THE ROTORUA LAKES

Protection and Restoration Action Programme

ROTORUA DISTRICT COUNCIL

Te Arawa Maori Trust Board

Environment Bay of Plenty REGIONAL COUNCIL

Lake Okareka Catchment Management Action Plan

Environment Bay of Plenty
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Working with our communities for a better environment

Foreword

We are pleased to present the Lake Okareka Catchment Management Action Plan. The Action Plan is a “blueprint” for the future to improve water quality in the lake.

The values that people place on the lake environment are put at risk by the very presence of communities and commercial, industrial and agricultural activities. It is not a matter of people creating “pollution”. It is just that the common plant nutrients – nitrogen and phosphorus – naturally flow out of the places we occupy. Lakes are very sensitive to how much nitrogen and phosphorus they can process. Several of our lakes have too many of these nutrients, and algal blooms and reduced clarity are the consequences.

We see the Action Plan as the best way to meet community expectations to protect the long-term quality of Lake Okareka. The integrated nature of the Action Plan will ensure the desired outcomes are achieved. Don’t expect immediate changes but we can make a difference in the coming years.

Development of the Lake Okareka Catchment Management Action Plan has also provided a trial for the Action Plan process for other lakes. However, we recognise that the Lake Okareka process was a guide or example only. Action Plan methods and processes will be adapted to suit the individual characteristics and community of each particular lake catchment.

The Okareka community has been directly involved in the development of the Action Plan through representatives on the working party and smaller focus groups, and through submissions on the proposed Action Plan.

Rotorua District Council, Environment Bay of Plenty and Te Arawa Maori Trust Board look forward to working with the Lake Okareka community to achieve the Key Recommendations of the report.

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Chairman
Environment Bay of Plenty

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Mayor
Rotorua District Council

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Chapter 1: Key Recommendations

1 That Rotorua District Council proceed with urgency with a fully reticulated sewage scheme within the Lake Okareka catchment, that makes provision for limited additional dwellings within the catchment and amenities at Lake Tikitapu.

2 That Environment Bay of Plenty proceed to establish wetlands, pending the outcome of consultation, investigations and the granting of any resource consents required.

3 That Environment Bay of Plenty and Rotorua District Council discuss with individual rural landowners best practice options for land use management to control and reduce the nutrient load to the lake.

4 That Environment Bay of Plenty and Rotorua District Council make provision for land use changes in the Lake Okareka catchment, including:

- Regional and district plan changes;
- Consultation and negotiation with landowners on an individual or collective basis;
- Investigation of a regional park concept.

5 That Environment Bay of Plenty continue to evaluate engineering and treatment options, including but not limited to, the hypolimnetic discharge.

6 That Environment Bay of Plenty implement a monitoring programme to assess the ongoing nutrient load status within the catchment and the effectiveness of individual actions.

Chapter 2: Background

2.1 Purpose of the Lake Okareka Catchment Management Action Plan

The purpose of this Action Plan is to:

- Set out the factors that influence the long-term environmental quality of Lake Okareka;
- Outline the process used to develop the Action Plan;
- Guide Rotorua District Council and Environment Bay of Plenty's actions in the Okareka catchment to attain Lake Okareka's water quality goal;
- Inform the Okareka community, Bay of Plenty residents, decision-making authorities and other organisations about these actions to improve the water quality of Lake Okareka.

2.2 Long Term Water Quality Goal

2.2.1 Lake Okareka – a highly valued lake

Lake Okareka is a "mesotrophic" lake, meaning it has moderate levels of algal productivity and it is still reasonably clear and clean. Public reserves around the lake provide good access and allow people to value the experience of the natural environment and picturesque views. There are wildlife habitats, wetlands, a native forest backdrop to the east and partially to the other sides, and access to walkways. The lake is used extensively for recreation, such as boating, fishing, water skiing and bathing. All of this contributes to the high value that permanent residents and visitors place on Lake Okareka and its surrounds. A water quality decline over recent years threatens these values.

2.2.2 Lake Okareka's water quality target in the Regional Water and Land Plan

Through a separate consultation process Environment Bay of Plenty has set out a lake management policy structure in its Proposed Regional Water and Land Plan. In the Plan, an environmental water quality target is specified for each lake. This meets the desire expressed by the various lake communities that the water quality of the Rotorua Lakes should not deteriorate further and that some should be improved. The Plan also specifies that Action Plans will be used to identify actions to improve lake water quality.

The water quality target for each lake has been set as a Trophic Level Index (TLI) (see Appendix 1 for an explanation of the TLI). The higher the TLI, the lower the water quality. Lake Okareka's target TLI is 3.0, but its current TLI (measured June 2002 to June 2003) is 3.2.

TLI GOAL	CURRENT TLI
3.0	3.2

2.2.3 The strategy for the lakes of the Rotorua District

At the same time as the Regional Water and Land Plan was being developed, a joint "Strategy for the Lakes of the Rotorua District" was adopted by Rotorua District Council, Environment Bay of Plenty and Te Arawa Maori Trust Board. This policy document sets out the long-term protection, use, enjoyment and management goals for the Rotorua Lakes catchments. Seven project modules were identified as requiring implementation. The water quality project was identified as the highest priority and has aligned well with the Regional Water and Land Plan.

2.2.4 Calculations for the TLI goal

Rutherford and Cooper (2002) recommend that to achieve an average Trophic Level Index (TLI) of 3.0, each sub-index of the TLI should be reduced by 0.3. While the current averaged TLI for Lake Okareka is 3.2, the original average value of 3.3 has been used in the calculation. Rutherford and Cooper estimated that average lake concentrations of 5 mgP/m^3 and 183 mgN/m^3 would give an average TLI of 3.0. Current lake concentrations are 6.5 mgP/m^3 and 230 mgN/m^3, implying that a nutrient reduction of 21% is required.

Catchment loads were estimated using a well-established method (Hoare, 1980, 1987). The method relates the catchment load to the in-lake levels of nitrogen and phosphorus. An estimated 10.98 tonne/year of nitrogen and 0.41 tonne/year of phosphorus is being discharged annually from the catchment into the lake.

Load reductions needed to reach the target TLI are 2.32 tonne/year of nitrogen and 0.07 tonne/year of phosphorus.

Although Lake Okareka currently has the best water quality of the five Rotorua Lakes exceeding their long term TLI, it is considered to be at a point where future deterioration could increase markedly.

2.3 Causes of Lake Okareka's Water Quality Deterioration

2.3.1 Development within the catchment

The Lake Okareka catchment has residential and rural communities but not intensive agriculture. Development within the catchment has resulted in the build up of nutrients in the lake waters and lake bed sediments. Most development and land use activities in the catchment contribute to the nutrient load.

2.3.2 Nutrient absorption/release from soils

The soils of the Rotorua Lakes catchments tend to be phosphorus-absorbing because of the allophane clay content. However, water from cold springs tends to be naturally high in phosphorus (Timerperly, 1983) because of the dissolved minerals from the underlying volcanic geology. The extent and nature of activities carried out on the land can lead to phosphorus runoff or leaching into waterways.

Pumice soils of the central volcanic plateau, in their natural condition, tend to have a low nitrogen content (Vincent, 1980). In a forest situation nitrogen is recycled within the forest and a small amount is lost to leaching. Increased levels of nitrogen exist in pasture soils from nitrogen fixing plants and fertiliser application, and more nitrogen is lost to runoff and leaching.

2.3.3 Grazing animals

Grazing animals enhance the turnover of nitrogen, returning some nitrogen to the soil in dung. Nitrogen in urine spots has been shown to be a significant source of nitrogen leached from pasture (Russelle, 1996), particularly during the autumn to spring period. Generally, the higher the intensity of grazing-based farming, the higher the levels of nitrogen and phosphorus entering water bodies.

2.3.4 Septic tanks

Sewage from human communities also contains nitrogen and phosphorus. Septic tank effluent disposal releases nitrogen into groundwater, which then flows into streams or lakes. Estimates of nitrogen input from septic tanks into Lake Okareka vary from 16% to an upper limit of 44% of the total load from the catchment. Phosphorus from septic tank effluent can be efficiently removed in allophanic soils, but absorption sites on allophane clay particles may become saturated. Once this happens, the soil particles can no longer absorb phosphorus.

2.3.5 Waterfowl

Waterfowl recycle nutrients within a lake as they graze on aquatic plants and return nutrients to the water as dung (Bioresearches, 2002). They can increase the levels of soluble nutrients in the water, which are then available for algal growth. Waterfowl are not a driver of total lake nutrient levels in the way that external inputs from the catchment are. Waterfowl can cause localised bacterial levels to increase if they congregate in large numbers. But overall, waterfowl are not considered a significant source of nutrients in the Lake Okareka catchment.

2.3.6 Nutrient release from anoxic lake bed sediments

Lake Okareka is slowly showing increasing evidence of oxygen depletion (anoxia) in the bottom waters towards the end of summer, which causes nutrients (particularly phosphorus) to be released from the lake bed sediments. If the level of nutrients released increases it will further enhance algal growth (resulting in decreased clarity) and cause even greater depletion of oxygen in the lower levels of the lake. This cycle of deterioration is much more difficult to reverse than it is to avoid. It is therefore important to act now to safeguard the water quality of Lake Okareka for the future.

2.3.7 Land use in the Lake Okareka Catchment

Table 1 and Figure 1 show the various types of land cover in the Lake Okareka Catchment at 2003. Table 2 and Figure 2 show a detailed breakdown of the type of farming on pasture. Scientists have studied the average output of nitrogen and phosphorus from different land uses and have categorised these with typical nutrient export coefficients. Once the export coefficients have been determined for the land uses in a catchment, a spreadsheet model can be constructed to illustrate an annual nutrient budget. The budget has been updated from the draft working papers, following a detailed review of the catchment land use and matters raised by members of the Action Plan working party. This annual nutrient budget for Lake Okareka is presented in Appendix 2.

Table 1 Land Cover (2003) in the Lake Okareka Catchment

Land Cover	Area	
	ha	**%**
Bare ground	13	0.7
Indigenous forest	690	35.2
Exotic forest	135	6.9
Grassland[1]	615	31.4
Exotic scrub	72	3.7
Mixed woody mosaic[2]	19	1.0
Unspecified woody vegetation	15	0.8
Built urban	43	2.2
Wetlands	12	0.6
Lake reeds	2	0.1
Water[3]	342	17.4
Total	**1958**	**100**

Table 2 Farming type (2003) on Pasture in the Lake Okareka Catchment

Land Cover – Grassland	**Area**	
	ha	**%**
Sheep and beef	484	78.7
Sheep, beef and deer	28	4.6
Sheep	49	8.0
Beef	33	5.4
Deer	5	0.8
Other	16	2.5
Total	**615**	**100**

[1] Grassland also includes retired areas along the lake edge of Playne's property, the recreation reserve on northern side of lake, the grassed area by ski lodge, the small areas of grass within planted forest etc.
[2] Mixed woody mosaic is areas of mixed exotic and native bush e.g. mixed willow and native bush adjacent to Millar Road.
[3] The lake area is 342 ha and there are direct inputs of nutrients to the lake from rainfall.

