown that potassium, bromine, ozone and ultraviolet light are possible alternatives to chlorine (NIMPIS 2004). To date, more than 30 other compounds have also been studied to determine their potential effectiveness against zebra mussels as well as their environmental side-effects (Sea Grant 2004).

4. Decontamination facilities and the decontamination network

4.1 DECONTAMINATION FACILITY DESIGN

We consider that any wash-down system must be convenient for boaties to use. This means it should be quick, simple and hassle free. An ideal wash-down facility would:

- Allow easy access from the road without the need to back-up boat trailers
- Be designed to accommodate a high number of users without having negative impacts on road and wash-down users
- Be able to be activated without the driver leaving the vehicle
- Take no more than 1 minute to clean the boat from pulling into the wash-down area to leaving it

As well as convenience, any facility design would need to address the risk of vandalism. Vandalism can be in the form of physical damage to the facility, or the facility being used by users other than boaties (e.g. those wanting to clean their vehicles). This can be addressed through location, security lighting, surveillance cameras, signage and, finally, enforcement.

4.2 LOCATION OF FACILITIES

When considering a decontamination network, it is important to remember that not all boats would require decontamination from both pest weeds and fish eggs. Rotorua District boat owners who only use their craft on the Rotorua Lakes pose a cross-contamination risk from weeds but not from fish. Only those boats from the Waikato and Taupo areas pose both weed and fish egg contamination risks. A decontamination system that removes or destroys weeds only is likely to be less complex and expensive than a system that addresses both pests. This is based on the assumption that eggs could get to places on a boat trailer that weeds cannot, and therefore would require a more sophisticated decontamination system.

Based on the above assumptions, we propose that the decontamination network includes two tiers. The first tier systems will address both fish and weed pests, and the second tier systems will address only pest weeds.

Decontamination facilities need to be located where they capture 100% of boats travelling to and, in some cases, between the lakes. This is often difficult, as some lakes (e.g. Lake Rotoiti) can be accessed from a number of roads. The ability to provide power and water for the facilities also needs to be considered when determining their location; however, the prime consideration must be their ability to 'do the job'.

Table 2 presents a proposed decontamination network, showing the ideal locations for Tier 1 and Tier 2 facilities that will protect the Rotorua Lakes from both between-lake and out-of-district contamination. The term 'ideal locations'

TABLE 2. PROPOSED DECONTAMINATION NETWORK SHOWING THE IDEAL AND CLOSEST POTENTIAL LOCATIONS FOR FACILITIES.

Tier 1 facilities would address both pest weeds and fish, whereas Tier 2 facilities would only address pest weeds.

	IDEAL LOCATIONS	CLOSEST POTENTIAL SITES	TYPE OF FACILITY
Out-of-district contamination			
1	State Highway 5, west of the Ngongotaha roundabout	Tarukenga Scenic Reserve or the eastern edge of Mamaku Forest Park	Tier 1
2	State Highway 5, between the Atiamuri turnoff and Old Taupo Road	Rest area within SH5 road reserve opposite Whakarewarewa's overflow car park	Tier 1
3	Tauranga Direct Road	Mangapouri Scenic Reserve	Tier 2
4	State Highway 33, north of the Maniatutu Road turnoff	Pokopoko Stream Scenic Reserve	Tier 1
5	At Lake Okaro	Near the boat ramp	Tier 1
6	Rerewhakaaitu Road, west of Brent Road	Within road reserve on Rerewhakaaitu Road just west of Brent Road	Tier 1
7	State Highway 30, east of Kawerau Rd East	On SH30 road reserve east of Kawerau Road East	Tier 1
Between-lake contamination			
8	Lake Okataina Road	Lake Okataina Road reserve near the entrance to the school camp	Tier 2
9	Tarawera Road, west of the first Okareka turnoff	Tikitapu Scenic Reserve west of Tarawera Road, just north of the Blue Lake	Tier 2
10	State Highway 30, just west of Lake Rotoma	Lake Rotoma Scenic Reserve	Tier 2

is used to reflect the fact that some locations would not be able to accommodate a facility (e.g. due to limiting terrain). Consequently, potential sites are also shown. The table has been divided into those facilities addressing out-of-district contamination and those addressing between-lake cross-contamination.

