N.Z. Motor Caravan Assn. Inc.

The Association of Self-Propelled Caravans.

SUBMISSION TO CHRISTCHURCH CITY COUNCIL CITY SERVICES COMMITTEE.

PREPARED AND PRESENTED BY E PETER HEATHERINGTON ON BEHALF OF THE NEW ZEALAND MOTOR CARAVAN ASSOCIATION INCORPORATED.

SUBJECT: DUMP POINTS FOR DISPOSAL OF EFFLUENT FROM CARAVANS AND MOTOR CARAVANS

NZMCA PURPOSE STATEMENT

The purpose of the NZMCA is to foster and advance the Motor Caravan movement by providing relevant services and information, promoting fellowship, vehicle safety, road courtesy and protection of the environment.

BRIEF HISTORY OF THE NEW ZEALAND MOTOR CARAVAN ASSOCIATION.

The New Zealand Motor Caravan Association (NZMCA) was formed in 1956 and has been an Incorporated Society since 1970. An Insurance scheme for motorhome owners was organised and adopted during the late 1960's. After three years of study and negotiation, Self Containment for motorhomes was adopted by the Association in 1976 as a desirable requirement for motorhomes. However, it was not until 1990 and after considerable development that self containment was accepted by the Ministry for the Environment as the New Zealand Standard NZS 5465 1990.
NZMCA now offers incentives to members to have their vehicles inspected by certified Officers. Should the equipment within the vehicles meets the requirements of the NZ Standard, then a Self Containment warrant will be issued for that vehicle. An increasing number of members are up grading facilities to obtain Self Containment warrants.
NZMCA has a 10 point Environmental Care Code, the purpose of the code is self explanatory, and in the main is adhered to by the membership. Membership is also proud to promote the NZMCA Clean Green Image.

The NZMCA is a growth organisation, the membership growth rate is set out below:

#	1- 1000	19 years		representing	500	motorhomes
#	1001 - 2000	6 years		--	1000	--
#	2001 - 3000	5 years		--	1500	--
#	3001 - 6000	7 years		--	3000	--
#	6001 - 10,000	3 years		--	5000	--
#	10,001 - 12,000 +	2 years	1998	--	6000 +	--

It has been suggested there is a proportional increase in the number of rental motorhomes becoming available for hire, along with privately owned vehicles the owners of which are not members of NZMCA. I understand some rental firms are providing effluent holding tanks in new vehicles.

The problem of disposal of effluent was of concern to Officers of the NZMCA back in 1976. They negotiated with Government Departments with the view of establishing facilities to dispose of effluent.
On 9 October 1987 NZMCA Officers, along with other organisations, and including representatives from the Department of Health, Department of Conservation and Ministry for the Environment reached an agreed action plan, ISBN 0-477-05834-5 dated January 1988 refers.
Page 21 of the above mentioned document headed RECOMMENDATIONS FOR THE FUTURE MANAGEMENT lists the options for future management.
Item 2 refers to "provision of more toilet facilities at campsites and rest areas"
Item 3 refers to "provision of more sewage disposal points"
Item 6 refers to "Officially adopting national standards for self containment and disposal point construction"

Item 2. Is applicable to the Christchurch City Council in that I would suggest the provision of toilets in all parks and reserves, where possible to provide same at a reasonable cost.

Item 3. Is applicable to the Christchurch City Council.

Item 6: A national standard has been established covering the minimum requirement for self containment for motor caravans and boats. NZS 5465 1990 refers. A standard has been provided for construction of disposal points Christchurch City Council TW1 33 refers. I must point out that while it may be desirable to have a self contained room as shown on TW1 33 it certainly is not a requirement. A room as shown is used to empty porta-pottie and cassette type toilets, however these types of toilets may be emptied into the typical in ground dump point installation. Of course the facility can be provided at a fraction of the cost without the self contained room.

Owners of motorhomes, hirers of rental motor homes and caravanners, have in the main actioned requirements suggested in item 6 regarding the minimum standard of Self Containment for vehicles. The requirements of items 2 & 3 have not been actioned. This causes a major problem in that vehicles have effluent holding tanks but there are no public dump points in the city.