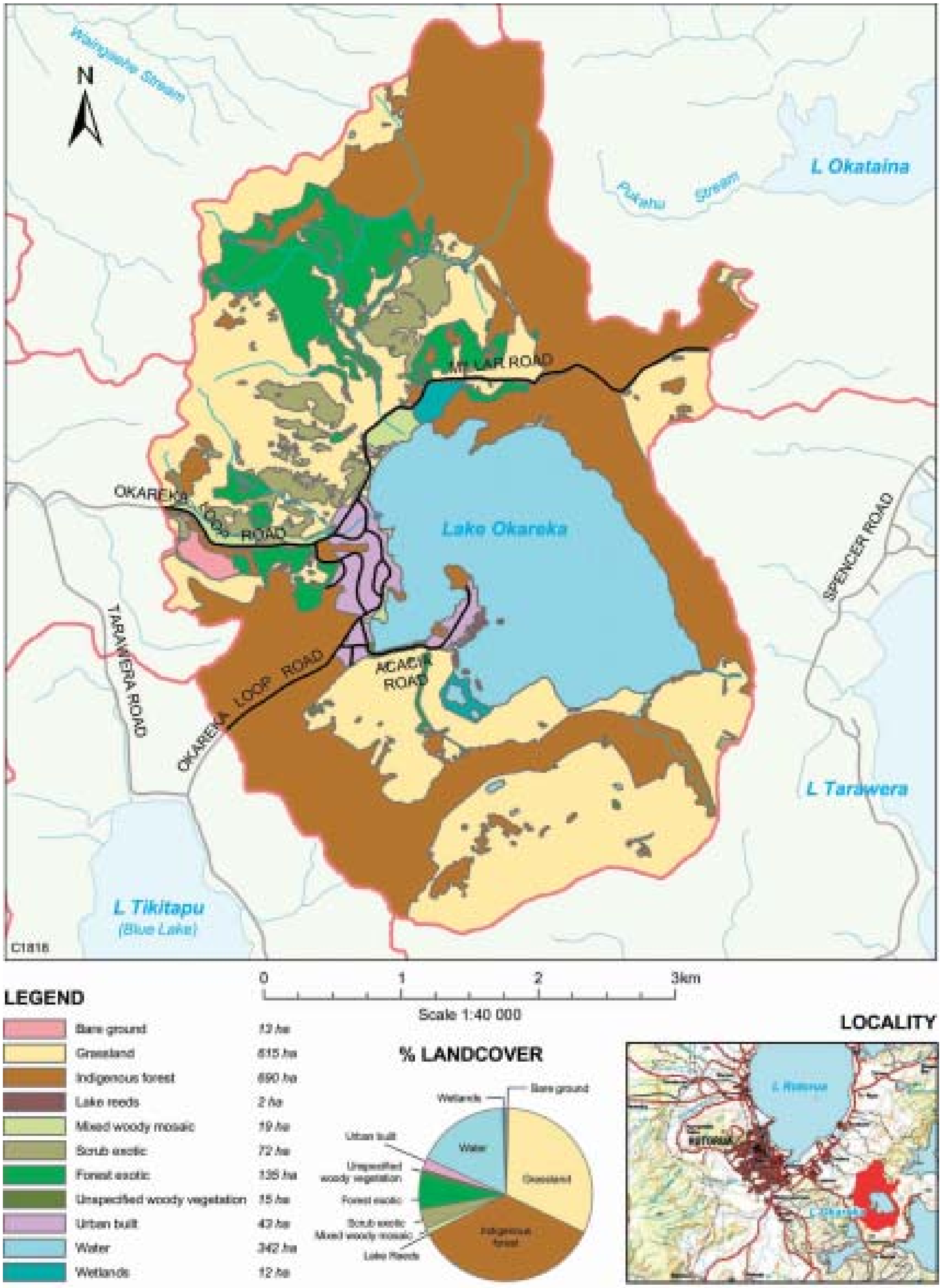


Figure 1 Land Cover (2003) Lake Okareka Catchment

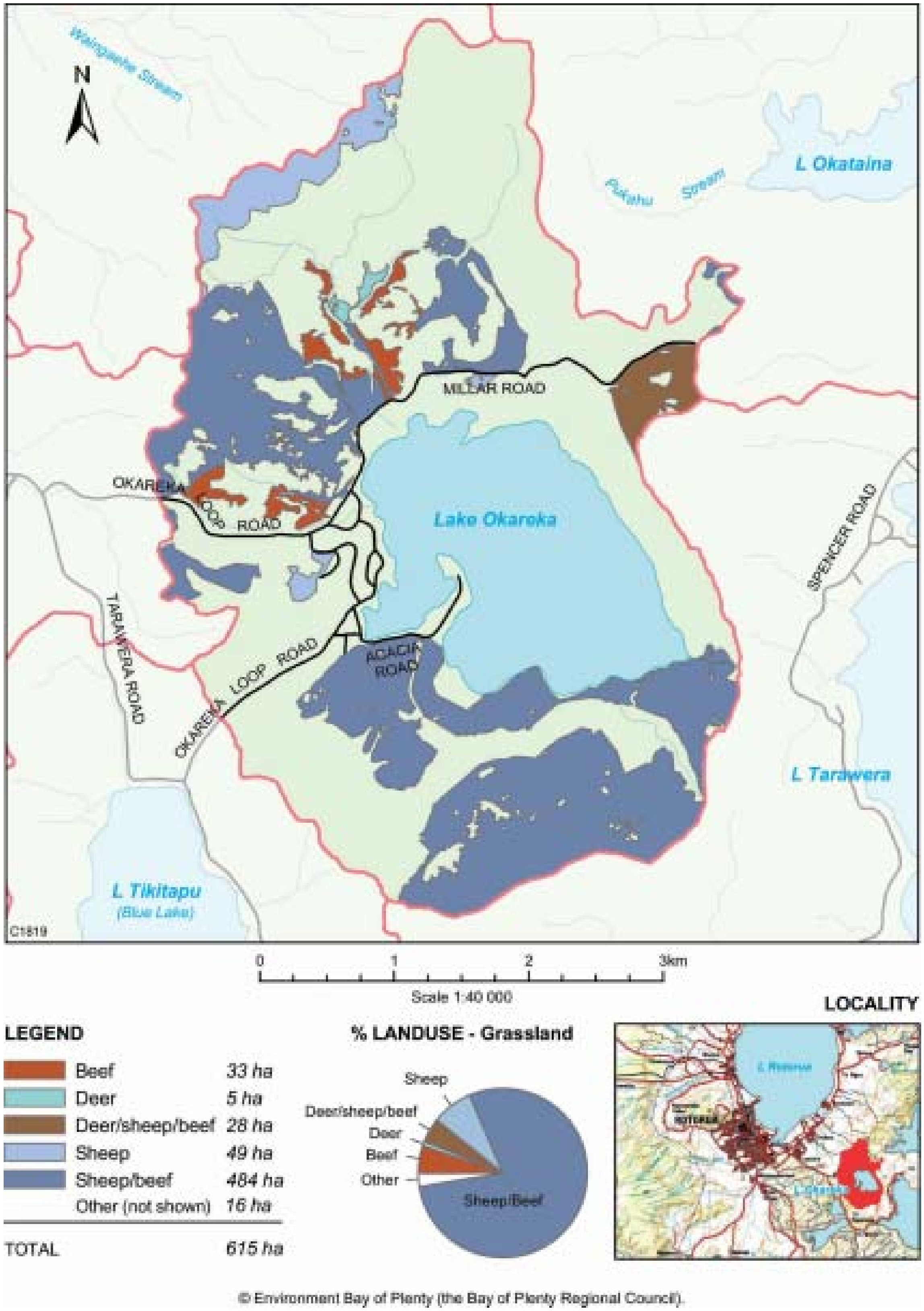


Figure 2 Land Use (2003) of Pasture – Lake Okareka Catchment

2.4 Level of Nutrient Reduction Required

2.4.1 Nutrient concentration and nitrogen / phosphorus ratio

There are two aspects for consideration when assessing long-term nutrient reduction goals. These are: nutrient concentrations in the lake water and the nitrogen to phosphorus ratio (N/P).

Higher nutrient concentration increases the amount of food that algae use, swelling their numbers. As algae cells die and sink, their decomposition uses up oxygen in the bottom waters. A lack of oxygen causes lake bed sediments to release nitrogen and phosphorus. So by reducing the nutrient concentration it is hoped that the cycle of nutrient releases from the lakebed sediments can also be reduced.

It is this release of nutrients (particularly phosphorus) from the sediments that can significantly alter the N/P ratio, driving it downwards to a level that favours the development of blue-green algal blooms. The current ratio of N/P in Lake Okareka is about 36, so the lake is labelled "phosphorus limited". This means that it is a lack of phosphorus that limits algae growth. However, the best technical advice is to reduce both nitrogen and phosphorus inputs into the lake.

2.4.2 Initial nutrient reduction targets

To reach the Lake Okareka TLI water quality goal of 3.0, it has been calculated (Rutherford and Cooper 2002) that the annual nutrient load to the lake from the catchment needs to be reduced by 2.32 tonnes of nitrogen and 0.07 tonnes of phosphorus (as measured from the 2003 baseline).

The calculation is based on the in-lake quality and is not affected by any uncertainties in determining the catchment nutrient budget.

Nitrogen	**Phosphorus**
2.3 Tonnes	0.07 Tonnes

2.4.3 Revised nutrient reduction targets

The Action Plan working party discussed the need to be conservative when determining the actual removal targets for nitrogen and phosphorus to account for margins of error in the nutrient budget and nutrient reduction target. There is no simple way to calculate what an appropriate buffer would be, however the consensus was that a 10% level would be appropriate. On this basis the revised targets are:

Nitrogen	**Phosphorus**
2.5 Tonnes	0.08 Tonnes

The practical implementation required to reach these targets may be imprecise, though monitoring of nutrient reduction from individual actions will aim to be as accurate as possible. A lack of pinpoint accuracy for scientific figures does not negate the clear need for action.

2.5 Working Party Process

2.5.1 Role of the working party

Draft working papers were prepared in early 2003 by Environment Bay of Plenty, which gave background information on nutrient reduction targets and options to achieve these targets.

A working party of representative stakeholders was established to assist in the evaluation of options for the required catchment nutrient load reduction. The members of the working party are listed in Appendix 3. The working party met during 2003, on 30 April, 28 May, 6 August, and 22 October.

2.5.2 Evaluation of options

The working party did a SWOT analysis (strengths, weaknesses, opportunities, threats) of various options. Several focus groups were established to investigate a number of the options in more detail. They were reported back to the full group.

Criteria and weightings were developed by the working party for evaluating the various identified options. The criteria were developed with regard to the matters raised in the SWOT analysis. The options were then evaluated and ranked. The method and calculations used by the working party is outlined in Appendix 4.

2.5.3 Ranking of options

The final ranking of options by the Lake Okareka Catchment Management Action Plan working party is listed in Table 3.

Table 3 Rank of Lake Water Quality Improvement Options

Rank	Option
1	200 ha land: buy – convert to low nutrient status – sell
2	200 ha land conversion: pasture-to-trees
3 =	Sewerage reticulation of entire Okareka settlement
3 =	400 ha land conversion: pasture-to-trees
5	Cartage of Okareka sewage to Rotorua sewage treatment plant
6	100 ha land conversion: pasture-to-bush settlements/lifestyle blocks
7	Sewerage reticulation of settlement excluding lakeside properties (because of excavation difficulties for pipes and pumps beside the lake)
8 =	Hypolimnetic discharge and treatment
8 =	Riparian plantings (not including wetlands)
10	Wetland development
11	On-site effluent treatment plants with nutrient stripping
12	Treatment walls in the ground

2.5.4 Reconvening of the Action Plan working party

The Action Plan working party will be reconvened periodically to discuss the success/failure/otherwise of the various actions in the Plan, and to propose amendments to the Action Plan if necessary. These post-Action Plan meetings can also give comment on the proposals for land use change, wetlands, sewerage schemes, and other topics as they arise.

2.6 Development of the Lake Okareka Catchment Management Action Plan

2.6.1 The proposed Lake Okareka Catchment Management Action Plan

The analysis by the working party, combined with information on the various options was drafted into the proposed Lake Okareka Catchment Management Action Plan. The proposed Action Plan also contained eight summary recommendations from the working party to Rotorua District Council and Environment Bay of Plenty.

The proposed Lake Okareka Catchment Management Action Plan was open for submissions from 16 December 2003 to 20 February 2004. On 25 January an Open Day on the proposed Action Plan was held at Okareka. Members of the community listened to presentations and asked questions, discussed the proposed Action Plan with council staff, and learned about the submissions process.

After the public submission period closed, staff summarised all written submissions received on the proposed Action Plan, and drafted recommendations to a hearing committee on whether the submission points should be accepted, rejected, or accepted in part. This was presented as a Staff Report on Submissions.

2.6.2 Lake Okareka Catchment Management Action Plan Hearing

Submitters to the proposed Action Plan were given an opportunity to present their submissions in person at a public hearing. The hearing was held at Rotorua District Council chambers on 19 and 20 April 2004. The hearing committee was made up of representatives from each of the three strategic partners involved with the Rotorua Joint Lakes Strategy Committee: Environment Bay of Plenty, Rotorua District Council and Te Arawa Maori Trust Board.

After the hearing, the hearing committee deliberated on the written submissions and presentations. Their decisions were incorporated into a report: Hearing Committee's Decisions on Submissions. From this report the Lake Okareka Catchment Management Action Plan was changed to incorporate the hearing committee's decisions.

2.6.3 A guide for future Action Plans

The process for Lake Okareka has produced the first completed Action Plan. As such it may be used as an example for other lakes' Action Plans where appropriate. However each lake has its own unique problems and solutions. The format and process for other Action Plans will vary to meet the specific issues and situations of each lake.

2.6.4 Use of Action Plan as evidence of consultative process

The working party process used to create the proposed Lake Okareka Catchment Management Action Plan also meets the criteria in the Local Government Act 2002 for a special consultative process. This gives extra weight to the Action Plan's contents by showing that due process has been carried out. The Action Plan's recommendations can be integrated into both Councils' Long Term Council Community Plans.

The Action Plan and summary of submissions is also evidence of the strong community impetus for action to improve the water quality of Lake Okareka. It will be used to lobby local Ministers of Parliament, the Minister for the Environment and central government for assistance to ensure that the recommendations contained in the Action Plan are actioned as soon as possible. The Action Plan can also be included as part of briefing papers to Cabinet.

Chapter 3: Okareka Sewerage Scheme

3.1 Nutrient Reductions and Other Benefits

3.1.1 Current sewage treatment at Okareka

Almost all the urban and rural dwellings within the Lake Okareka catchment are currently serviced by the traditional method of on-site effluent treatment - septic tanks and soil soakage systems. The contribution to the nutrient load of Lake Okareka from these systems has been recognised as highly significant.

Basic septic tanks were never designed to be efficient nutrient removal systems. They act as solids and scum retention units where little wastewater treatment occurs. At best they can reduce suspended solids by 80% and total nitrogen and phosphorus by 25% (Gunn, 1994).

The treatment of wastewater from these systems is reliant on the interaction between the effluent and the soil as it passes through the soakage field to the groundwater. Adequately sized, well-maintained septic tanks and sufficiently large, well-sited soakage fields are prerequisite to a properly functioning septic tank system. At a number of Okareka properties the ground conditions and location of treatment fields are not adequate for efficient treatment.

3.1.2 Pathogen Risk and Nutrient Input

Pathogens (disease-causing agents) are inherent in any sewage treatment system. The septic tank system, especially if not performing to its optimum, has poor pathogen removal. Concerns have been raised regarding effects on lake water quality of having a large number of these systems in close proximity to the lake edge.

Following investigations to quantify both the nutrient source and pathogen contamination risk it was concluded that:

- 16-44% of the total inorganic nitrogen input to the lake comes from septic tanks (Ray & Timpany, 2002). A theoretical average of 10g/person/day nitrogen gives an estimate of 22%.

- To meet Bathing Water Standard Guidelines a minimum set-back distance of 16 metres between the lake edge and the effluent treatment field is recommended. To meet the NZ Drinking Water Standards for viral contamination a minimum set-back distance of 51 metres is recommended (Pang et. al., 2001).

3.1.3 Benefits from an alternative treatment system

Reducing the number of basic septic tanks in the Lake Okareka catchment in favour of other sewage treatment options should have almost immediate benefits in terms of nutrient reduction and will greatly reduce the risk of contamination from pathogens associated with traditional on-site sewage treatment.

3.2 Sewerage Reticulation Network

3.2.1 Full reticulation investigation

The construction of a fully reticulated sewerage scheme for Okareka has been given the highest priority by the Okareka community. The result of the Lake Okareka Action Plan development has been reported to the Rotorua District Council Finance and Policy Committee. The draft Rotorua District Council Ten Year Plan also indicates that works on the scheme are proposed to start in 2004 and be completed in 2008.

The exact design of the system will be based on the results of a feasibility study to be undertaken in July – September 2004.

Wastewater would be collected from individual dwellings and piped to a central treatment and disposal unit. The proposed Activities Programme (refer *3.8*) describes a feasibility investigation of the options for reticulated collection of sewage. In a controlled, engineered environment there is the ability to treat the effluent to a very high standard prior to disposal to the receiving environment.

3.2.2 Reticulation options

- Conventional Gravity and Pressure Mains. This would collect wastewater (sewage) from individual dwellings and pipe it to a central disposal unit. Septic tanks would be cleaned and de-commissioned as properties were connected to the system.

- Septic Tank Effluent Pumping System. This would also collect wastewater (sewage) from individual dwellings and pipe it to a central disposal unit, but septic tanks would not be subsequently de-commissioned. Instead, the septic tanks would form an integral part of the reticulation system.

Irrespective of the reticulation system installed, the wastewater from each residence will be piped to a central treatment area. An investigation of the treatment options will be included in the feasibility study.

3.2.3 Treatment and disposal sites

Local treatment and disposal will require the identification and selection of potential sites in the Lake Okareka catchment. The final choice is to be confirmed during October – December 2004.

3.2.4 Indicative layout of pipelines and pumps

An indicative layout of pipes and pumps based on the available contour information and a walk over survey was shown to the community, working party and hearing committee. It must be stressed that without the results of the feasibility study and further consultation with all the potentially affected landowners the exact design and location of the system is not yet known.

The sizes, locations and grades of the proposed sewage pipelines and pump stations will be developed in the preliminary design phase to be carried out in January – July 2005.

Although a number of pipes could be located in the road reserve, there could be a number of cases where it may be easier, less costly and efficient in terms of the overall system to cross private properties. Consents from property owners as required by the Local Government Act 2002 and the Resource Management Act 1991 will be sought prior to proceeding with construction.

3.2.5 Pipeline materials

Pipeline materials could be either Polyvinyl Chloride or Polyethylene (plastic pipes) and the construction method could be either open trench or directional drilling depending on the difficulty of specific sites.

3.2.6 Individual property connections

Connections to the newly installed sewer reticulation system will be provided up to the boundary of each property. It will then be the individual property owner's responsibility to connect their wastewater plumbing system to the service connection provided. Rotorua District Council can require this under the Local Government Act 2002.

3.3 Sewerage Reticulation Service Area

3.3.1 Proposed service area

The proposed service area will include all the Rural E (lakeside settlement) properties within the urban area of the Lake Okareka catchment.

The service area will also include the campsite and public facilities located at Lake Tikitapu (Blue Lake). The small additional load generated and the relative proximity to the Okareka settlement makes this is a viable proposition. The addition of sewered facilities at popular walkways, reserves and boat ramps in the catchment is also to be evaluated by Rotorua District Council in conjunction with Environment Bay of Plenty.

The full extent of the proposed service area will ultimately depend on the options chosen as a result of the feasibility study.

3.3.2 Potential future service areas

As the Okareka catchment is relatively small, it is possible to extend the service areas with modern piping and pumping technology. A fully reticulated scheme offers the flexibility to service areas away from the current settlement that may be in visually unobtrusive areas of the catchment. This could include the 'Rural A' properties south of Acacia Road and west of Ridge Road. Additional capacity should be built into the system to accommodate the estimated number of limited new residential properties that may be developed in the future through infill and subdivision.