As well as permanent facilities, it may be advisable to have at least one mobile decontamination unit to help cope with high boat-traffic periods (e.g. trout season opening day).

A decontamination network could consist of existing facilities or of new facilities built on private or public land. The following sections discuss each of these options.

4.2.1 Existing facilities

With regard to costs, it would clearly be advantageous to utilise existing wash-down facilities rather than construct new ones. A number of service stations around the district offer either automatic or manual car-cleaning facilities that could conceivably be used for boat cleaning. While automatic car-washing facilities are not suitable for boat cleaning, it would be possible to add a boat-washing configuration to the existing facility (i.e. when the facility is to be used for cleaning a boat, the code number punched in by the customer automatically changes the method of cleaning inside the wash-bay). Manual facilities are usually coin-operated water blasters that can be used to clean a car or boat. Therefore, no modifications would be required for this method.

The use of existing facilities is a less desirable option for a number of reasons, however:

- Existing facilities are not always conveniently located for boaties
- The two cleaning methods are not the best for decontamination purposes unless appropriate chemicals are used, in which case they could pose a health hazard
- Most existing facilities are unlikely to have the physical space to handle a large number of boats at any one time

4.2.2 Locating decontamination facilities on private land

The alternative to using existing facilities is the construction of purpose-built new facilities. As new facilities require land, costs are prohibitive. Therefore, one option is to locate new facilities on private land in a way that creates a symbiotic relationship between the land owner and the wash-down facility. However, we consider that it is unlikely that land owners would allow a boat decontamination facility to be constructed on their land without some benefits flowing to them. Therefore, as funds are limited, it may be difficult to fund a land owner's requirements and meet the costs of maintaining the facility.

A more practical relationship is if the land owner receives benefits other than direct payment. The most likely candidates are businesses that benefit from increased 'foot traffic', such as petrol stations and road-side businesses, e.g. eating establishments, that would benefit from boaties using a decontamination facility in their proximity.

While this option seems an ideal win-win situation, there are significant barriers to its success. The first relates to logistics. Existing businesses wanting to locate a decontamination facility on their land with the hope of enticing boat owners to use their services (e.g. have breakfast before going to the lake) will be faced with the logistical difficulty of providing significant car and boat-trailer parking and manoeuvring areas. The more successful the business becomes at enticing boaties to use its services, the more space would be required. Few businesses in the Rotorua District have the room required for this type of logistical layout. The second barrier relates to long-term commitment. Businesses, by their nature, are dynamic. Therefore, an existing or new owner may decide at some point that they do not want a decontamination facility on their site.

4.2.3 Locating decontamination facilities on public land

Assuming that a lease with private land owners is cost prohibitive, the remaining practical option is to locate decontamination facilities on public land. The most obvious option would be to locate facilities on DOC-managed land or on road reserves.

As non-complying activities, decontamination facilities on road reserves would require resource consents under the Operative Rotorua District Plan[1]. However, there should be no resistance to this as long as environmental and engineering issues are resolved (P. Marshall, Senior Planner, Rotorua District Council, pers.

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1 www.rdc.govt.nz/Our+Services/District+Plan+and+Policy/District+Plan.htm (viewed 1 June 2006).

comm. March 2004). It should also be noted that under the same District Plan, such facilities would also require a Licence to Occupy (K. Lloyd, Development Engineer, Rotorua District Council, pers. comm., March 2004).