Christchurch City Council was not represented at the Consultative Group meeting held on 9 October 1987. However the report states that the Municipal and Counties Associations were UNABLE TO SEND REPRESENTATIVES TO THIS MEETING that indicates those Associations would have been invited.

Appendix 1, clause b, headed, Agreed Actions, item 5 states "The Department of Health will send a circular to local authorities encouraging provision of dump stations in areas other than camping grounds"

A foot note to appendix 1, states "the Municipal Association and Counties Association, should be asked to adopt a policy of advising local authorities"
1. "To take the initiative in organising provision of dump stations in their regions, eg. through joint ventures between commercial interests;"
2. "Of the need to ensure existing toilet facilities are well signposted and maintained".

Eleven years after the report was released we have many caravans and motor caravans owned by Christchurch property owners, or visiting in Christchurch, fitted with effluent tanks, and no **public** dump points available to dispose of effluent.

As a Rate Payer, I believe the Christchurch City Council has a responsibility to provide public dump points, and I trust I will have convinced this Committee that the Council should accept that responsibility.

Yes, there are dump points available at some camping grounds. However the Proprietors of some camping grounds will not permit effluent dump points to be used unless the owners of the vehicle have "overnighted" at that camp. Other Proprietors charge ridiculous prices for use of the dump point, while access to dump point in other camps is so restricted only small vehicles can use the facility.

Since February 1997, I have consulted and corresponded with several City Council Officials on the subject of establishing dump points located on, or close to, the four main routes into and out of the city.
Alas, I have not been successful. While there has been agreement that the facilities are required, there have been many reasons given for the lack of progress, the main one being the location of such facilities.

On 7 September 1998 I wrote to the Manager Waste Unit, suggesting a Working Party, involving a representative from each of the City Council Units affected, be arranged to discuss the problem of the location of dump points. The Manager responded to my letter, however, there was no agreement as to a Working Party.
Location is still the main problem. Cost of the installations was a concern to me. However this should have been resolved by the suggestion that the facilities be located near a sewer, with the least expensive option being close to an exiting toilet block.

On 9 November1998, I wrote to the Chairperson of the City Services Committee, as a result of that correspondence I was invited to discuss the subject matter with the City Services Committee.

The availability of PUBLIC dump points on the four routes into and out of the City is of value to the City.
Some of the advantages are:
Further support of "The City that shines" logo.
Considerably reduces the risk of unauthorised dumping of effluent within the city boundaries

Make the City a more environmentally friendly City.
Visitors will spend more time within the City enjoying all the facilities the Council has so generously provide.
Because visitors spend more time in the City it follows that more tourist dollars will be captured.
Owners of motorhomes and caravans who are Rate Payers have a facility within their City which saves them the inconvenience of travelling out of the area to dump.
The City will be recognised as providing a facility that has been available in smaller centres for many years.

I wish to thank the Committee Members for their attention and resulting dialogue, and anticipated support in progressing the establishment of the four dump points to an early conclusion.

Yours Faithfully

E Peter Heatherington
Resourse Assistant
NZMCA

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BACKGROUND INFORMATION FOR PRESENTATION TO THE CITY SERVICES COMMITTEE ON *PHRAGMITES AUSTRALIS* BY THE ROYAL FOREST AND BIRD PROTECTION SOCIETY.

Decision Requested

1 Given that:

1) *Phragmites australis* is a recognised biosecurity risk; and,
2) The use of *Phragmites australis* is unlikely to be authorised in the foreseeable future under the Biosecurity Act.
3) The presence of effective benign alternatives may preclude consent being given under the Resource Management Act.

2 That the Council decides to:

1) End the present experimentation with *Phragmites australis* until such time that the use of Phragmites australis can be considered safe.
2) Consider allocating the funds - expected to be spent on Phragmites - to the development of native plant alternatives for use in wetland sewage treatment in Christchurch.

Phragmites australis is recognised as a biosecurity risk.