3.4 Sewage Treatment Plant

3.4.1 Model of treatment plant

The proposed treatment option may be an SBR (Sequencing Batch Reactor) plant. The plant or reactor is fitted with aeration systems. The treatment process, which is a natural biological process, provides an environment for bacteria within the effluent to convert nitrogen into gas. Phosphorus is removed as it becomes attached to the sludge and removed from the liquid waste stream. The settled sludge can then be finally disposed to landfill, or may in future be used in the production of combustible biosolids.

3.4.2 High rate of nutrient removal

This process has an established performance in nutrient removal. Existing installations in New Zealand have been proven to remove 85 – 90% of nitrogen and 10% – 15% of phosphorus from the effluent. Further removal rates of nitrogen are achievable by the addition of carbon (from methanol), or addition of lime to remove phosphorus. Facilities for chemical additions could be retrofitted as the need arises.

3.4.3 Treatment plant site

An option for local treatment is to construct the treatment and disposal plant at a single site to allow for the greatest efficiencies in operation and maintenance of the system. SBR plants cover a small area and can be designed to be visually unobtrusive even when constructed close to residential areas. Photographs of a similar installation in Taupo are seen in Figure 3.

The site requirement is estimated to be 3 hectares. The initial walkover and desktop studies identified two possible sites. As clarified through the working party and submissions process, without further detailed evaluation studies and consultation with all the potentially affected landowners, the exact location and design of the treatment system, pipes and pumping infrastructure is not yet known.

If this option is chosen the exact location will be developed during the preliminary design phase.

Figure 3 Aerial Views of Acacia Bay, Taupo, SBR Treatment Plant (within the grove of trees)

3.5 Effluent Disposal System

The disposal system for local treatment would be a rapid infiltration/bed/trench system. This involves the construction of a series of covered trenches where the treated effluent from the SBR plant is disposed through a system of perforated distribution pipes. This system requires a smaller area and is less obtrusive than spray irrigation.

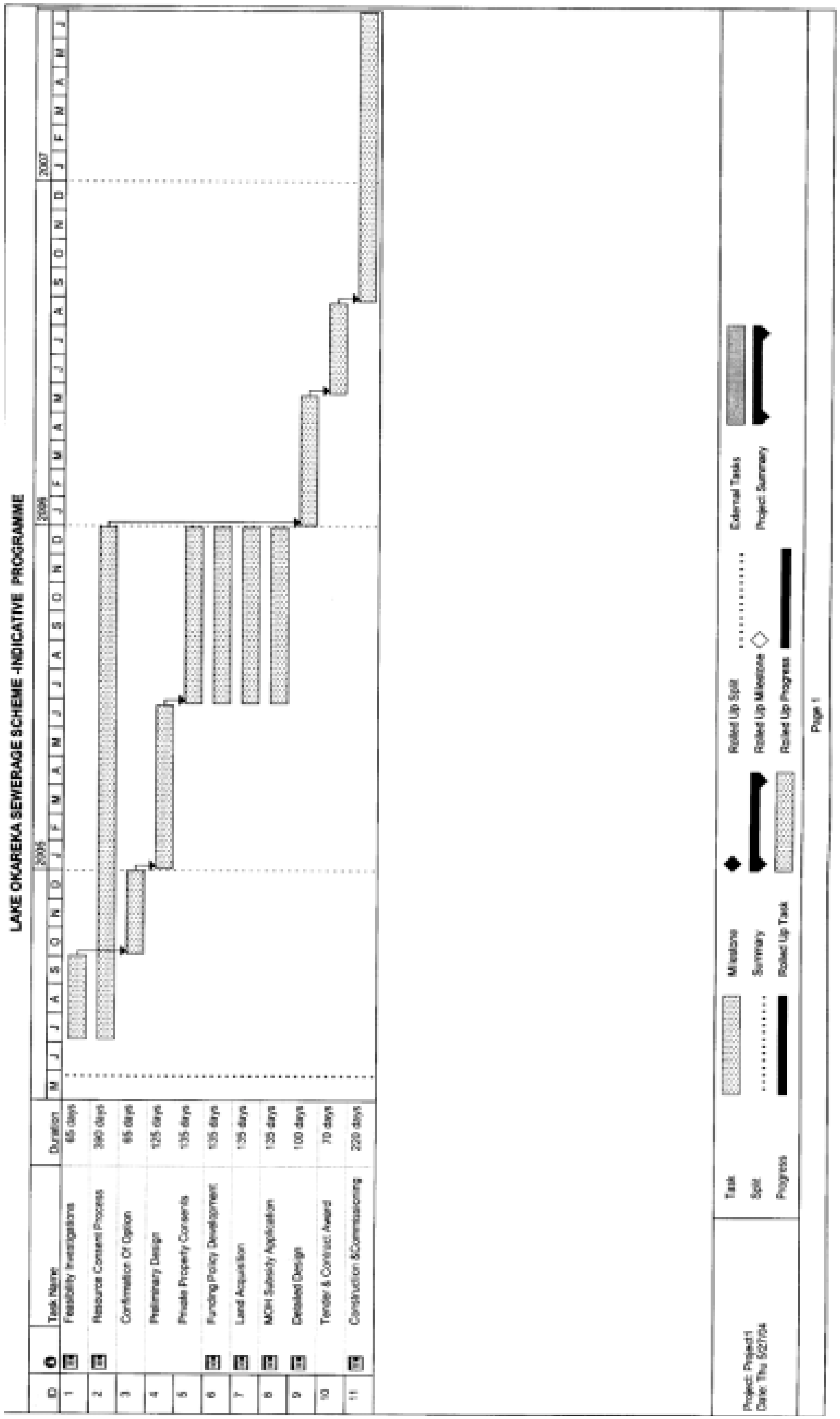
3.6 Inter-catchment Flows

There is no practicable way to stop natural inter-catchment hydrological flow. As sewage treatment plants are not capable of 100% removal of nitrogen and phosphorous there will continue to be inter-catchment nutrient leakage. The Action Plan working party and many submitters to the proposed Action Plan supported the view that major sewerage systems should preferably be stand-alone (i.e. the effluent treatment confined and remedied within an individual catchment and not shifted to another catchment). As a long-term strategy the contaminant load in individual catchment waters would be treated at source.

3.7 Timeframe for Implementation

Deadlines for the implementation of this scheme may vary, depending on the process of landowner negotiation, design and construction work that must occur. If designation routes or resource consents are appealed or agreement with landowners is difficult, the timeframes will become longer. Alternatively, if everything proceeds smoothly, the sewerage scheme may be implemented sooner than expected. A programme of implementation is detailed in Figure 4.

Figure 4 Indicative Sewerage Implementation Programme and Timeframes



3.8 Activities and Proposed Programme

3.8.1 Feasibility investigation of options

Rotorua District Council will investigate the feasibility of the following options:

- Reticulation: Conventional gravity and pressure mains, or Septic Tank Effluent Pumping System.

- Treatment and Disposal: Local treatment and disposal (site identification and selection).

3.8.2 Resource Management Act 1991 process

This area is zoned *Lakes A* under the proposed Variation 12 to the Rotorua District Plan.

Advice was sought from Sigma Consultants regarding the implications of Variation 12 to the construction of the proposed sewerage scheme. They stated that because of the restrictive nature of the District Plan Earthwork Rule, the project at best could be a Discretionary Activity, but may fail to meet rules for vegetation clearance, structures, sewerage collection and disposal, viewpoints, buffers and noise.

As a provider of public infrastructure, Rotorua District Council can be a requiring authority and use a designation process (under the Resource Management Act 1991). Requiring authorities must balance the public benefits of the proposed work alongside the environmental effects, which can mean resolving conflicting objectives.

Considering the above, Sigma Consultants recommended that Rotorua District Council proceed with a Notice of Requirements to Designate. This process is estimated to cost about $30,000 to $40,000. It will provide a comprehensive consent for the scheme. The designation is consistent with Council's practice for utilities elsewhere and is suited to projects such as a sewerage scheme.

Regional consents for discharge and earthworks will also be required in addition to the District Plan Designation process.

The intention is to start with the designation process at the same time as the feasibility investigations, and to progress all the resource consent applications in conjunction with the engineering investigations works.

The time allowed for this activity does not take into account any delays resulting from appeals to the Environment Court on resource consents or the designation.

Rotorua District Council's intention is not to proceed with the detailed design until after the resource consents are approved and appeals resolved. Any delays in the resource consent process will have an impact on the timeframe for completion of the sewerage scheme.

3.8.3 Summary of implementation process

Based on the result of the feasibility investigations, Council will have to decide on the following:

- Extent of the proposed scheme service area.
- Reticulation option (conventional STEP system or combination).
- Treatment and disposal options.

The preliminary design work will further develop the option chosen to a stage where:

- Sizes, locations and grades of the proposed sewerage pipelines and pump stations are identified.
- Location of the proposed treatment and disposal site is determined.
- Treatment process is confirmed and the sizes and requirements of the different treatment components are determined.
- Disposal system size and configuration established.
- Cost estimates are refined to within ± 20%.

The outcome of this work will enable Council to proceed with the:

- Consents for work on private property.
- Consent applications to Environment Bay of Plenty for earthworks and discharges.
- Notice of requirements to designate.
- Development of the specific funding policy for this scheme.
- Provisional application for Ministry of Health subsidy.
- Acquisition of land for the treatment and disposal site.

3.8.4 Detailed design and tender documentation

The detailed design work will take into account the result of consultation with private property owners and the requirements of the approved resource consents in the final plans and specifications.

3.8.5 Tendering and contract

The intention is to undertake the construction of the scheme as two separate contract packages: one for the reticulation system, and the other for the treatment and disposal system. They would be implemented concurrently.

3.9 Cost and Funding

Based on the preliminary investigations and indicative layouts of the proposed sewerage system the indicative capital cost was \$4.0m - \$4.2m depending on the final siting of the treatment and disposal facilities. In addition it will cost on average \$2000 per property to connect each individual property to the reticulation system.

A 50% subsidy for the scheme will be sought from the Ministry of Health to lighten the financial cost to Okareka residents. It must be acknowledged that there will be an up-front cost to Okareka households that has yet to be determined. An indicative charge per property is set at \$17,000 (this is before any government subsidies).

It should also be noted that the commissioning of a reticulated scheme and treatment plant will not by itself reduce the nutrient levels in the catchment to the target levels and that other options such as land use change will be considered in tandem.

3.10 Requirements for Non-Reticulated Residences

Residences and amenities in the Okareka catchment that are not connected to the sewerage scheme will have to upgrade their septic tank to an advanced on-site sewage treatment system with a high nutrient removal capability soon after the sewage scheme is completed. This is seen as an equitable solution as all households on standard septic tanks are currently contributing to the nutrient load of the lake. It is important that the nutrient-reducing benefits of a reticulated sewage scheme are not eroded by the continued use of unconnected conventional on-site systems. Until the treatment plant is operational, residences with septic tanks that do not meet specifications will not be forced to upgrade unless there are seriously adverse environmental effects from the continued operation of that septic tank. In that case the system must have a certificate of compliance by 1 December 2004, or risk enforcement action.

3.11 Other Sewage Treatment Options Considered

Other options identified for reducing the nutrient load associated with the present septic tank systems in the catchment were: partial sewerage reticulation, cartage, and advanced on-site effluent treatment systems. Partial sewerage reticulation would reduce the benefits of nutrient removal from sewage in the catchment, and would not solve the problem of bacterial contamination near lake-edge properties. Cartage from Okareka to the Rotorua city sewage treatment plant would have a similar cost to a stand-alone facility (long term), and raise major concerns with health authorities. Also it would transport the nutrient load to another catchment that already has serious nutrient excess issues. A pipeline to the Rotorua wastewater treatment plant would also transfer the nutrient problem. Advanced on-site effluent treatment for each household would have a similar overall cost to a stand-alone facility, and nutrient removal achieved is much more variable than the reticulation option.

All three of these options ranked lower than the chosen option in the Action Plan working party's evaluation matrix.

Chapter 4: Wetlands

4.1 Nutrient Removal and Other Benefits of Wetlands

4.1.1 Nitrogen removal from groundwater and overland flow

Where lake edge wetlands exist, a substantial amount (up to 98%) of the dissolved inorganic nitrogen can be removed from the groundwater moving through that wetland by coupled nitrification – denitrification to nitrogen gas, sediment storage in the form of organic nitrogen, and a small amount by plant uptake.

Intact riparian wetland vegetation along lake margins or streams can form zones that are very efficient at removing nitrogen from groundwater by denitrification. This process depends on the build-up of organic rich sediments and abundant denitrifying bacteria (Gibbs & Lusby 1996). In large stream wetlands, the nitrogen removal capability is largely dependent on a similar process. The nitrogen removal efficiency varies according to how much of the inflowing water seeps out through organic rich zones. These zones contain high levels of denitrifying bacteria. High rates of surface flow through a small wetland does not achieve as much nitrogen removal as the water does not have enough time in contact with organic rich zones.

4.1.2 Nutrient removal through wetlands at Lake Okareka

It is estimated that 0.3 tonnes/yr nitrogen and 0.01 tonnes/yr phosphorus could be removed through the establishment of wetlands at Lake Okareka. Initially the wetlands were seen as “extra benefit” by the working party – however as the nutrient targets were increased by 10% (as a buffer), the nutrient reductions from wetlands need to be included in the estimates.

4.1.3 Habitats for aquatic, plant and avian species

Fresh-water wetlands can house a wide range of plants and animals, many of which are rare within the region. Waterfowl include dabchicks, shags, herons, ducks, gulls, pied stilts, and others. Fish such as eels, mudfish, and kokopu thrive in the shallow, organic-rich waters with aquatic plants. Because only approximately 3% of freshwater wetlands remain in the Bay of Plenty, many wetland species are under-represented in the region. Building wetlands around lakes increases the habitat for these species. Wetlands also provide fishers and waterfowl hunters with more recreational opportunities.

4.1.4 Public education programmes

Another benefit to the establishment of a wetland is public education about their value: their ecological functions, biodiversity, nutrient reduction, habitat for aquatic species. Display boards can be used, similar to those along the wetlands walkway at the southern side of Lake Okareka. School field trips, visits by Environment Bay of Plenty staff, and newsletters about a new wetland can all promote awareness and knowledge about riparian and lake-edge wetlands. Public education will play an important role in the establishment of wetlands around Lake Okareka.

4.1.5 Wetland Care Groups

Environment Bay of Plenty encourages and supports the development of wetland care groups. Wetland and land care groups play an important role in the maintenance of existing and constructed wetlands. Landcare Okareka has already indicated a willingness to help in wetland construction and maintenance.

4.2 Initial Sites for Wetlands

Two areas for wetlands have been identified; other areas for wetland establishment or enhancement may also be possible. The identified areas are:

- Southern lake edge Playne property (low lying areas)
- Millar Road Stream diverted wetland (below Millar Road)

These two areas are shown on Figure 5 below. It must be noted that the area boundaries shown on the map are purely indicative, and the exact size, shape and location of these proposed wetlands will vary from those shown here.