As most of the proposed locations for the facilities are on road reserves managed by Transit New Zealand (Transit) (Table 2), it was important to obtain their view. The proposed decontamination network was, therefore, discussed with Transit's National Planning Manager (D. Sylvester, Transit New Zealand, pers. comm.). Generally speaking, Transit conveyed that it is unlikely to object to decontamination facilities situated on its road reserves as long as environmental and logistical issues are resolved and Transit does not have to bear any costs. While Transit cannot charge a lease for occupying road reserves, a licence to occupy is likely to be required. One of the terms of this licence may be that the licence will be cancelled if Transit requires the road reserve for roading purposes. It should also be noted that Location 7 (Table 2) is unlikely to have sufficient room within a road reserve to accommodate a decontamination facility; therefore, adjacent land would need to be purchased.

4.3 CONSTRUCTION/OPERATIONAL COSTS

The method of decontamination will affect costs associated with establishing and maintaining a decontamination network. Of the two methods recommended for further consideration in this report, there is little information on ultrasonic irradiation. However, it can be assumed that this method is likely to be more costly than the second recommended method (a high-pressure, multiple-nozzle wash-down system, similar to that manufactured by Washtech Solutions Ltd).

In discussions with the owners of Washtech Solutions Ltd (N. O'Dwyer, pers. comm. July 2004), an indication of costs for establishing and maintaining a decontamination network was provided. This varied from \$100,000 to \$150,000 per facility, with a maintenance cost of c. \$5,000 per annum. This indication assumes that sites are ready for construction and have suitable services. Assuming the network includes ten facilities, this would mean a cost of \$1–1.5 million to establish the network, and c. \$50,000 per annum to maintain it.

The cost of providing ready-to-build sites for the network is difficult to determine and beyond the scope of this report. However, these costs would have to include:

- Obtaining resource consent from both the Rotorua District Council and Bay of Plenty Regional Council, as well as any other compliance costs
- Site clearance
- Construction of access to and from the site to meet council and/or Transit New Zealand standards
- Addressing stormwater and wash-down runoff
- Providing a reliable water supply
- Providing three-phase power supply to each site

4.4 INCENTIVES TO USE THE NETWORK

A boat decontamination network is only as good as its level of use. Ideally, and in the first instance, the incentive for boat users should be an uncontaminated lake/river. It is not unreasonable to expect that in most cases this incentive would be enough, and it would be driven by awareness through education, which is already occurring. To further encourage the use of decontamination facilities, a reward system could be put in place. For example, ticket printers that are activated by use of the wash station could be installed at each decontamination facility. Recipients of such tickets could then be eligible for regular draws for a worthwhile prize, such as fishing tackle, boating accessories, etc.

As a last resort, and in combination with creating awareness and providing information, enforcement could be considered.

4.5 MONITORING SUCCESS

The decontamination network should be considered successful if no pest organisms are introduced into the lakes. A number of methods are available for monitoring the success of the network. Since the lakes are already monitored, it would be advisable to monitor the use of the decontamination facilities themselves. This could be achieved through random visual monitoring to determine the number of boats passing the facility without using it.

When considering a monitoring system, it should be noted that not all boats would require decontamination. Some local boaties use their craft on one lake only. Indeed, this is the situation for a large number of anglers (A. Lang, Rotorua District Council Harbour Master, pers. comm., March 2004). This situation is advantageous, as it reduces pressure on the decontamination network. If enforcement were ever to be initiated, it would be a good idea to exempt those who do not pose a threat. For example, boaties could be issued a ‘one lake’ sticker that exempts them from using the decontamination network.

5. Case study—State Highway 5

While the optimum control of pest organisms in the Rotorua Lakes requires a network of boat decontamination facilities, it would be prudent to begin with a single site and monitor its success, so that improvements can be made to subsequent sites.