3 *Phragmites australis* is a widespread reed which grows in most parts of the world. It is native to Australia, but for some reason (probably the relative isolation of New Zealand) it is not native to New Zealand. In all places where *Phragmites australis* is used commercially it is native.

4 *Phragmites australis* has a number of characteristics which make it a potentially successful weed. It is a vigorous grower and reproduces vegetatively by the formation of underground rhizomes. The rhizomes are difficult to destroy making the plant difficult to kill. Like bamboo, the rhizomes are hard-tipped and pointed with considerable penetrating power. The growth form of *Phragmites australis* will crowd out other plants.

5 It is unfortunate that many of the characteristics which make the plant ideal for wetland sewage treatment also make it an effective weed.

6 *Phragmites australis* is recognised as a biosecurity risk. In 1993 the now former Ministry of Agriculture and Fisheries assessed the plant as a biosecurity risk and ranked it amongst the worst eight water weeds in New Zealand (encl.). *Phragmites australis* is considered to be among the world's worst weeds.

Risk is unnecessary.

7 There are native alternatives to *Phragmites australis*. Much of the work on native plants for wetland sewage treatment has been carried out by the National Institute of Water and Atmospheric Sciences (NIWA) which has produced a booklet of guidelines for the use of native plants in wetland sewage treatment systems (see encl.).

8 The use of native plants has been proposed for the Christchurch City Council's own proposals for the Belfast wastewater upgrade. If the Council wishes to pursue an environmentally benign form of wetland sewage treatment without the biosecurity risks posed by *Phragmites australis* it can do so.

An alternative approach

9 As has been shown above, the use of the plant *Phragmites australis* in wetland sewage treatment systems is unnecessary. Hence the Council can choose to pursue the use of wetland treatment systems (indeed Forest and Bird would encourage the Council to do so) without resorting to a biosecurity risk.

10 The Council could decide to be a leader within New Zealand by utilising native alternatives to Phragmites, alternatives that have been proven to work (see encl.).

11 Presently, the Council spends a small amount of money on research into the use of Phragmites australis. Given that the plant is unlikely to ever be permitted for use in New Zealand, the Council faces the likelihood that the information gained from this research will never be put into practice.

12 An alternative strategy for the Council could be to use the money it is planning to spend on Phragmites australis to trial the use of native species for Christchurch's sewage treatment. This is an area of work that is likely to attract Sustainable Management Fund or similar funding. As a stakeholder in the natural environment, Forest and Bird would actively support such an approach.

13 The use of native species in wetland sewage treatment systems would compliment the successful work of the Council in restoring Christchurch's waterways. Christchurch's areas of natural habitat are considerably diminished and the formation of wetland sewage treatment systems that use native species could be a significant step forward in the restoration of suitable indigenous habitat.

Geoff Keey
Researcher
17.3.99

From a submission by Forest & Bird 1998

4.1 This is understood to be the first application that the Canterbury Regional Council has considered under s80D of the Biosecurity Act. Hence there is value in identifying the principles and questions that should be addressed when assessing applications under s80D.

4.2 **The Precautionary Principle.**

There is a history in New Zealand of well-intentioned introductions of 'useful' species that have gone wrong - gorse, rabbits, ferrets, stoats, possums with major impacts on native wildlife and habitats and a significant economic cost. The outcome of introducing or increasing the use of non-native species is generally uncertain and unpredictable. Hence the burden of proof should lie with applicant in demonstrating that the species does not pose a threat to indigenous ecosystems. Where the species has recognised pest characteristics the test should be very strict. Any risk assessment should address the likelihood of further applications as a result of an initial precedent and the problems that could pose for pest control in the future.

4.3 **Risk assessment should be based on ecology.**

Assessment of the environmental risk should be based on a thorough assessment of the ecology of the pest species that is proposed to be used. Such an assessment should include documented evidence to identify, amongst other things, the plant pest's:

- Invasive abilities;
- Habitat limits;
- Competitive ability;
- Potential effects;
- Methods of spread including the range and distribution of vector species;
- Methods of control and effectiveness.