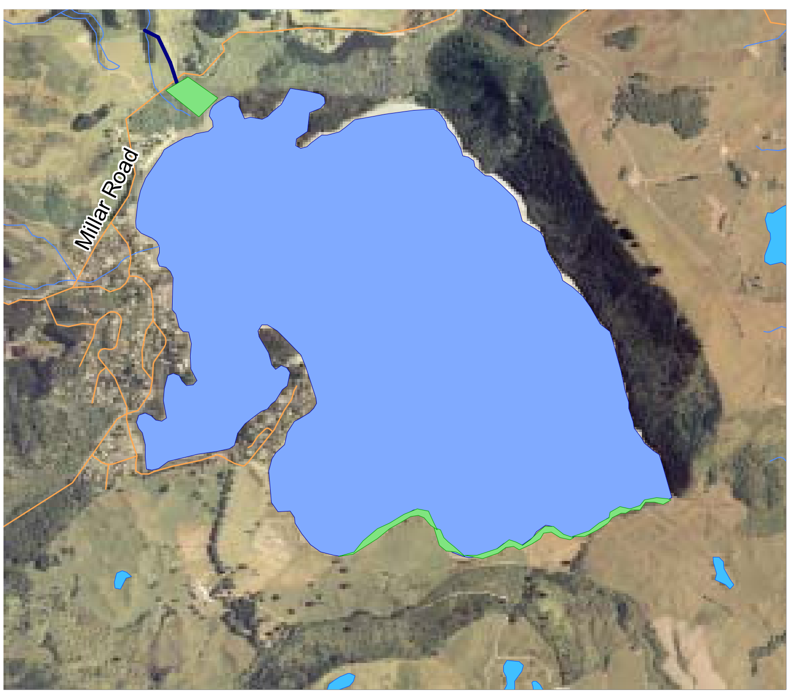


Figure 5 General Location of Two Potential Wetland Areas

4.2.1 Southern Lake edge Playne property (low lying areas) wetlands

Seepage from the farmed plateau to the south flows north to the lake. It appears that there are preferred pathways for the sub-surface flow, at least some of which coincide with ephemeral overland flow channels. At these sites the seepage will be intercepted at the lake margin by planted wetlands, where appropriate.

4.2.2 Millar Road stream diverted wetland

If around 4 litres/second was diverted from the Millar Road stream and treated in a wetland then half of the nutrient reduction target from wetlands could be obtained. Chris Tanner and David Ray from NIWA have investigated the feasibility of diverting part of the Millar Road stream flow from several hundred metres upstream of the bridge, via a pipeline, to the culvert that passes under Millar Road to the east of the bridge. Flow through this culvert would then be directed into a constructed wetland located between Millar Road and the lake. Figure 6 gives an artist's impression of the completed wetland.

Figure 6 Millar Road Wetland

Only a proportion of the Millar Road stream flow will be diverted to the wetland. This is to lessen adverse effects on the stream's important trout fishery values. It is the most significant trout-spawning stream in the Lake Okareka catchment. Mature trout tend to congregate at the mouth of the river before "running" up it to spawn. This makes the Millar Road stream mouth and Boyes Beach the most popular fishing location at Okareka during the winter. The Millar Road stream is also a spawning ground for koaro. The design for the stream diversion and wetland will recognise and give consideration to these values.

As only part of the stream's flow will be treated, the nutrient reduction from the wetland will not be as great as if the whole stream went through a wetland. However, the nutrient reduction from the diverted flow is still worthwhile.

4.2.3 Cost of wetland construction

The total cost of constructing these wetlands for Lake Okareka is estimated to be $150,000, spread over three years of wetland construction.

4.3 Other Wetland Sites

4.3.1 Study to identify additional sites for wetlands

There may be other areas in the Lake Okareka catchment where wetlands with nutrient reduction benefits could be established, for example the Okareka Loop Road/Summit Road corner. Environment Bay of Plenty will identify sites for potential wetlands in the Lake Okareka catchment. Identified sites will also require consultation with landowners and affected parties, and contractual agreements for their construction and maintenance.

4.3.2 Enhancement of lake-edge wetland areas

Lake-edge reed and wetland areas could be enhanced to trap sediments and remove nitrogen, phosphorus and bacteria from surface water flows entering the lake. Lake-edge wetlands can also remove faecal bacteria and phosphorus from groundwater contaminated with septic tank effluent, and also help treat stormwater inflows.

4.3.3 Wetland at the Lake Okareka outlet

One suggestion raised in submissions and at the hearing was for a wetland at the Lake Okareka outlet, possibly to treat a hypolimnetic discharge. Because the outlet channel is lower than the surrounding land, substantial earthworks would be required to excavate the area down to the level of the channel. Another option would be to pump the outflow to the height of the surrounding land – not very high but still requiring infrastructure and maintenance. Approval from the landowner would be required for any of these options to happen.

It is doubtful that a wetland at the outlet would have much effect on water quality of the outflow to the Waitangi Stream, as the lake's surface water has low levels of nutrients compared to other water flows entering the Waitangi Stream, on the Tarawera side of the divide.

Wetlands are useful for denitrification processes, and settling and absorbing phosphorus attached to soil particles. Nutrients released from lake bed sediments during anoxic conditions in the hypolimnion have a low nitrogen : phosphorus ratio. The phosphorus is in a soluble form (not attached to soil particles) so would have low absorption rates in a wetland. Other options for treatment of any hypolimnetic discharge will be considered as part of the investigation into the feasibility of that project.

The prioritised option for this area is to eliminate stock access to the lake. The outlet channel and remainder of the lake edge is to be fenced off and revegetated as part of an Environment Bay of Plenty Environmental Programme on the Playne Farm.

4.4 Maintenance of Wetlands

Environment Bay of Plenty co-ordinates wetland maintenance with contractors, local groups like Landcare Okareka, and landowners. The responsibility for wetland maintenance varies for each wetland. Allocation of responsibility is negotiated individually through Environmental Programmes or other contracts.

4.5 Consultation Process

Consultation at different stages of wetland development is very important for their success. Environment Bay of Plenty will consult with the landowner and the wider community. The Department of Conservation and Fish & Game (Eastern Region) will also be consulted about sites and designs of wetlands at Okareka where appropriate. Consultation will occur at these stages:

- Conceptual stage (after identification of a potential site) – discussion and permission from landowners, notify other organisations and the community for comment.
- Design Stage – continued contact with landowners, and other people/organisations as appropriate.
- Post-design stage – with the community and relevant organisations, and for contract negotiations.
- Consent stage – with all affected parties.

4.6 Timing of Wetlands Construction

The construction of wetlands in the initial two sites aims to be completed within three years (June 2007). It is likely that construction or enhancement of other wetlands in the lake catchment may also happen within this time.

4.7 Removal of Reed Beds for Boat Access to Lake Okareka

4.7.1 Current situation

Along the Okareka settlement lake edge, a number of passages have been cleared through reed bed vegetation to give boat access to the lake from private properties. The passages are cleared of vegetation, and are occasionally dredged. Some members of the community have raised concerns about this situation. They believe that it is unacceptable, as Lake Okareka is a regional icon of national importance that should be protected from earthworks and reed bed removal.

4.7.2 Value of reed bed vegetation

Reed bed vegetation at Lake Okareka provides a habitat for many fish and invertebrate species. It can act as a water filter along the land-water boundary, and is part of the natural character of Lake Okareka. The proliferation of passages cleared through reed beds/wetlands may diminish these values.

4.7.3 Proposed Regional Water and Land Plan and Tarawera River Catchment Regional Plan Rules

Rule 65 of the (Proposed) Regional Water and Land Plan lists the disturbance of wetlands on the bed of a lake to maintain access to boat ramps or jetties as a discretionary activity. Likewise, Rule 12.2.5(e) of the Tarawera River Catchment Regional Plan also states that disturbance of the bed of any lake within the Tarawera River catchment (including Lake Okareka), is a discretionary activity.

Consents have been issued for reed clearance and dredging in the past, subject to conditions. Once a consent has been issued, it may be reviewed if there are adverse environmental effects resulting from the exercise of that consent.

4.7.4 Community discussion on options

It would be worthwhile for the Lake Okareka Ratepayers and Residents Association, local residents and interested organisations to discuss how to avoid, remedy or mitigate the adverse effects of jetty access to the lake from private properties. Options could include:

- an alternative lake access for boats,
- sharing common boat accessways between nearby residents,
- removing existing jetties and boat sheds so residents use public access ramps,
- an inflatable raft mooring system that does not require excavation through lake edge wetlands.

It is preferable for Okareka residents to agree as a community on what action should be taken, which can then be presented to Environment Bay of Plenty and Rotorua District Council.

Chapter 5: Land Use Management – Best Practice Options

5.1 Nutrient Reductions and Other Benefits

5.1.1 Explanation of best practice options

Best practice options (also called best management practices) for land use management allow an existing land use to reduce negative environmental impacts (like nutrient export) from that land. They are unlikely to achieve large nutrient reductions relative to the targets. They have many benefits to landowners, such as:

- Enhanced visual appearance and landscape values of land.
- Protection of the productive capacity of land.
- Increased biodiversity values.
- Reduced erosion on steep slopes.
- Economic resilience through diversification into tree crops.
- Fertiliser savings from targeted application.

Examples of best practice options include:

- Retirement of steep, erosion-prone land to native bush or forestry.
- Exclusion of grazing animals from waterways.
- Wetlands to catch nutrient runoff.
- Farm nutrient budgets to determine optimal annual fertiliser requirements.
- Winter holding areas to reduce pugging of soils.
- Application of advanced fertiliser formulas that bind nitrogen so it is not leached away.
- Sediment traps.

5.1.2 Continuing improvement in best practice options

Nutrient loss reductions and increases in farm productivity from best practice options can continue to grow as new farming practices evolve and new products enter the market. Research on ways to minimise nutrient loss while reaching economic goals has increased in recent years.

5.1.3 Partnerships between Environment Bay of Plenty and landowners

Good working relationships between Environment Bay of Plenty and local landowners is a high priority, in order to exchange information on best practice options that could be used at Okareka. Environment Bay of Plenty will inform landowners about new farming practices and products that improve water quality as they become available.

5.2 On-Farm Nutrient Assessments

On-farm nutrient assessments produce a nutrient budget for each farm. The assessments also list actions that farmers can take to reduce their nutrient loss while improving their farm productivity.

Environment Bay of Plenty has completed on-farm nutrient assessments for all the farms within the Lake Okareka catchment, and identified potential best practice options. Environment Bay of Plenty staff will use this information when working with farmers to reduce nutrient export from their farms. Working with landowners is a key component to the implementation of best practice options.

5.3 Environmental Programmes

5.3.1 A contractual agreement

Environmental programmes are contractual agreements with rural landowners to implement various best practice options on their farm. They often involve funding from Environment Bay of Plenty and/or Rotorua District Council in recognition of the benefits these actions have for the district and the region (from a clearer lake). Council staff develop the environmental programme through negotiations with landowners. Environmental programmes detail specifications of works or management changes, and allocates responsibility and cost share for initial works and subsequent maintenance.

5.3.2 Landowner commitment

It is imperative that landowners are fully involved in the process, as they will be the ones most affected by any changes, and in many cases will be investing time and money into making the changes on their land. Retirement of land and other best practice options can come at a cost from initial capital outlay and subsequent reduced production potential. The economic and environmental benefits are often longer-term.

Some landowners have already undertaken significant land retirement, adopted some best practice options, and are working with Environment Bay of Plenty to further reduce nutrient runoff.

5.3.3 Voluntary adoption of best practice options

Best practice options can be introduced separately from an official environmental programme. If a landowner comes across a farming technique or product that will reduce the farm nutrient export to the lake, or will improve nutrient efficiency and farm productivity, the landowner is encouraged to use that technique or product to benefit Lake Okareka and their farming practice.

An application to the Sustainable Management Fund to undertake land use change assessments has been lodged by a number of community groups. This may assist in the process of using best practice options to restrict increases in nutrient inputs to Lake Okareka and the other Rotorua Lakes.

5.4 Proposed Regional Water and Land Plan

5.4.1 No increase in current nutrient export from rural land use

Although best practice options are useful to reduce nutrient inputs, there also needs to be an environmental bottom line, a “nutrient discharge cap”, to ensure that nutrient levels from farming do not increase. Rules in the (Proposed) Regional Water and Land Plan have been drawn up through a separate process to control overall long-term nutrient inputs to the Rotorua Lakes. These rules in section 9.4 of the (Proposed) Regional Water and Land Plan are explained in Appendix 5, and are currently under appeal.

In essence, the rules permit landowners to undertake activities on their land so long as they do not result in a net increase in the export of nutrients, otherwise a consent will be required. Best practice options may offset possible increases if a farmer wishes to intensify farmland use.

5.4.2 Possible alterations from Environment Court or plan changes

These rules may change due to Environment Court decisions, or from variations or plan changes to incorporate relevant land use controls specific to the Lake Okareka catchment. The relevance of section 9.4, its effectiveness in Okareka and possible changes will be discussed in the future with the Lake Okareka Catchment Management Action Plan working party, landowners, and the wider community.

5.4.3 Viewpoints of rural and urban residents

In the Lake Okareka catchment some future development by major rural landowners will be restricted by rules to control nutrient export. When the Action Plan working party discussed the matter on two occasions it was found that a split existed between the urban population and the rural population.

Urban representatives generally supported nutrient controls. Controls would protect the nutrient reductions gained by the significant investment in a sewerage scheme, and would ensure that the long-term water quality goal was reached. The rural landowners generally considered that they would be unreasonably penalised. Controls would limit their ability to receive greater economic returns from their land.

5.5 Variation 12 of the Rotorua District Plan

Variation 12 no longer contains lists of activities but manages land use through a series of environmental performance standards. The permitted activity rules are described as presenting a “low visibility” strategy. The ability of the landscape to absorb change in terms of natural character is the prime driver for the rules and the thresholds specified in the supporting performance standards. The Variation contains measures to manage the environmental effects of development such as traffic and noise. Variation 12 is described in Appendix 6.

In the Sensitive Rural Management area, overall pastoral farming and forestry activities can continue. Disturbance of indigenous vegetation is controlled. Buildings and structures are managed in a similar way to the Settlement area in terms of design and services. Earthwork controls are customised to enable the construction of tracks compatible with both the landscape and land use practice.

Systems for stormwater and sewage disposal are to be designed to manage the effects on-site wherever practicable and regional rules for sewage disposal must be met. There are three management areas applicable to the Okareka Catchment: Sensitive Rural, Bush Settlement and Settlement. Bush Settlement areas and the management of Maori land were under appeal to the Environment Court at the time this Action Plan is adopted.

5.6 “Living near Lakes” – Urban Best Management Practices

5.6.1 Examples of best practice options for residents in lake settlements

It is important that best practice options are undertaken by urban residents living within lake catchments as well as rural landowners. Best practice options for lake catchment urban residents can include:

- Making compost from kitchen and garden organic waste and using it as a nutrient source for gardens, rather than using fertilisers from outside the catchment.
- Using permeable materials when constructing driveways or carparks, to reduce stormwater runoff.
- Regularly servicing septic tanks/advanced on-site effluent treatment systems.
- Disposing of car bodies, oil, household rubbish and other refuse correctly, rather than leaving them on the roadside or dumped elsewhere.
- Not discharging untreated sewage into the lake from boats that stay overnight on the lake.
- Using less soap and detergents with high nitrogen or phosphorus content.

5.6.2 “Living near lakes” booklet

These best practice options will be outlined in a booklet called “Living near Lakes”. Originally published by the Department of Conservation in 1988, at the time this Action Plan is adopted the booklet is being updated by Lakes Water Quality Society. It is intended that the booklet will eventually be distributed to many residents living within the catchment of Lake Okareka and other Rotorua lakes, and also made available to schools and other organisations.

5.7 Aerial Top-Dressing

5.7.1 An issue of concern

Aerial top-dressing is an issue of concern for many Rotorua residents. Some watch planes applying fertiliser to farmland near the Rotorua lakes, and surmise that with spray drift, some of the fertiliser will end up in a lake. It is unlikely that large proportions of fertiliser are regularly entering lakes, simply because of the incentive not to do so – the landowner pays the top-dresser to deposit the fertiliser onto his/her property, not into the lake.

However, it is important for Environment Bay of Plenty to have a rule that sets conditions on aerial top-dressing near the Rotorua Lakes to avoid noticeable amounts of fertiliser entering the lake. Fertiliser could enter the lake through spray drift or direct deposition from incorrect application of fertiliser. As fertilisers are designed to release nutrients for plant uptake, if they enter the lake they promote weed and algae growth.