The first facility should be located where it will stop the worst pest organisms from contaminating the most sensitive lakes. A Tier 1 facility within State Highway 5 road reserve opposite the Whakarewarewa overflow carparking area (see Fig. 1) would best suit this purpose for the following reasons:

- The worst aquatic pests come from the Waikato and Taupo
- Signage can be used to direct those coming from the Waikato to the Whakarewarewa facility, thus potentially covering both high-risk areas

For the purpose of this case study, we assumed that a high-pressure blasting system would be used, similar to that manufactured by Washtech Solutions Ltd (see section 3.1).

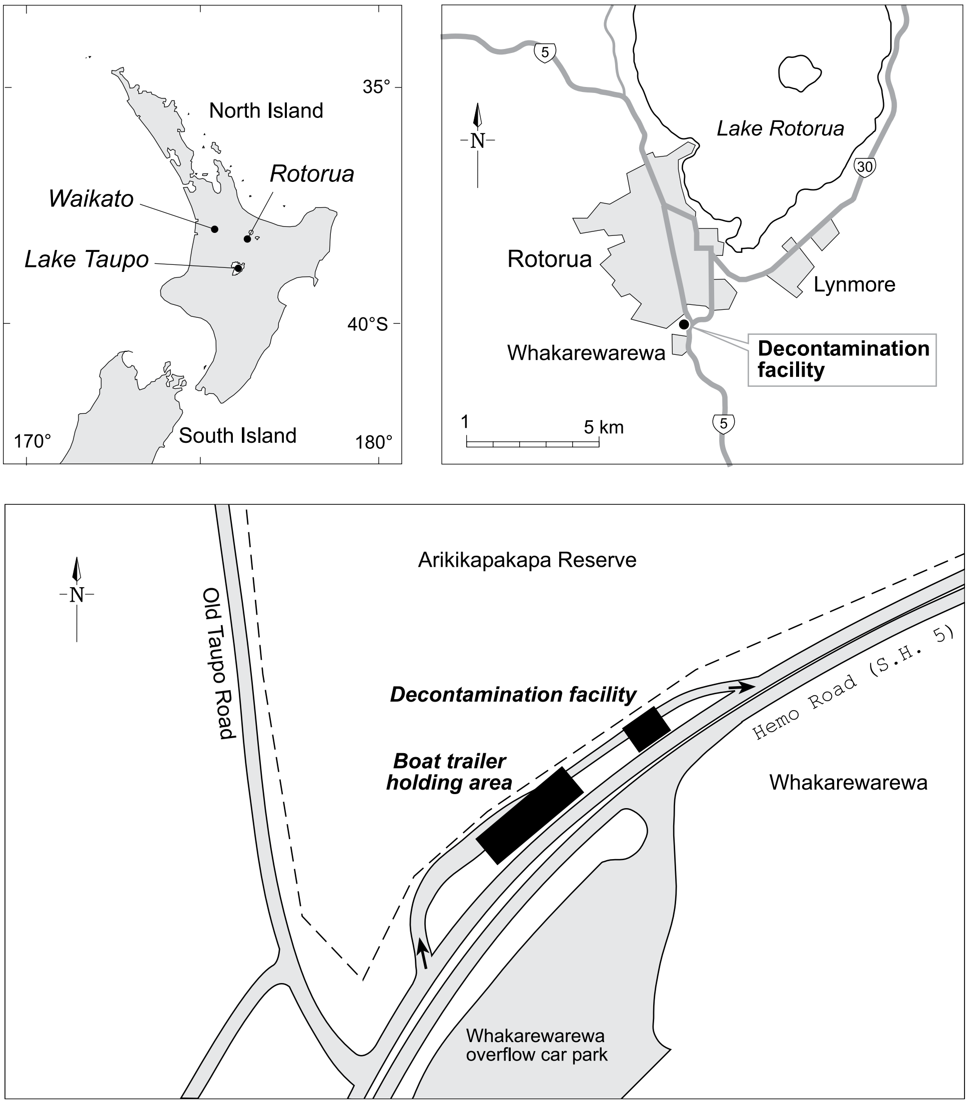

Figure 1. Location of proposed decontamination facility within the State Highway 5 road reserve opposite the Whakarewarewa overflow car park.