4.4 **Relate the ecology of the species to the site of the application.**

The risk assessment should relate the ecology and methods of control of the species to the location to which the application for an exemption is sought. The risk assessment should consider possible receiving environments, the vectors which may be present either now or in the future and the appropriateness of control methods to the areas to which the pest could spread.

4.5 **Consultation.**

Any application for an exemption to a clause in a pest management strategy should outline the consultation undertaken and evidence of consultation with affected parties should be shown. This has not been done in this application.

4.6 **Consideration of alternatives.**

The application should show what alternatives were considered and the grounds under which they were rejected. This has not been done in this application, despite there being known viable alternatives.

5. The risk of using Phragmites australis.

5.1 *Phragmites australis* has the potential to become a serious plant pest should its distribution be permitted to increase.

5.2 The Ministry of Agriculture and Fisheries (as it then was) assessed the weediness of a number of noxious plants in New Zealand in *Biological Success and Weediness of the Noxious Plants of New Zealand.* The information for this review was gleaned from a combination of available world literature and the personal knowledge of the authors. In the review, *Phragmites australis* was assessed according to:

- Its capacity for obstruction of waterways (3/3)
- Suppression of other species (3/3)
- Health impairment (1/3)
- Water quality impairment (2/3)
- Damage to natural areas (3/3)
- Extent of suitable habitats (3/3)
- Resistance to management practices (3/3)

5.3 This assessment gave the weed a ranking of 18/21 which compares with water hyacinth (19/21), alligator weed (18/21), Lagarosiphon (18/21). The review classed *Phragmites australis* as one of eight wetland 'superweeds'. The assessment is appended.

6 Necessary to use *Phragmites australis*?

6.1 Forest and Bird does not believe that it is necessary to use *Phragmites australis* in wetland treatment. Suitable indigenous alternatives should be used instead.

6.2 The Christchurch City Council is proposing to use a subsurface wetland treatment system in Belfast which will be using indigenous species. The species that are proposed to be used in association are:

Reedbed

Schoenoplectus tabernaemontani (formerly *S. validus*), lake bullrush

Baumea articulata, jointed twig rush

Edge and embankment

Phormium tenax, harakeke or native flax
Carex secta, purei, makura
Carex geminta
Carex virgata
Carex maorica
Carex coriacia
Cyperus ustilatis

6.3 The National Institute of Water and Atmospheric Research has developed guidelines for the development of wetland treatment systems, primarily for the treatment of dairy farm effluent (although as 6.2 above shows, the systems are not restricted to dairy farm effluent). Their guidelines include a range of indigenous species that can be used for wetland treatment systems. These guidelines also warn against the use of *Phragmites australis.*

6.4 Forest and Bird notes that there is no reference source of information supplied by the applicant to support the assertion that *Phragmites australis* has 5-6 times the delivery capacity (of oxygen to the rhizosphere) of the next most efficient species, or that this results in reed beds that are five times as efficient..

7. General comments on the application.

7.1 Forest and Bird considers that the application contains significant deficiencies, particularly in its failure to consider alternatives and the weak assessment of environment risk. There is no reference to New Zealand literature which clearly indicates that the *Phragmites australis* has serious potential as a weed species, claims about the benefits of *Phragmites australis* are unsubstantiated and there is no recognition that indigenous species are a satisfactory alternative.

7.2 The assessment of effects is of questionable value because it has not been prepared by an independent ecologist or agency but by a company that is committed to the use of the weed for its own commercial gain.

7.3 Given the poor quality of the assessment of environmental risk, Forest and Bird does not have confidence that the applicant has sufficient awareness or grasp of the risk posed by *Phragmites australis* for there to be any confidence in the ability of the applicant to prevent its spread were permission to be gained.

7.4 Forest and Bird has no confidence in the proposed methods of control. Imazapyr has been withdrawn from the New Zealand market. Forest and Bird would be

extremely concerned if control involved spraying plants on waterways, especially if those areas contained significant botanical values.