5.7.2 Additions or amendments to Regional Air Plan

Environment Bay of Plenty should review provisions in its Regional Air Plan to address the effects of aerial top-dressing of fertiliser within the Rotorua Lakes catchments, especially near the lakes themselves. This change to the Air Plan may be made together with other plan changes, or as part of a formal plan review process in the future.

Chapter 6: Land Use Change

6.1 Management of Land Use Change

6.1.1 Preservation and change

To achieve Lake Okareka's nutrient reduction targets (in particular phosphorus targets) land use change of up to 200 ha will be needed in the next 3–5 years. The form of such change is the most contentious issue to arise during the Lake Okareka Action Plan process. Land use change should enhance, protect or maintain the existing natural character and landscape values of the area.

Management of land use change is challenging in an area of high environmental quality such as the catchment of Lake Okareka. The catchment has existing, highly valued, outstanding natural character that is vulnerable to change. It is characterised by a small settlement surrounded by native bush, forestry and rural land in a tranquil, clean, aesthetically pleasing, intimate catchment.

It should be noted that the rural landscape is already constantly changing due to farming activities, natural events and ecological processes. The catchment lies in an active geothermal and volcanic region that has the potential to cause radical change as demonstrated during the Tarawera eruption.

In addition human-induced change is an inevitable part of living in the rural environment.

- Farming methods change.
- New types of rural production will occur.
- Crops (including trees) will be harvested.
- New people and new ideas and values will come.

6.1.2 Removal of grazing animals

A number of scenarios for land use change have been identified. They all require the removal of grazing animals from the land, and replacement with land uses with lower nutrient export potential, such as plantation forestry, native bush, or bush settlements (lifestyle block-size properties with a house and native bush cover). This will reduce the long-term nutrient export from the catchment and help improve lake water quality.

Land use change can involve a range of options that may be more financially attractive to both the landowner and the Councils. A mix of land use changes should be pursued to bring about a targeted reduction.

6.1.3 Role of best practice options

Best practice options currently being researched (see Chapter 5) can also reduce nutrient export, with the benefits of maintaining existing land uses. They are less visually intrusive, and may be easier for landowners to implement. While best practice options do not negate the need for land use change, land use management and best practice options are a high priority in this Action Plan.

6.2 Individual Agreements and Consultation

6.2.1 Land use tailored to land characteristics

Deciding on the most appropriate land use for a unit area of land is the most fundamental decision to be made by the land user. Different land uses subject the land to different levels of erosion and runoff of nutrients. The type of land use selected should be a function of the land's particular characteristics. The question to be answered is which crop, animal or combination of crops and animals should be grown, if any? Which is most appropriate, trees (forestry), wool (pasture), dairy (pasture), crops from arable land, or horticulture? Or is it better to retire the land into native bush?

Where changes in land use are proposed, land users must be informed as to the range of options available. In some cases it may be appropriate to have mixed land uses within a single farm. It was strongly advocated in submissions from rural landowners that decisions on land use change are not removed from landowners' control, but that proper consultation and negotiation occurs between landowners, Environment Bay of Plenty and Rotorua District Council.

6.2.2 Okareka large landowner group

An option to be explored by Environment Bay of Plenty and Rotorua District Council is to facilitate the formation of an Okareka "large landowner" group, with a cooperative mandate to collectively bring about significant reductions in nutrients with land use change that is reasonable to all parties. Conclusions from any large landowner group would be implemented through individual agreements between landowners and Environment Bay of Plenty and/or Rotorua District Council.

6.2.3 Regulation under the Resource Management Act

Regional councils can control land use to maintain or improve water quality. District Councils can also manage the environmental effects of ongoing changes to enhance the water quality of Lake Okareka. There is direction given to territorial authorities under the Resource Management Act to determine appropriate levels of subdivision and development in such circumstances. These are set out through the district plan process.

There is some protection for existing land uses under the Resource Management Act 1991 if they were lawfully established prior to the Act coming into force and the effects of the use remain essentially the same.

6.2.4 Property-specific changes

Environment Bay of Plenty and Rotorua District Council should approach individual landowners to discuss what land use change is possible on their property. All the options can be discussed, with their benefits and costs, with the overall aim of achieving 200 ha land use change in the Lake Okareka catchment from livestock farming to trees. This could be a mixture of exotic and native tree plantations, native bush, and bush settlements. For any land use change these factors must all be taken into account:

- Protection of amenity values.
- Maintenance or enhancement of landscape views (especially in areas with visual prominence).
- Lake water quality improvement.
- Concerns raised by Okareka residents.
- Equity issues between landowners, including economic benefits or costs.
- Limited additional housing resulting from Variation 12 to the Rotorua District Plan (currently under appeal), and any subsequent plan changes.

6.3 200 Ha Pasture-to-Trees

Nutrient export co-efficients for the Lake Okareka catchment have been estimated (see Appendix 2). The export co-efficients for pasture in this catchment are comparatively low at 7kg/ha for nitrogen and 0.03kg/ha for phosphorus. These co-efficients are representative of low to moderate dry stock farming.

Therefore if 200 ha of pasture was converted to trees (with export co-efficients of 2.5kg/ha nitrogen and 0.004kg/ha phosphorus), then the reduced nutrient load would be 0.9 tonnes total nitrogen and 0.05 tonnes total phosphorus. These are significant reductions, particularly for phosphorus.

It is considered that a maximum of 200 ha could be converted to another land-use out of a total of approximately 600 ha of pasture. This level of change should not overly impact the landscape of the catchment. The economic viability of remaining land will be an important factor. This option was ranked number two overall by the Action Plan working party.

More detailed work on suitable tree species, silvicultural and harvesting regimes for areas to be forested is needed for landowners to be reassured that the retired land will return a profit in the future; in particular if voluntary agreements are to be pursued. Alternatively Environment Bay of Plenty or Rotorua District Council could offer incentives or outright purchase of land. Land retired in this manner need not become reserve but could be leased as forest to industry operators. The pasture-to-trees options were rated highest by the Action Plan working party.

6.4 Bush Settlements

6.4.1 Financial benefits

Utilising agricultural land for bush settlement blocks has financial benefits to landowners as the financial returns could be significant and relatively quickly realised. A valuer (Boyes Campbell & Associates 2003) conservatively estimated that the “lifestyle blocks” value at Okareka is approximately $68,000 per hectare. This compares to farming value that (excluding any lakeside influence) would be in the range of $4,000 - $8,000 per hectare, depending on contour. While these figures are a broad overview they show the bush settlement option to be financially attractive to the landowner.

6.4.2 Strict conditions

Any limited number of bush settlements that are negotiated with the landowner must have strict conditions to ensure that levels of nutrient export from the land to the lake are minimised, and landscape views and amenity values are maintained or enhanced. Feedback from the community should assist in the development of these conditions. The conditions would include:

- specific building sites and driveway locations,
- maximum site coverage building restriction, with the balance in native bush (possibly covenanted under a QE2 Trust or Nga Whenua Rahui Trust),
- ban on livestock,
- all-weather surfaced access roads and driveways,
- height restrictions on buildings,
- connection to the community sewerage scheme if possible (otherwise an on-site effluent treatment system with equivalent nutrient removal),
- sited to avoid adverse effects on amenity values, and
- separate from prominent landscape forms.

6.4.3 Variation 12 provisions

Under the Lake A Zone proposed activity rules in Variation 12 to the Rotorua District Plan, a maximum of 68 new dwellings may be developed (subject to decisions on appeals to the Environment Court) in the following zones:

- Settlement – 44
- Bush Settlement – 14
- Sensitive Rural – 10

6.4.4 Nutrient export from bush settlements

In assessing nutrient impacts for bush settlements a number of assumptions are required. If the pasture coefficients are applied then 100 ha of pasture will produce 0.7 total nitrogen and 0.03 total phosphorus.

If this 100 ha of pasture was converted to twenty-five, 4 ha lifestyle blocks then the following nutrient levels could result. It is assumed that each dwelling uses an advanced on-site effluent treatment system.

	Pasture		Planted Bush (no animals)		50% Bush/Pasture (animals)	
	N T/yr	**P T/yr**	**N T/yr**	**P T/yr**	**N T/yr**	**P T/yr**
Pasture	0.7	0.03	-	-	0.35	0.015
Advanced OSET	-	-	0.04	-	0.04	-
Bush	-	-	0.25	0.004	0.12	0.002
Total	**0.7**	**0.03**	**0.29**	**0.004**	**0.51**	**0.017**

Careful planning and restrictions would need to be in place to achieve a reasonable level of reduction. The nutrient reduction from the 50% bush/pasture option is low, and is not appropriate for this nutrient-sensitive lake catchment. The 100% bush and dwelling would see a reduction of 0.4 tonnes total nitrogen and at least 0.02 tonnes total phosphorus. If the dwellings were linked to the community sewage scheme then the nutrient reductions would be greater. This option ranked number 6 in the Action Plan working party’s ranking of options.

6.5 200 Ha (Buy-Sell) Conversion

This option achieves the same level of nutrient removal as landowner conversion, but assumes that a reasonable proportion of the financial outlay could be recovered through Rotorua District Council or Environment Bay of Plenty reselling the converted properties. It also gives greater certainty of outcome, as land use change to trees can happen without negotiations with landowners. This option ranked the highest due to the improved costing, but the possibility of buying the land is dependent on a willing seller.

6.6 Regional Park

This option involves local, regional or central government (and possibly also Okareka residents) buying a portion of pasture land and establishing it as a regional park. Animals would be removed and it could be planted into forestry, an arboretum, native bush, grassland, a recreational park, or a combination of these. The option was not discussed by the Action Plan working party, but was suggested and approved of in various submissions to the proposed Action Plan.

Environment Bay of Plenty should investigate the concept of a regional park in the Lake Okareka catchment as part of the overall 200 ha land use change target. Various funding options can be discussed with the community and landowners. A regional park may not be appropriate in the Okareka catchment, but it should be considered alongside the other options for land use change as part of investigations and negotiations with rural landowners. Again, this option would require a rural landowner willing to sell part of their land for the park.

Chapter 7: Engineering and Treatment Options

7.1 Potential Nutrient Reductions

7.1.1 Possible solutions

The working party process identified two engineering solutions with potential to reduce nutrient concentrations in Lake Okareka: a hypolimnetic discharge and treatment walls.

7.1.2 Nutrient reductions

A pipe from the bottom of the lake to the outlet could remove water that has a high phosphorus concentration during the March – May period (a hypolimnetic discharge). A flow of 100 litres/second would remove 0.03 tonnes/yr phosphorus from the water from March to May, which is 37% of the phosphorus reduction target. Nitrogen would also be removed but this would be small compared to the nitrogen reduction target for the Lake Okareka catchment. Figure 7 illustrates the basic idea of the hypolimnetic discharge.

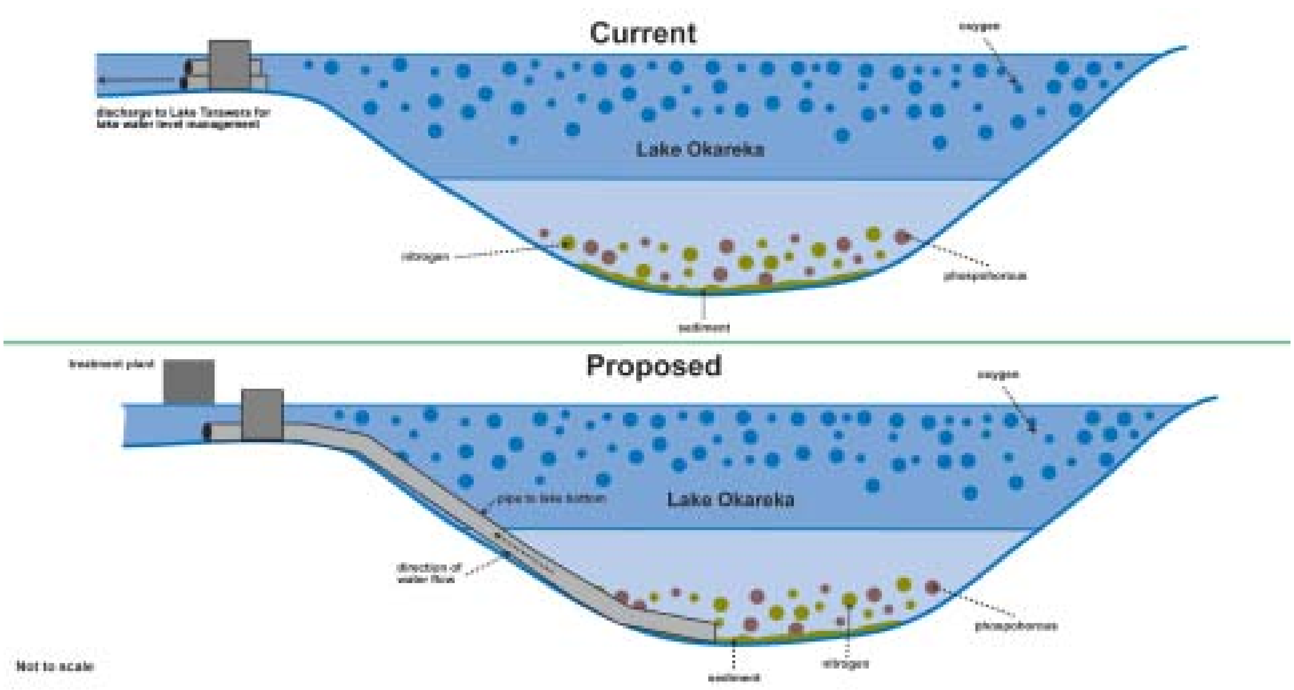


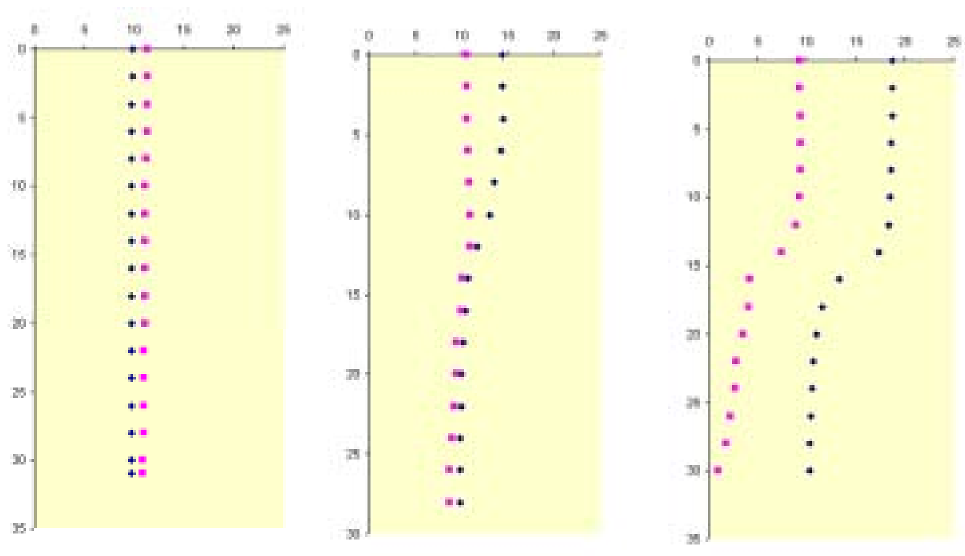
Figure 7 Hypolimnetic discharge

Treatment walls use trenches filled with organic material to intercept and treat groundwater. The aim is to facilitate denitrification of nitrates from the groundwater to nitrogen gas. They require suitable areas for trenches to be dug to intercept main groundwater flowpaths. Nutrient reductions from treatment walls vary depending on where they are placed and the nature of the nearby subsurface flows. They have been trialled in New Zealand and overseas with mixed results. Environment Bay of Plenty will trial a treatment wall beside Lake Rerewhakaaitu, and will consider its applicability to improve the water quality of Lake Okareka.