5.1 ACCESS

Access to the facility will be from State Highway 5, as shown in Fig. 1. The arrows indicate the entrance and exit to and from the facility, while the filled rectangles represent the facility itself and the boat/trailer holding area for use during busy periods.

5.2 PLANNING ISSUES

The case-study facility would be a non-complying activity and therefore would require a land-use resource consent from the Rotorua District Council and discharge permits from Environment Bay of Plenty. It is likely that key issues to be addressed in the resource consent application would relate to visual amenity, road safety and water quality.

5.3 OUTLINE OF COSTS

Costs associated with the case-study facility will include the cost of:

- Resource consent
- Construction
- Administration
- Maintenance

5.3.1 Resource consent

The main cost of compliance is likely to be associated with obtaining resource consent. Assuming the application is processed as notified, and no appeals to the Environment Court are lodged, this process could cost between $5,000 and $10,000.

5.3.2 Construction

Estimated construction costs associated with the case-study facility are shown in Table 3. From these figures, it can be assumed that construction costs will be between $140,000 and $180,000.

5.3.3 Administration

Administration costs include monitoring costs as well as normal administration activities. These are assumed to be between $2,000 and $4,000 per annum.

5.3.4 Maintenance

Washtech Solutions Ltd indicated that maintenance costs are likely to be between $4,000 and $6,000 per facility per year.

5.3.5 Summary of costs

Table 4 provides a summary of estimated costs to establish and maintain the case-study facility.

TABLE 3. ESTIMATED CONSTRUCTION COSTS ASSOCIATED WITH THE CASE-STUDY FACILITY ON STATE HIGHWAY 5 ROAD RESERVE.

REQUIREMENT	COST
Surveying and layout design	$5,000
Earthworks	$5,000
Road surfacing	$20,000
Water	$3,000
Power	$8,000
Stormwater	$10,000
Landscaping and signage	$2,000
Wash-down facility	$100,000
Total	$153,000

TABLE 4. ESTIMATED COSTS TO ESTABLISH AND MAINTAIN THE CASE-STUDY FACILITY ON STATE HIGHWAY 5 ROAD RESERVE.

ACTIVITIES	ESTIMATED COST		
Establishment costs			
Resource consent	$5,000	to	$10,000
Construction	$140,000	to	$180,000
Total	$145,000	to	$190,000
Annual costs			
Administration	$2,000	to	$4,000
Maintenance	$4,000	to	$6,000
Total	$6,000	to	$10,000

5.4 MONITORING SUCCESS

To monitor the success of the case-study facility, both the number of boats driving through the facility and the number of boats not using the facility should be counted.

6. Conclusions and recommendations

Biological diversity in the Rotorua Lakes is vulnerable to the establishment and spread of aquatic pests both from within and outside the district. In particular, these include pest fish species and a range of lake weeds. A network comprising ten decontamination facilities should provide complete out-of-district and among-lake protection from contamination. These facilities should be located on public land, such as DOC and road reserves. In general, Transit New Zealand has no concerns about locating decontamination facilities within its road reserves providing that compliance and occupation issues are resolved. Prior to establishing a complete decontamination network, it is advisable to establish a single 'case-study' facility and monitor its success.

A number of decontamination methods are possible. These include:

- High-pressure water blasting
- Low-pressure water/chemical application
- High-temperature steam cleaning
- Dry heat application
- Dipping
- Dipping combined with ultrasonic irradiation
- Combination dipping/high-pressure water blasting

Due to issues such as cost, user safety, efficiency and environmental effects, only high-pressure water blasting and dipping combined with ultrasonic irradiation are recommended for further investigation.

In the event that all potential options for a decontamination facility prove unsatisfactory, a greatly increased in-lake surveillance programme should be considered.

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