8 Decision requested.

Forest and Bird requests that the application by Oceans Environmental on behalf of the Selwyn District Council for an exemption to rule 7.1 of the Regional Pest Management Strategy be declined.

Kevin Smith,
Conservation Director,
Royal Forest and Bird Protection Society.

Forest & Bird statement of evidence at hearing

26 The applicant may well present an argument that their proposed measures of control are as effective or more effective than compliance. Given that the applicant is proposing to establish risk where there is presently none, this would be a bold argument. However Forest and Bird recognises that the applicant may attempt to mount an argument on these grounds. Hence the test in 80D(2)(b) may apply in this case.

27 The key question with regard to this test is whether the Canterbury Regional Council can have confidence that the applicant's proposed measures are as effective or more effective than compliance, which in this case involves the prevention, rather than management of risk.

28 The applicant may mount an argument that it is unreasonable or innapropriate to enforce the ban on propagation. Hence, the test in 80D(2)(c) may apply. In this particular case the question that would need to be addressed is whether the Canterbury Regional Council can be satisfied that enforcing the ban in this case is either unreasonable or innapropriate and this would hinge to some degree on the availability of alternatives.

29 The applicant may present an argument that the development of their cultivar is an event that makes compliance either unnecessary or innapropriate (s80D(2)(d)). The test that applies here is similar to that of s80D(2)(a) in that the Canterbury Regional Council would need to be confident that the proposed cultivar was unable to spread and therefore posed little or no risk.

Does *Phragmites australis* pose a significant risk?

30 When considering whether a plant is likely to pose a risk, more than its current and historic behaviour should be considered. Risk assessment is based on predicting the likelihood of certain future adverse events happening and the potential impact of those events. Hence, some assessment must be made about future behaviour. This will need to based to some degree on a theoretical assessment and to be valid, should be based on the plant's ecology.

31 That past trends are not sufficient can been seen in the example of boneseed which posed little apparent threat for some time before exploding all over the Port Hills.

32 Before putting forward Forest and Bird's opinion on the weediness of Phragmites, I wish to address some matters from the evidence of the applicant. I wish first to note that this hearing is addressing risk not certainty. The questions to ask are not, will adverse events occur, but rather could adverse events occur and if so, with what consequences.

33 A fundamental question with regard to this application is whether the Canterbury Regional Council can be satisfied that the plant will not set viable seed. In recalling the discussion about polyploidy, I am reminded of a quote on the wall in my office regarding crisis management - I have seen the truth and it makes no sense. While the question to be addressed is not that problematic, it must be noted that whether the plant sets seed is a question for which there is no clear answer.

34 From Dr Conner's evidence it can be seen that:

1) *Phragmites australis* seems to be quite variable in its ability to set seed.
2) Although papers from 1950 to 1986 would indicate it sets little or no seed in Europe, a 1996 paper shows that there is commercial seed production in the Netherlands.
3) Also, a 1996 paper shows that the plant sets seed in Australia.
4) Australian plants are octoploid as are the Canterbury Botanic Gardens plants.
5) Pollen fertility does not seem to be a barrier to seed production.
6) Whether or not *Phragmites australis* is self compatible has not been tested.
7) Self compatibility cannot be accurately predicted on the basis of current compatibility information.
8) The plant form Murchison in cultivation in 1972 did set some seed and it is considered that it may have some degree of self compatiblility.
9) Evidence that the plants from the Botanic Gardens have never set seed is only anecdotal and Dr Conner emphasised that point in his presentation of evidence

35 When considered together, these points lead to the conclusions that, firstly, that *Phragmites australis* could be self compatible and the evidence from Murchison points in this direction and, secondly, that this plant may be of Australian origins and may be fertile. In such circumstances the precautionary principle requires that Council acts on the basis that seed can be set, for I wish to suggest that the Council cannot be satisfied that the plant will not. low probably – high impact!