7.2 Hypolimnetic Discharge

7.2.1 Lake stratification over summer

In June and July, Lake Okareka is fully mixed with the waters uniform in temperature and similar dissolved oxygen concentrations from top to bottom. In October the surface water begins to warm and the lake stratifies into top and bottom water (epilimnion and hypolimnion) between 10 and 15 metres deep (refer to Figure 8).



July October March

◆ Temperature oC

■ Dissolved oxygen g/m3

Figure 8 Graphs of Lake Temperature and Dissolved Oxygenation during Stratification

7.2.2 Nutrient release from hypolimnion

By March in Lake Okareka, the dissolved oxygen concentration in the bottom water (hypolimnion) has become depleted as it does not mix with aerated surface water. Over March, April and May, phosphorus and nitrogen are released from the sediment and accumulate in the bottom water. When the lake de-stratifies and has the same temperature through the water column, the bottom waters mix with the surface waters, distributing the nutrients throughout the water column.

If it were possible for the bottom waters to be discharged out the Lake Okareka outlet instead of the current surface outlet, then more phosphorus and nitrogen would be removed from the lake before it mixes with surface waters and becomes available for algae growth. The hypolimnetic discharge may be able to achieve this.

7.2.3 Investigations in progress

The length and depth of the pipeline extension required to capture the enhanced nutrient concentrations is not known. While it was initially proposed to trial a small pipeline over the 2003/04 period, an engineering evaluation ruled it out as impractical. Instead a monitoring programme is being carried out over March, April and May 2004 to assess the level of phosphorus release from the sediments and the depth at which a pipe would have to be placed to withdraw the phosphorus.

If the results from the monitoring programme are positive, engineering calculations will be carried out to determine the optimum size of pipe that will allow a flow with the pressure head that is available. There should be enough pressure to drive an outflow from deeper in the lake without need for a pump. A new design for the outlet would be required.

Once the lake and engineering investigations have been completed, preliminary costs for the project will be estimated, and then a decision will be made whether or not to proceed with the hypolimnetic discharge. If it does proceed it will be completed within 2-3 years (June 2006 – 2007).

7.2.4 Treatment of the hypolimnetic discharge

Treatment of the discharge will also be required to remove phosphorus before the discharge is released. This is to ensure that the water discharged to Lake Tarawera would be of a higher quality than at present. At the Lake Okareka outlet there is enough room to treat the discharge to reduce the nutrients entering Lake Tarawera. The main option considered for treatment of the discharge is a flocculation plant.

A flocculation plant is the most reliable option for treating the discharge, as it can be trialled and manipulated through engineering. The plant would percolate a flocculent like alum, ferric chloride, Phoslock, or another product through a pooled outflow. This would remove the phosphorus from the water. The phosphorus would then be siphoned or filtered from the water.

While no adverse effects would be expected from the outflow, potential effects, cumulative effects and effects on cultural values of this addition will be considered in any consent application.

Treated water could be discharged back into Lake Okareka to avoid issues with Lake Tarawera, but this would require pumping. The option will be considered as part of the overall investigation.

A wetland to treat the discharge is discussed in section 4.3.3. It could provide additional treatment to ensure that the flow to the Waitangi stream has fewer nutrients than before the hypolimnetic discharge. Other options for treatment may also be considered by Environment Bay of Plenty.

7.2.5 Resource Consent Process

Resource consents would be required for the pipeline structure and a treatment station, and for the discharge itself. This would include a thorough assessment of environmental effects. A consent application is to be initiated by the end of 2004 if the research, treatment options and environmental effects all indicate that the project is worthwhile. If this happens, the final details of the hypolimnetic discharge would be discussed with the community through the consent process.

7.2.6 External Nutrient Sources still to be Targeted

Through the hearings and deliberations process, it was agreed that the target amount of land use change will not be changed by the feasibility of the hypolimnetic discharge option. The long-term efficiency and effectiveness of the hypolimnetic discharge in removing phosphorus are as yet unproven, while land use change gives measurable reductions in both nitrogen and phosphorus. If studies show that the discharge will not provide the expected level of phosphorus removal, or if it proves too expensive, the money budgeted in Environment Bay of Plenty's Long Term Council Community Plan may be better spent on converting 200 Ha of pasture into another land use.

Chapter 8: Other Lake Management Considerations

8.1 Biomanipulation

8.1.1 Explanation of Biomanipulation

This method was raised through the submissions and hearings process for the proposed Lake Okareka Catchment Management Action Plan. In essence, biomanipulation is a manipulation of the food chain within a lake to limit algae growth and to restrict the size and duration of algal blooms. Biomanipulation is typically used in lakes that are small, closed systems. It tends to work better in shallow lakes as organisms are less spatially separated by depth.

The main goal of biomanipulation is to reduce algae levels in a lake. It has no effect on external nutrient loads, but may (theoretically) reduce internal nutrient loads by slowing down the deoxygenation of the hypolimnion because fewer algae die off and decompose.

If algae and cyanobacteria (blue-green algae) are over-predated, their numbers will diminish. This requires an increase in the numbers of their predators – zooplankton, especially larger sized zooplankton. There are two main ways to do this:

- decrease population of species that predate on zooplankton,
- increase population of species that predate on zooplankton predators.

8.1.2 Decrease population of species that eat zooplankton

The reduction in fish that eat zooplankton would require a fish kill or removal, most likely through application of piscicides (poisons that kill certain fish). This is likely to be opposed by many people, and there would be some undesirable environmental side effects, such as a decline in other species and zooplankton.

8.1.3 Increase population of species that predate on zooplankton-eating species

This second option was trialled by Fish and Game, as part of an experiment to find the optimal trout stocking rate for Lake Okareka. The young trout predate smelt and bullies, which reduce the number of larval smelt and bullies that eat zooplankton. They did not record a noticeable improvement in water quality that could be attributed to biomanipulation. This concurs with overseas research that over-stocking of this level of the food chain (species like trout) does not appear to provide be effective by itself (Riedel-Lehrke, 1997).

8.1.4 Results from biomanipulation trials

Biomanipulation trials overseas have sometimes produced positive results early on, but often five to ten years later the lakes return to their previous state. An increase in zooplankton numbers may not have a major effect on blue-green algae, as they are not a major food source for zooplankton and they may even clog the filtering systems of zooplankton.

8.1.5 Viability of biomanipulation at Lake Okareka and other Rotorua Lakes

Environment Bay of Plenty may evaluate the use of biomanipulation as a tool to improve the water quality of the Lake Okareka.

8.2 Restricting Spread of Pest Fish and Weeds

8.2.1 Integration of Pest management into Lake Management Strategy

Pest fish and weeds are a serious threat to the Rotorua Lakes, including Lake Okareka. A long-term strategy for lake weed and pest fish management is to be presented to the three strategic lake management committee partners (Environment Bay of Plenty, Rotorua District Council and Te Arawa Maori Trust Board) for integration into overall lake management. A suite of integrated methods should be used to avoid the spread of weeds and pest fish into Lake Okareka and other lakes, and to remove them if incursion occurs.

NIWA (National Institute of Water and Atmospheric research) is surveying all the Rotorua Lakes for species and distribution of lake weed. This will be used in the development of a Regional Aquatic Weed Surveillance Strategy. Environment Bay of Plenty and the Foundation for Research, Science and Technology (FRST) are assisting with the funding of the weed survey and the strategy development. The strategy will be an important management programme for controlling weed spread in the Rotorua Lakes.

8.2.2 Regional Pest Management Strategy

The Environment Bay of Plenty Regional Pest Management Strategy aims to manage pests in an integrated way for environmental protection and enhancement. In Lake Okareka's situation koi carp and catfish are the two largest pest fish threats. Environment Bay of Plenty and the Department of Conservation will jointly undertake surveillance and destruction of these fish if they are found in Lake Okareka.

8.3 Stormwater Treatment

8.3.1 Filtering of stormwater contaminants

Stormwater is a contributor of nutrients to the lake, as shown in Table 7 in Appendix 2. Stormwater can also contain other contaminants like oil, grease, heavy metals, and sediment. Rather than draining stormwater directly to the lake (along with its contaminants), stormwater treatment systems can be used such as swales, detention ponds and wetlands. Given the hilly topography of the Okareka settlement, the best method of treating stormwater may be to build or enhance wetlands around stormwater outlets, to filter stormwater before it reaches the lake.

Environment Bay of Plenty will look at this option as part of their investigations for wetland sites in the Okareka catchment.

8.3.2 Review of stormwater infrastructure

To retro-fit the existing infrastructure at Okareka to incorporate stormwater treatment areas would be difficult. Rotorua District Council will review the stormwater infrastructure at Okareka to identify areas where swales, grass strips, wetlands or other filtering systems could be put in place to reduce nutrients and improve the quality of stormwater entering the lake.

8.3.3 Variation 12 restrictions on urban development

As part of Variation 12, a restriction for new development is the allowed proportion of impermeable surfaces. Permeable blocks must be used for driveways and other sealed areas. This should reduce runoff from these sites. Additional runoff from roads and other sources will be treated in some way, possibly through engineered solutions, wetlands, ground soakage or other methods, so that contaminants and nutrients entering the lake can be minimised.

Chapter 9: Monitoring

9.1 Benefits of Monitoring

Monitoring is important to assess whether the Action Plan actions are effective in improving the water quality of Lake Okareka in the long term. Monitoring programmes assess the nutrient load status regularly. Some individual actions are already being monitored for their effectiveness.

The Action Plan working party promoted a monitoring programme to assess reductions in nutrient loads from implementation of various actions. Groundwater monitoring bores can also be used to help assess the long-term nutrient inputs to the lake.

The existing monitoring of the lake and lake edge water quality will also continue, and will be reported to the community.

9.2 Water Quality Monitoring

9.2.1 Natural Environment Regional Monitoring Network

The Natural Environment Regional Monitoring Network (NERMN) is Environment Bay of Plenty's programme for general 'state of the environment' monitoring. The programme is divided into modules with lake monitoring budgeted as a separate module. Lake monitoring results are reported annually because of their relevance to lake management issues.

The proposed Regional Water and Land Plan (pRWLP) also reinforces the need for ongoing monitoring of the nutrient load status to the lake, and the effectiveness of individual actions (provisions listed in Appendix 5). This is consistent with section 35(2)(a) of the Resource Management Act 1991, which states:

"*Every local authority shall monitor the state of the whole or any part of the environment of its region or district to the extent that it is appropriate to enable the local authority to effectively carry out its functions under this Act.*"

9.2.2 Trophic Level Index

A major thrust in reporting the lake results is calculation of an annual figure for the Trophic Level Index (TLI). This is composed of four interrelated factors that are calculated together to form a sensitive indicator of lake quality (further discussed in Appendix 1). The four factors are total phosphorus, total nitrogen, secchi disc depth (clarity) and chlorophyll *a* (amount of algae).

In the pRWLP the TLI is used to set lake water quality goals and monitor changes in lake water quality. A baseline quality has been set for each lake at a specific TLI level. Lake Okareka's baseline level is 3.0. Lakes that are clearly deteriorating have:

- A three-yearly average TLI level 0.2 points or more above the baseline level for two consecutive years.
- An increase in bottom water deoxygenation rate.
- An increase in nuisance algal blooms.

This situation triggers an Action Plan process as for the Lake Okareka Catchment Management Action Plan (refer Method 35 pRWLP). Monitoring of the progress made towards achieving the target TLI is also to be reported to all relevant parties and the community.

The use of the TLI in the pRWLP and Method 35 were both under appeal to the Environment Court at the time of this Action Plan's adoption.

9.2.3 Other water quality indicators

Water quality is monitored for all the Rotorua Lakes. Indicators that are monitored include: nitrogen levels, phosphorus levels, secchi depth, chlorophyll *a*, hypolimnetic deoxygenation, algal and cyanobacterial levels, toxicity, aquatic plants, and indicator bacteria at swimming sites.

9.3 Individual Actions Monitoring

9.3.1 Wetland monitoring

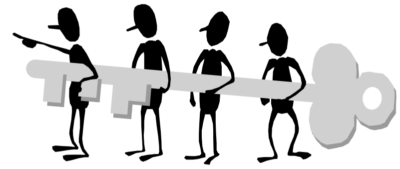
The constructed wetlands proposed in Chapter 4 will be monitored for effectiveness in removing nutrients. A previous study (Gibbs, Lusby 1996) on nutrient removal from a lake-edge wetland at Okareka showed a very high rate of nitrogen removal, and some phosphorus removal also. Nutrient reduction rates from constructed and restored wetlands will be monitored.

9.3.2 Sewerage monitoring

The effects on the wider environment of the sewage reticulation, treatment and disposal at Okareka will be monitored. Monitoring will be a requirement with any consent granted for the discharge of treated sewage in the Lake Okareka catchment. This is to assess the effectiveness of the sewerage reticulation and sewage treatment plant, to ensure that it reaches its promised nutrient removal rates and to identify any potential areas for improvement within the system.

9.3.3 Other actions

Other actions discussed in this report will also be monitored to determine their effectiveness at reducing nutrient loads to Lake Okareka.



Chapter 10: Summary of Actions

The actions listed in Table 4 are drawn from the previous nine chapters, and also include the Key Recommendations listed at the beginning of the Action Plan.

Table 4 Identified Actions in Lake Okareka Catchment Management Action Plan

Identified Action	**Agency**	*Section ref.*
Proceed with urgency with a fully reticulated sewage scheme within the Lake Okareka catchment that makes provision for limited additional dwellings within the catchment and amenities at Lake Tikitapu.	RDC	1
Proceed to establish wetlands, pending the outcome of consultation, investigations and the granting of any resource consents required.	EBOP	1
Discuss with individual rural landowners best practice options for land use management to control and reduce the nutrient load to the lake.	EBOP & RDC	1
Make provision for land use changes in the Lake Okareka catchment, including: • Regional and district plan changes; • Consultation and negotiation with landowners on an individual or collective basis; and • Investigation of a regional park concept.	EBOP & RDC	1
Continue to evaluate engineering and treatment options, including but not limited to, the hypolimnetic discharge.	EBOP	1
Implement a monitoring programme to assess the ongoing nutrient load status within the catchment and the effectiveness of individual actions, and report the results back to the LOCMAP working party and the community.	EBOP	1
LOCMAP to assist in lobbying local Ministers of Parliament, the Minister for the Environment and central government for assistance to ensure that the recommendations contained in the Action Plan are actioned as soon as possible.	RLJSC	2.5.7
LOCMAP to be included as part of briefing papers to Cabinet.	RLJSC	2.5.7
Integrate LOCMAP provisions into Long Term Council Community Plans.	RDC & EBOP	2.5.7
Evaluate the addition of sewered facilities at popular walkways, reserves and boat ramps in the Lake Okareka catchment.	RDC & EBOP	3.3.1
A 50% subsidy for the scheme to be sought from the Ministry of Health for the Okareka sewerage scheme	RDC	3.9
Public education is to play an important role in the establishment of wetlands around Lake Okareka.	EBOP	4.1.4
Identify further sites for potential wetlands in the Lake Okareka catchment.	EBOP	4.3.1
Investigate the enhancement of lake-edge reed and wetland areas around Okareka.	EBOP	4.3.2
Give attention to using wetland areas to help treat stormwater flows from the Okareka settlement.	EBOP & RDC	4.3.2
Negotiate fencing and revegetation of the Lake Okareka outlet channel and nearby lake margins with landowner.	EBOP	4.3.3
Consult with landowners, wider community, and relevant organisations about	EBOP	4.5

wetland sites, designs and maintenance.		
Discuss options to avoid, remedy or mitigate the adverse effects of private jetty access to the lake through lake edge reed beds and wetlands.	EBOP, RDC & OKR	4.7.4
Inform landowners in the Lake Okareka catchment about new farming practices and products that improve lake water quality as they become available.	EBOP	5.1.3
Discuss the relevance and effectiveness of section 9.4 of the Regional Water and Land Plan and possible changes with the LOCMAP working party, landowners and the wider community.	EBOP	5.4.2
Update and distribute the “Living near Lakes” booklet.	LWQS & EBOP	5.6.2
Review provisions in the Regional Air Plan to address the effects of aerial top-dressing of fertiliser within the Rotorua Lakes catchments, especially near the lakes themselves.	EBOP	5.7.2
Consider facilitation of an Okareka large landowner group to collectively discuss land use changes that are reasonable to all parties.	EBOP & RDC	6.2.2
Trial a treatment wall beside Lake Rerewhakaaitu, and consider its applicability to improve the water quality of Lake Okareka.	EBOP	7.1.2
Assess the hypolimnetic discharge and decide whether or not to proceed with the proposal.	EBOP	7.2.3
Evaluate the use of biomanipulation as a tool to improve the water quality of Lake Okareka.	EBOP	8.1.5
A long-term strategy for lake weed and pest fish management is to be presented to the RLJSC for integration into overall lake management.	EBOP	8.2.1
Undertake surveillance and destruction of koi carp or catfish if they are found in Lake Okareka.	EBOP & DOC	8.2.1
Review Okareka’s stormwater infrastructure to identify areas where swales, grass strips, wetlands or other filtering systems could be put in place to reduce nutrients and improve the quality of stormwater entering Lake Okareka.	RDC	8.3.2