36 It seems that all parties accept this plant can spread vegetatively. Furthermore, it would appear that this plant is a variety with a high degree of vigour. I note that there have been concerns expressed that this plant may be spread by nesting pukeko. The spread of the plant by birds does not appear to have been addressed anywhere in the application. Furthermore, it should be bourne in mind that if the plant does escape, it will be difficult to control. Hence the consequences of an escape are quite serious.

37 In the original application, the applicant provided a risk assessment that, to be quite frank, was the poorest environmental assessment that I have seen. The applicant argued that the plant does not pose any significant risk to the environment and the grounds for this view were that:
a) in his view, the plant is a true marginal plant, and does not live in open water or survive on dry land,

b) that the plant will only migrate up to 1/2 a metre on open water, and
c) that the plant does not produce much viable seed.

38 In respone to this I would point out that:
a) his description of a marginal plant would be my description of a wetland plant and wetlands are of significant conservation value and are under threat for a number of reasons, including weeds.
b) He does not address the question of spread into expanses of shallow water such as Te Waihora.
c) Any seed is too much seed and as Dr Connor's evidence shows, reproduction by seed cannot be ruled out.

39 The poor quality of the environmental risk assessment means that Forest and Bird does not have confidence in this application. I note that the Northland Regional Council and Dr Colin Burrows have questioned this section of the application in their submissions.

40 The applicant commissioned an environmental risk assessment to accompany this application. While this is a commendable improvement on the assessment within the orginal application, there are some gaps in this risk assessment which Forest and Bird considers are fatal to the risk assessment's conclusions.

41 The first weakness in the assessment is the failure to correctly identify the risk of seed spread. From Dr Conner's evidence at this hearing it can be seen that there is a risk that this plant may set set viable seed. This risk was dismissed by the assessment. Anecdotal evidence that no-one has seen the plant flower does not constitute sufficient information to discard a risk.

42 Following on from this failure to identify the above risk, there is no assessment provided of the consequences of wind blown seed establishing in any down-wind wetland areas such as Cooper's Lagoon or Te Waihora. Any establishment in these areas would be extremely problematic. Firstly, there is the period of time that could elapse between dispersal and discovery. Secondly there is the risk that mechanical control may not be effective. Thirdly, there is the innapropriateness of using Arsenal over waterbodies or in areas with a significant component of indigenous or other valued vegetation. Finally, there is high likelihood that any established plants would competitively exclude other wetland plants.

43 Further problems with the assessment put forward by the applicant lie in the lack of clear logical pathways between the identification of the risk and its assessment. There needs to be clear reasons given for why particular events meet particular classifications.

44 There is also no evidence to indicate that the assessment has any ecological basis. The proposed consequences of the risk assessment are provided in terms of the

consequences for the operation of the reed bed. For example, the very high consequence category is decribed as "spread in wider region requiring at least one season to correct and possible closure of treatment plant required". The second part to this assessment is of little relevance to this hearing as the risks that are of concern are the risks to the possible recieving environment, not to the operation of the reed bed. The risk assessment fails to consider the consequence of not being able to irradicate the plant, which seems to be the norm for plant pests.

45 There is no consideration of the multiplication of risk that arises from the precedent setting nature of this decision. On the grounds given above, I wish to suggest that you may consider it wise not to place too great a weighting on the applicant's assessment of risk.

46 My final consideration in terms of the risk posed by Phragmites is the difficulty of controlling this plant. I do not wish to say too much about this as other submitters have provided plenty of evidence of how difficult Phragmites is to control. However, I do wish to note that as Arsenal is a total control herbicide, Forest and Bird considers that it is wholly unsuitable for use in wetlands, on open water or on or near any conservation land.

47 Forest and Bird considers therefore that the species Phragmites does pose a threat. Furthermore, as the applicant is unable to show convincingly either, that the proposed cultivar cannot seed or that Phragmites is readily controllable and considering that a sterile plant can still reproduce vegetatively, Forest and Bird considers that the applicant's proposed cultivar also poses an unnacceptible risk.

48 Forest and Bird accepts the Northland Regional Council's assessment of the evidence put forward by the applicant regarding the risk posed by the cultivar. Northland Regional Council submission argues that there is no guarantee that the plant will not seed in favourable conditions, the time period of research to date is insufficient for the conclusions to be made on seeding ability and that no proper study has been made of the flowering characteristics of the genetic material in question over the past 25 years.

Are there appropriate alternatives?

49 While the matter under consideration is primarily on the matter of the botanical risk of the plant, in terms of S80D(2)(c), the matter of whether it woud be unreasonable to decline the exemption occurs. There are alternatives that could be used for wetland treatment that would enable benign land based disposal to occur.

50 As Forest and Bird's submission outlined, there is a proposal in Belfast for a wetland treatment system that uses native species. During the week, I spoke to the Christchurch City Council and was informed that an application for resource

To File
218/21

Office of the

PARLIAMENTARY COMMISSIONER FOR THE ENVIRONMENT

Te Kaitiaki Taiao a Te Whare Pāremata

29 July, 1998

CRC 250-1
1998208

Ms Eugenie Sage.
Royal Forest and Bird Protection Society
PO Box 2516
CHRISTCHURCH

Dear Ms Sage

Thank you for your recent letter about the proposed use of *Phragmites australis* in the Canterbury region. This issue has already been brought to our attention by Dr Colin Burrows of the University of Canterbury.

Enquiries carried out by this office show that phragmites is recognised as a pest by the Canterbury Regional Council. However, we have also found phragmites reed beds being strongly promoted as a cost effective application for wastewater treatment. The Waipa District Council has been given a presentation claiming that savings of 25 % ($1.5 million) would be achieved if a phragmites reed bed application was used instead of conventional technology for the treatment of Te Awamutu sewage.

Such bold claims suggest a fervour held by the promoter that may not be matched by an equivalent order of environmental risk assessment. A comprehensive evaluation by regional councils, of applications for exemptions from regional pest management strategies, is therefore required. Further enquiries are now being carried out with the Waikato and Canterbury regional councils to ascertain evaluation procedures and the provisions of regional pest management strategies that would apply when an application is received to enable the establishment of phragmite reed bed effluent treatment systems.

One piece of information that may be of interest to you, which came to our notice in a Waikato Regional Council report, is that the National Institute of Water and Atmospheric Research Ltd has developed expertise in the development of reed bed treatment technology. This work, carried out in connection with reed bed applications for dairy farm waste water, suggests that there may be alternatives to phragmites that are comparably effective.

Yours sincerely

Bob McClymont
Director Citizens' Concerns
for Parliamentary Commissioner for the Environment

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Phragmites australis Phragmites ESCE assessment of Weediness 1993 Poaceae

FORM
Course, erect perennial reed 1.5-2.5 m tall (to 6 m in water) with horizontal rhizomes to 20 m and short vertical rhizomes with annual aerial shoots. Forms floating islands (sudds).

HABITAT
Zone between aquatic and terrestrial habitats on margins of fresh or saline (to 2.2% chlorinity). best in water over silt and mud, sealevel to 3000 m (Tibet), invading salt marsh, waterlogged soils to disturbed moist soils. Tolerates enriched water, fluctuating levels, moderate water movement (to 0.05 m/sec), pH 2.8-8.6 (2,3).

COUNTRIES
Native to most countries except NZ (Norway and Canada to Australia, S. Africa, S. America). Uncommon in tropics, 70°N-43°S (Tasmania) (2).

NEW ZEALAND
Established at Hawkes Bay, Murchison.

UTILISATION
Shore line protection, stabilisation of sediment, root zone treatment of sewage (America, Europe, Australia), stock feed, thatch, shelter fences, matting, cellulose, paper, alcoholic drink from rhizome, ducks feed on seeds, suppress weeds on polders (2).

BIOLOGICAL SUCCESS RATING (0-3)

__3__ Versatility Extremely adaptable - one of the most widely distributed flowering plants. Limited by strong water movement and severe anaerobic conditions (less tolerant than *Typha*). Shoots killed by frost (2). Responds to high phosphorus. While characteristic of wet places, also grows in woodlands and rocky places (2). Grows in water >2 m deep. Rhizomes can withstand considerable drying (3). Killed by sea water.