Key:

LOCMAP Lake Okareka Catchment Management Action Plan

EBOP Environment Bay of Plenty

RDC Rotorua District Council

TAMTB Te Arawa Maori Trust Board

RLJSC Rotorua Lakes Joint Strategy Committee

DOC Department of Conservation

LWQS Lakes Water Quality Society

OKR Okareka residents

& and

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Appendices

Appendix 1 – Trophic Level Index

Four lake quality parameters are combined to construct the Trophic Level Index (TLI): total nitrogen, total phosphorus, secchi disc depth and chlorophyll *a*. The combination of these parameters reflects the dynamics of the annual lake cycle. It is like a combination of iron, glass, rubber and plastic making a car. The final product is more than just a collection of parts. With a car, fuel is added to make it work. The seasons (spring, summer, autumn, winter) provide the fuel to make lake processes work. Processes like oxygenation and de-oxygenation of the hypolimnion (bottom waters) are incorporated in the monthly slices of the state of the lake after lake mixing in June, and then become integrated into the annual TLI.

The monthly TLI is composed of data from the portion of the lake that is being oxygenated from the atmosphere. In Figure 9, the vertical tube represents the region of the lake that is sampled for the monthly TLI (which is representative of Lake Okareka itself). The sample is a vertical slice of the lake, captured in a tube. About September, the lake stratifies and the bottom water becomes isolated from the atmosphere and therefore does not have access to oxygen to re-oxygenate itself. At this stage water from the hypolimnion is not sampled. In the months that follow until June of the next year de-oxygenation takes place at a rate that is characteristic of the lake's state. Dead algal cells are the equivalent of BOD (biochemical oxygen demand) as they sink into the bottom waters. The dead algae use up oxygen as they decompose. Nutrients will be released from the sediment if oxygen falls to low levels. This is also a characteristic property of a lake and the rate changes as the state of the lake changes.

The monthly TLI does not take the hypolimnion processes into account until the June mixing. This is because it is at this stage that the nutrients become released into the general body of the lake and become available for algal growth. This is how the phenomenon of stratification, de-oxygenation and nutrient release can be expressed in a repeatable manner and incorporated into the TLI.

The hypolimnion processes (stratification, de-oxygenation and nutrient release) are reflected in the TLI. For example, dramatic changes in recent lake history at Lake Rotoiti can be seen in the TLI.

Table 5 Trophic Level Index of Lake Rotoiti, 1999-2003

Year	Rotoiti TLI	Comment
1999	4.05	The major change in the lake, which is well known is reflected in the elevated TLI in 2003.
2000	3.96	
2001		
2002	3.99	
2003	4.53	

Blue-green algal blooms occur more frequently above a certain TLI level. The worst quality waters experience the blue-green blooms e.g. Okawa Bay (TLI 5.3), Lake Okaro (TLI 5.7). Lake Rotoehu began to experience blue-green algal blooms in 1994 when the quality of the lake deteriorated and the TLI moved from 3.7 to 4.8. The Rotoehu TLI has fallen slowly since then and in 2004 no blue-green blooms occurred. The annual TLI will no doubt be closer to 3.7 for 2004 than to 4.8.

All the sites with blue-green algal blooms have been identified in the Regional Water & Land Plan as being above the specified baseline quality and requiring remedial actions derived in community-based Action Plans.

The one exception is Lake Tarawera. Here a large inflow of water with low nitrogen to phosphorus ratio enters the lake along the shoreline adjacent to Rotomahana. This favours blue-green algae and when conditions are calm they can assume bloom proportions. However, the process of formulating Action Plans will extend to all the Rotorua lakes in the near future.

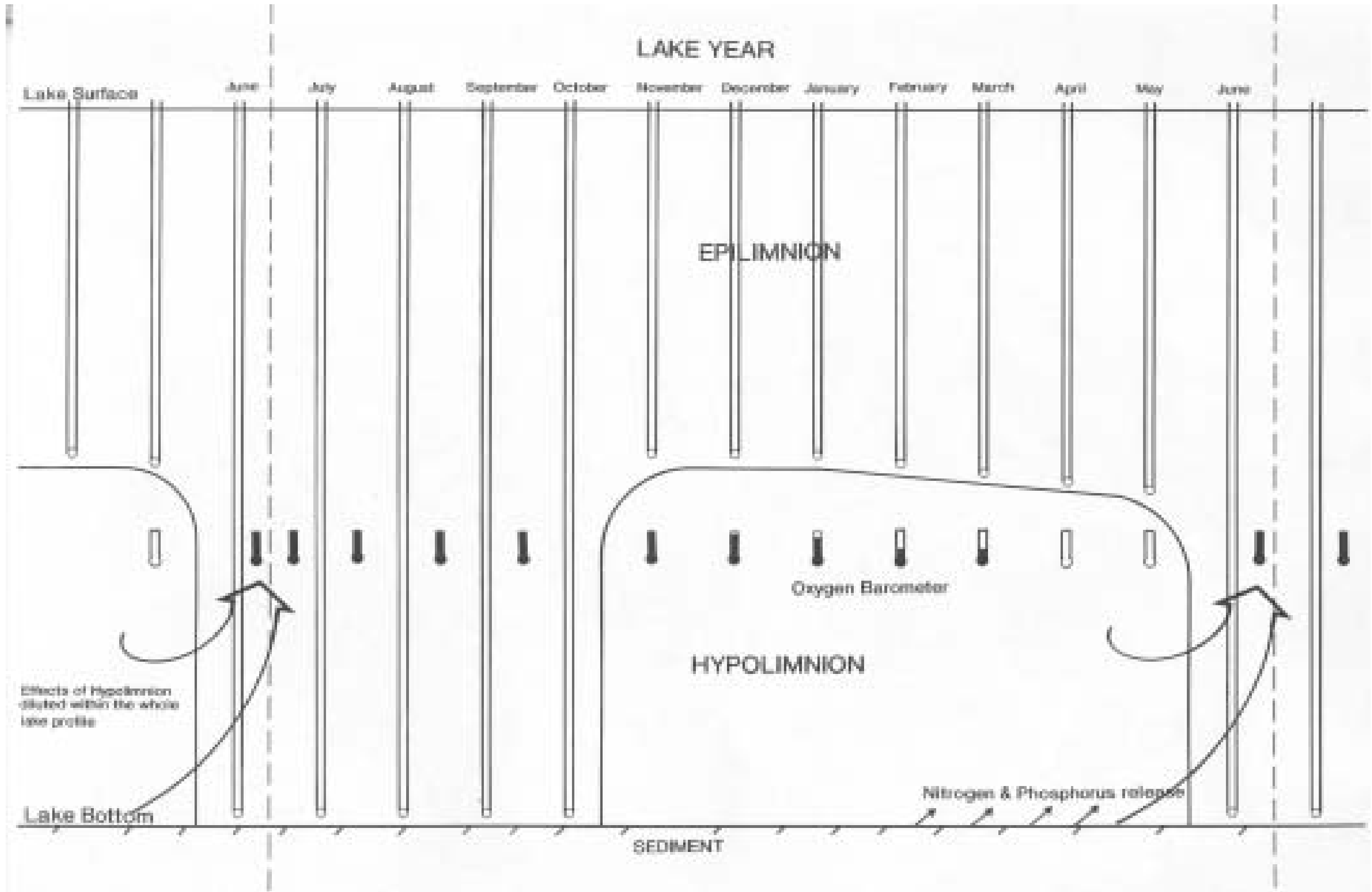

Figure 9 Annual Hypolimnion/Epilimnion Changes

Appendix 2 – Nutrient Export Coefficients

Catchment land use modelling is based on the premise that a certain area of land undergoing a certain land use will have a specific output of nitrogen and phosphorus that relates to that land use. This is termed its “nutrient export coefficient”. A range of geographical and climatic factors affects this output. Also the way in which the land use is carried out can vary, which again results in variation of the average output.

Various nutrient export coefficients have been used for land use modelling in Rotorua’s lake catchments. There can be a large variation in the total output calculated from the land to the lake depending on which study is used to derive export coefficients. For this Action Plan Cooper and Rutherford (2002) have modelled the lake concentrations of nitrogen and phosphorus to determine the most likely nutrient export coefficients.

The coefficients have units of kg/ha/year or tonnes/km^2/year and provide a nutrient output in kg/year or tonnes/year once the area of the particular land use is known. To derive the coefficients, catchments with specific land uses are monitored over an extended period of time. There are some difficulties in doing this in the typical volcanic catchments of the Rotorua lakes, where considerable runoff travels to the lake via groundwater.

Some specific studies have been undertaken to derive coefficients.

Cooper and Thomsen (1987) studied pasture, pine and native forest catchments at Purukohukohu between Rotorua and Taupo. Their data is frequently used for Rotorua lake catchments and was used by Bioresearches (1991).

Williamson et al (1996) modelled the Ngongotaha catchment of Lake Rotorua and export coefficients from that study have been used by Ray et al (2002a).

Ray et al (2002b) sampled groundwater around the perimeter of Lake Okareka as well as using stream inflow data to calculate export coefficients.

Bioresearches have also incorporated an urban component to account for the output from urban lands. This is a significant load so should be included.

Table 6 Lake Okareka Catchment Nutrient Export Coefficients

Land cover	Note	Area	Nitrogen	Phosphorus	Nitrogen	Phosphorus
		ha	t/km^2/yr		t/yr	
Bare ground	1	13	0.25	0.050	0.03250	0.00650
Forest indigenous	2	693	0.25	0.004	1.73250	0.02772
Forest planted	3	126	0.25	0.004	0.31500	0.00504
Grassland						
Sheep and beef	4	470	0.70	0.030	3.29000	0.14100
Sheep, beef and deer	5	28	0.70	0.030	0.19600	0.00840
Sheep	6	49	0.70	0.030	0.34300	0.01470
Beef	7	33	0.70	0.030	0.23100	0.00990
Deer	8	5	0.70	0.030	0.03500	0.00150
Other	9	28	0.70	0.030	0.19600	0.00840
Scrub mixed	10	75	0.25	0.004	0.18750	0.00300
Mixed woody vegetation mosaic	11	44	0.25	0.004	0.11000	0.00176
Urban						
stormwater	12	46	0.29	0.066	0.13340	0.03036
septic tanks	13	288 houses			2.37600	0.02000
Wetland		5				
Internal	14				0.50000	0.13000
Rainfall					1.30000	
Total		**1615**			**10.97790**	**0.40828**

Note:

1	Estimate for the quarry area.
2-4,6,7,9-11	Ray and Timpany (2000b).
5,8	Estimate for deer as similar to sheep.
12	Urban stormwater derived from paper of Ray, Macaskill, Phillips, Golding, Bowman to the Lakes Symposium.
13	Nitrogen based on 10 g nitrogen per person per day and 2.3 people per household. Phosphorus based on monitoring data from Tauranga harbour sites with communities on septic tanks.
14	Based on Environment Bay of Plenty monitoring data.

Appendix 3 – Working Party Members

1	Jack Smith	Community
2	Roger Lorigan	Community
3	Lara Meyer	Community
4	Campbell Johnstone	Community
5	Sheryl Lyons	Community
6	John Herbert	Rural land-owner
7	Fenella Playne	Rural landowner
8	Marcel van Leeuwen	Rural landowner
9	James Blakely	Lake Okareka Ratepayers and Residents Association
10	Rod Stace	Lake Okareka Ratepayers and Residents Association
11	Malcolm Short	Federation of Maori Authorities
12	Rick Vallance	Ngati Whakaue Tribal Lands
13	Gifford McFadden	Federated Farmers
14	David Marshall/Phil Alley	Department of Conservation
15	Andy Garrick	Fish & Game (Eastern Region) New Zealand
16	Anaru Rangiheuea	Te Arawa Maori Trust Board
17	Neil Oppatt	Councillor Rotorua District Council
18	Janet Wepa	Councillor Rotorua District Council
19	Peter Barry	Councillor Rotorua District Council
20	Rosemary Michie	Councillor Environment Bay of Plenty
21	Bill Cleghorn	Councillor Environment Bay of Plenty

Staff Support

Environment Bay of Plenty :	John McIntosh (Manager Environmental Investigations) Paul Dell (Group Manager Regulation & Resource Management, Lakes Project Coordinator) Clive Tozer (Group Manager Operational Services)

Rotorua District Council:	Paul Sampson (District Engineer) Greg Manzano (Utilities Planning Manager) Nigel Wharton (Director, Environmental Services) Marc Fauvel (Policy Planner)

Appendix 4 – Evaluation of Nutrient Reduction Options

Criteria for Evaluation

Is the option proven?

(low risk)	A	Well proven, results known and tried in full operation.
	B	Principles understood. Variable % of nutrient removed in known examples.
	C	Limited field trials with variable success
(high risk)	D	Untried – no scientific support

What % of the nitrogen reduction target can the option achieve?

(%)

A	81 – 100
B	61 – 80
C	41 – 60
D	21 – 40
E	0 – 20

What % of the phosphorus reduction target can the option achieve?

(%)

A	81 – 100
B	61 – 80
C	41 – 60
D	21 – 40
E	0 – 20

What is the level of risk in implementing the option?

A	Able to implement with certainty (consents not required/gained, landowners agree)
B	High likelihood of being implemented (Consents likely to be gained, landowners likely to give approval, good community support)

C Uncertainty over ability to implement
(possible public process required, appeals likely, uncertain whether landowners agree)

D High probability of not being able to be implemented (Adverse reaction known, lack of community support)

E Unrealistic to expect implementation

What is the cost per tonne of dominant nutrient removed?

($ million)

F $2.5

E $2.1 – 2.5

D $1.6 – 2.0

C $1.1 – 1.5

B $0.6 – 1.0

A $<0.5

The Group discussed in detail the best way to try and cost both nitrogen and phosphorus. In the end it was decided to use the dominant nutrient. Where reductions in both nutrients are achieved it is not possible to split the cost per nutrient.

What is the timeframe for reduction in nutrient impacts from this option?

(years)

A 0 – 5

B 6 – 10

C 11 – 30

D 31+

Will the option impact other values positively or negatively?

A There will be significant positive impacts on other values

B There will be some positive impacts on other values

C No significant impact on other values

D There will be some negative impacts on other values

E There will be significant negative impacts on other values

'Other values' include values of things like wetlands, reserves, landscape, fisheries, or economic growth.

Will it adversely/positively impact another catchment?

A Significant Positive Impacts reduce another catchments nutrient level.

B Moderate Positive Impacts

C No Impacts

D Moderate Negative Impacts

Weighting

For the purposes of ranking a points system was applied however the working party felt that a written description was of more relevance when the information was presented to the wider community. The weightings indicate the significance that the working party considered appropriate for each criteria.

Table 7 Weighting of Criteria

	Criteria	Weighting
1	Is the option proven	3
2	What % of N target can option achieve	2.5
3	What % of P target can option achieve	2.5
4	What is the level of risk in implementing the option	2
5	What is the cost per tonne of dominant nutrient removed	2
6	What is the time reduction in nutrient impacts	1
7	Will the option impact other values (+ve/-ve)	1
8	Will it adversely/positively impact another catchment	1

Evaluation Table

Table 8 Evaluation of Options

<table>
<tr><th>Option</th><th>Proven</th><th>Nitrogen</th><th>Phosphorus</th><th>Risk</th><th>Cost</th><th>Time</th><th>Other Values</th><th>Other Catchment</th><th>Rank</th></tr>
<tr><td>multiplier</td><td>3</td><td>2.5</td><td>2.5</td><td>2</td><td>2</td><td>1</td><td>1</td><td>1</td><td></td></tr>
<tr><td rowspan="2">Sewerage (280)</td><td rowspan="2">A</td><td>B *</td><td>A</td><td rowspan="2">C</td><td rowspan="2">F</td><td rowspan="2">A</td><td rowspan="2">C</td><td rowspan="2">C</td><td rowspan="2">3≈</td></tr>
<tr><td>A (1.9)</td><td>B (0.01)</td></tr>
<tr><td rowspan="2">Sewerage (200)</td><td rowspan="2">A</td><td>D*</td><td>C</td><td rowspan="2">C</td><td rowspan="2">F</td><td rowspan="2">A</td><td rowspan="2">C</td><td rowspan="2">C</td><td rowspan="2">7</td></tr>
<tr><td>C (1.3)</td><td>D</td></tr>
<tr><td>Cartage</td><td>A</td><td>A (2.3)</td><td>A (0.02)</td><td>D</td><td>F</td><td>A</td><td>D</td><td>D</td><td>5</td></tr>
<tr><td>O/S nutrient stripping</td><td>B</td><td>C (1.4)</td><td>E (0.01)</td><td>C</td><td>F</td><td>A</td><td>C</td><td>C</td><td>11</td></tr>
<tr><td>200 ha pasture to forest</td><td>A</td><td>D (0.9)</td><td>B (0.05)</td><td>B</td><td>D</td><td>B</td><td>B</td><td>C</td><td>2</td></tr>
<tr><td>400 ha pasture to forest</td><td>A</td><td>B (1.8)</td><td>A (0.10)</td><td>D</td><td>D</td><td>B</td><td>D</td><td>C</td><td>3≈</td></tr>
<tr><td>100 ha pasture to lifestyle</td><td>A</td><td>E (0.35)</td><td>E (0.01)</td><td>B</td><td>A</td><td>C</td><td>D</td><td>C</td><td>6</td></tr>
<tr><td>200 ha land converted. Buy – sell</td><td>A</td><td>D (0.9)</td><td>B (0.05)</td><td>C 100</td><td>A</td><td>B</td><td>B</td><td>C</td><td>1</td></tr>
<tr><td>Riparian **</td><td>A</td><td>E</td><td>E</td><td>B</td><td>F</td><td>A</td><td>B</td><td>C</td><td>8≈</td></tr>
<tr><td>Hypolimnetic Discharge & Treatment</td><td>C</td><td>E (0.01)</td><td>C (0.03)</td><td>C</td><td>A</td><td>A</td><td>C</td><td>D</td><td>8≈</td></tr>
<tr><td>Wetlands (all)</td><td>B</td><td>E (0.3)</td><td>E (0.01)</td><td>C</td><td>A</td><td>A</td><td>B</td><td>C</td><td>10</td></tr>
<tr><td>Treatment wall</td><td>C</td><td>E50</td><td>E</td><td>C</td><td>?</td><td>?</td><td>?</td><td>?</td><td>12</td></tr>
<tr><td colspan="10">* The different evaluation is dependent on whether the system is focussed more on one nutrient or the other.
** Riparian works out as a very high cost /nutrient removed, mainly because it is phosphorus being removed and the rates are low. If the riparian area removes nitrogen (e.g. riparian wetland) then it could score higher total points. This would be a better approach than utilising a treatment wall at lake edge sites as is shown in Max Gibbs work on the riparian wetlands.</td></tr>
</table>

Appendix 5 – Proposed Regional Water and Land Plan Progress Summary

Environment Bay of Plenty's Proposed Water & Land Regional Plan identifies adverse effects on lake quality as a major issue in the Bay of Plenty region. Objective 10 of the Plan sets Trophic Level Indices (TLI) for each of the twelve Rotorua Lakes. The Plan adopts an integrated catchment management approach to lake quality to address the effects of all activities in a catchment, in particular the discharge of nutrients. Nutrients result from both:

- Point source discharges (sewage discharges, septic tanks, dairy shed effluent), and
- Export (leaching) of nitrogen and phosphorus from land use activities (also referred to as diffuse discharges).

A 'package' of non-regulatory and regulatory methods is specified in the Plan to achieve nutrient management in the lakes catchments. This is illustrated in the following Table 9.

Table 9 Regulatory and Non-Regulatory Methods to Achieve Lake Nutrient Reductions

Method	**Explanation**	**Application**	
		All Lakes	**Degraded Lakes**
Non-Regulatory Methods			
Riparian retirement	Encourage and fund the fencing and planting of riparian areas	✓	✓
Action Plans	Refer to this document	✓	✓ (degraded lakes are a priority)
Land acquisition	Buy land from willing sellers for retirement from production *i.e.* as a regional park		✓
Education on nutrient management	Educate community on appropriate nutrient management practices	✓	✓
Best management practices guidelines	Develop and document best nutrient management practices-Links to education	✓	✓
Environment Bay of Plenty Environmental Programmes	Plans to address environmental effects from a property – site specific and developed with landowner	✓	✓
Lake quality monitoring	State of the environment monitoring	✓	✓
Regulation			
Rules in section 9.4 ("Rule 11")	See over page for explanation	[1]	✓
Point source discharges	Discharges from sewage schemes, dairy sheds, etc to meet specified environmental standards	✓	✓

[1] Regulation may be introduced for other lakes where an Action Plan identifies that this is necessary to maintain or improve lake water quality. This would be through a plan change process in accordance with the requirements of the Resource Management Act 1991.

Section 9.4 of the Proposed Regional Water and Land Plan

The following relates to section 9.4 of the Proposed Regional Water and Land Plan as amended by Council's decisions on submissions (version 8.0), and does not account for possible changes made in relation to appeal resolutions.

Section 9.4 of the Plan (previously known as 'Rule 11') contains a series of rules to address the export (diffuse discharge) of nutrients from land use activities. The land use regulations only apply to the catchments of Lakes Rotorua, Rotoiti, Rotoehu, Okareka, and Okaro (i.e. where there is degraded lake water quality). Residential development within existing urban areas or settlements, or sub-divisions that exist as at 30 June 2004 are not restricted by the rules. Discharges from household effluent systems are addressed by specific rules in the review of the On-Site Effluent Treatment Plan (draft to be released for comment in June 2004).

The rules draw a 'line in the sand' regarding nutrients in the lakes catchments. Landowners of properties outside urban areas and settlements in the targeted lake catchments are to register the annual average export of nitrogen and phosphorus from the past three years, as measured by a baseline at 30 June 2004. Section 9.4 aims to prevent additional inputs of nutrients from land use activities in each lake catchment by capping nutrient exports at baseline levels. The community has already contributed to nutrient reduction measures (e.g. Rotorua sewage discharge to land system, riparian planting), and it would be unfair to allow land use changes to 'consume' the nutrient reduction benefits paid for by the community.

The rules restrict any activities that result in a net increase in the export of nitrogen or phosphorus from properties, including:

- Intensification of agricultural activities.
- Land use changes, such as dairy conversions.

Section 9.4 uses an effects-based approach. If a person intensifies their land use, but does not cause an increase in the export of nutrients from the property, the activity is permitted. For example, the person may identify that they can off-set an increase of nutrients by using mitigation measures such as retiring riparian margins, using a feed lot in winter, using a different stock food, etc. In this way the increase in nutrients is balanced by measures to reduce nutrients and there is no net increase in nutrients. An increase of no more than 10% of nutrient exports from the baseline is provided for in the rules to allow for statistical variation in nutrient models used to assess the nutrient exports.

There is also a rule to address the nitrogen and phosphorus component of point-source discharges of contaminants within the lake catchments.

Table 10 summarises that status of land use changes and intensification under Section 9.4:

Table 10 Status of Land Use Changes under Section 9.4

Activity	Status under Section 9.4
Existing land uses, where the export of nitrogen or phosphorus from the property does not increase above a baseline at 30 June 2004.	Permitted
Land use in existing urban areas, settlements and sub-divisions	Permitted
Changes to land use that decrease the export of nitrogen or phosphorus from the property relative to a baseline at 30 June 2004.	Permitted
Changes to land use that increase the export of nitrogen or phosphorus from the property where: • The increase is no more than 10% relative to the baseline; or • The increase above 10% can be fully off-set by nutrient management practices on the property.	Permitted
Changes to land use that increase the export of nitrogen or phosphorus from the property where the increase above 10% can be fully off-set by nutrient management practices within the same lake catchment.	Controlled
Changes to land use that increase the export of nitrogen or phosphorus from the property where the increase above 10%, and no mitigation measures have been identified by the applicant.	Discretionary (restricted)
Increases in the discharge of nitrogen or phosphorus from point source discharges	Discretionary (restricted)

The matters over which Environment Bay of Plenty retains control or discretion where a resource consent is required are measures to avoid, remedy or mitigate adverse effects on water quality, including surface water and groundwater (*i.e.* the rule is aimed at the issues that Environment Bay of Plenty is responsible for under the Resource Management Act).

Monitoring

The provisions in the Water and Land Plan that apply to monitoring of Lake Okareka and catchment are listed below.

Policy 22 — To research and monitor the effects of land use practices on surface and groundwater quality, and take appropriate action where such investigations indicate land use has significant adverse effects on water quality, or there is a high risk that future development would adversely affect water quality. This is particularly relevant to lakes, and groundwater used for municipal water supply.

Policy 29 — To continue to monitor and investigate the cause and effect of biological responses to the adverse effects of use and development activities. This includes, but is not limited to, aquatic weed, algal blooms and lake ‘foams’.

Method 51B — For the purposes of implementing section 9.4, Environment Bay of Plenty will use the following methods to assist the assessment of changes in nutrient export, and compliance with the requirements of section 9.4:

(a) The development of a protocol that will assist the exchange of information between Environment Bay of Plenty and Rotorua District Council for the purpose of assessing which land use of subdivision applications have the potential to increase nutrient export.

(b) Monitoring of catchments to provide information on land use and land use change.
(c) The investigation and evaluation of nutrient budget models at the property scale.
(d) Provision of advice to resource users on best nutrient management practices.

Method 52 Support the establishment and maintenance of community-based state of the environment monitoring programmes.

Method 54 Continue to monitor the state of the environment in the Bay of Plenty in accordance with Environment Bay of Plenty's Natural Environment Regional Monitoring Network (NERMN), and existing compliance and impact monitoring programmes.

Method 55 Use existing impact and state of the environment monitoring programmes to assess the combined effects of discharges of contaminants to water and surface water abstractions on water quality.

Method 56 Continue to investigate and clarify the nutrient exports of different land uses, and best nutrient management practices.

Method 56A Identify and monitor key sites in the catchments of lakes where Action Plans are developed to assess the extent of nitrogen and phosphorus reduction in the catchment.

Method 57 Use the results of NERMN monitoring to assess the effects of land use activities and changes in land use patterns on surface water and groundwater quality and quantity. With regards to water quantity, climatic variations, re-vegetation and other natural events will be taken into account.

Method 62 When bacterial or cyanobacterial levels are above that specified in the Water Quality Classification for an individual lake, river or stream, or other conditions arise that pose a risk to human health:

(a) Liaise with the Medical Officer of Health, District Councils, and the community. Investigate the cause of the problem and take action where appropriate.

Method 65 Monitor the following:

(a) The effectiveness of riparian management and plantings on water quality and instream biota using a programme that is consistent with national guidelines.

(b) Sites protected under covenants that are part of Environment Bay of Plenty Farm Plans, Environmental Plans and Environmental Programmes.

Appendix 6 – Proposed Variation 12 to Rotorua District Plan Progress Summary

In January 1998 the Environment Court directed Rotorua District Council (the Council) to undertake a Variation (a change) to the Proposed Rotorua District Plan (2002) to take better account of the landscapes and natural features of the Rotorua Lakes environment, which includes the catchment of Lake Okareka.

The work undertaken by the Council as a result of the Court's directive has resulted in Variation Twelve – Lakes A Zone. There are 18 objectives to the Variation which taken together form a Vision for how Council wants to see the area developed. The Vision Council has for the Lakes A Zone includes maintained or enhanced indigenous biodiversity and natural character of the Lakes Catchments, land management practices that avoid adverse effects on water quality, aquatic ecosystems, and wetlands, retained landforms, protected view shafts, acknowledgement of the settlements of Okareka and Tarawera, acknowledgement of Tangata Whenua, and recreational activities that do not detract from the natural character or landscape, protected viewpoints, and scenic corridors of selected roads.

This process has taken almost 6 years from the date that Council received the decision of the Court through the notification, submission and hearing processes.

Council decisions on Variation 12 were mailed to submitters on 1 May and publicly notified on 4 May 2002. Seventeen (17) References were received and replies were lodged with the Environment Court. Three of the appeals were subsequently withdrawn (Rangitihi, Allan and Federated Farmers).

The matters proceeding to go before the Environment Court concerned the provisions of the Variation in dealing with the development of Maori land and Bush Settlements. The Environment Court hearing of the appeals started in February 2004 but the hearing of the Iwi and Tarawera Lakes Protection Society References was subsequently adjourned.

The Court reconvened on 20-22 April to hear the McLean and Royal cases. The Court's decision in respect of all of the References relating to Bush Settlement matters is now awaited.

Three consent orders have been issued by the Court and a further four consent orders are circulating with the parties for signature. Two consent orders to resolve the Iwi references have been prepared and legal submissions prepared for the Court on points of difference.

It was indicated at the last hearing that the Court anticipated making a decision within two months and in this regard it is hoped that the decision will be available before the end of July 2004. The outcome of this decision will give direction as to whether bush settlement and new settlement areas proposed under the variation will be available development options in the catchment of Okareka.

Appendix 7 – Photos of Lake Okareka and its Catchment

Figure 10 *Lake Okareka, viewed from east to west, across the urban area to Lake Rotorua in the background. The Millar Rd stream catchment is at the top, right. The riparian area currently being retired is the lake margin at the bottom left.*

Figure 11 *The urban area of Lake Okareka showing the peninsula with farmland behind and to the right the road heading south to Tikitapu (the Blue lake). The bush catchment to the right of the road drains to the stream that enters the lake at the base of Summit Rd. This stream has very low nitrogen levels, which suggests that denitrification works efficiently in the adjacent wetland.*

Figure 12 Lake Okareka, viewed from west to east, across from the settlement to farmland on the southern edge of the lake, where the riparian margin of Lake Okareka is currently being retired from grazing.

Figure 13 The outlet of Lake Okareka flows a short distance from the lake. From there it is piped through the hill to join a spring fed stream flowing into Lake Tarawera.