__3__ Maturation rate Rapid from fragments.

__1__ Seeding ability Seeds mostly inviable, seedlings uncommon - encouraged by steady shallow water level and deposition of sediment.

__1__ Dispersal & establishment Wind, water, animals, machinery, in nesting material, intentional transplants. Establishment can occur from a single propagule (1).

__3__ Cloning ability Main means of reproduction by rhizome (mostly <1 m deep). Rapid coloniser of wet, disturbed sites. >80% of plant is underground (3). In unfavourable conditions can produce stolons.

__3__ Recovery Survives siltation, soil scouring, inundation, cutting of leaves.

__3__ Competitive ability Varies with habitat. Forms a network of rhizomes 12-15 m long on surface of moist soil (3). Invasion of other vegetation encouraged by disturbance and high soil moisture. Can invade salt marsh and wet disturbed soil. Seedlings not competitive whereas established plants compete mostly for light. In part of USSR average 33 new shoots/m^2/annum up to 2-3 m. Height growth ceases in mid summer (3). Depth of water is most critical factor for productivity (3).

__17__ Rating

WEED STATUS ASSESSMENT (0-3)

3 Obstruction Very effective barrier to movement and vision. Blocks canals, streams and drains.

3 Suppression Grows in dense, pure, or almost pure stands, crowding out other species (1). Interferes with fish production. Weed of crops in many areas.

1 Health impairment Provides shelter for mosquitoes which carry parasites.

2 Quality impairment Affects water quality. Can completely block small water bodies forming a floating mat over the entire surface.

3 Damage to natural areas Can grossly alter many habitats. Reduces natural plant diversity (1).

0 Other Alternate host of rice blast fungus, *Piricularia oryzae* (not present in NZ).

Opportunity

3 Extent of suitable habitats Very extensive - lowlands on stream margins. Is established in climatic zones CO and F2.

3 Resistance to management practices Difficult to control by management and herbicides but in Holland eradicated in polders by drainage, burning, cultivation (2). Biological control attempted overseas.

18 Esler index of weediness

References

(1) Ailstock, 1992

(2) Haslam, 1969

(3) Nikalojaveskij, 1971

From submission by Dr Colin Burrows 1998

Pest plant potential of *Phragmites australis*

The main points to address with respect to granting the permit for *Phragmites* to be used at Southbridge are (a) Whether there is a possibility that it could escape from captivity there, and (b) Whether the precedent that is set, if the permit is granted, will enable it, eventually, to escape to the wild in Canterbury or elsewhere, from any other locations for which *Phragmites* constructed wetlands are developed. A very long term view is needed. The reasons for concern are now outlined.

In the compilation by A.E. Esler, L.W. Liefting & P.D. Champion 1993: *Biological Success and Weediness of the Noxious Plants of N.Z.*, Ministry of Agriculture & Fisheries, *Phragmites australis* receives a high rating as a very successful aquatic weed, owing to: its capacity to obstruct waterways and suppress other desirable plants; its threat to aquatic ecosystems; the range of habitats it can occupy and its adaptability; the rapidity of its growth and its cloning habit; its ability to recover after damage and the difficulty of its control. It is classed among eight N.Z. aquatic **superweeds**, along with water hyacinth, alligator weed, and hornwort. Esler et al (1993) regard it as a major threat to N.Z. waterways and this could include hydro-electricity lakes, as it can form floating "sudd" islands.

Note that, in their guidelines for development and use of constructed wetlands for treatment of farm dairy wastewater Tanner & Kloosterman (1997) do not include *Phragmites australis* among suitable plants for this purpose. It is specifically excluded from consideration because of its character as a very bad, invasive weed.

Although in Europe some *Phragmites* plants flower and produce many seeds, others do not. Mr Keating, in the application says that the provenances of the species in N.Z. that flower do not produce **many** viable seeds. This is probably on the authority of Dr H. Connor, who, with Dr M. Philipson has examined the embryology of the species. However, even a few viable seeds could be enough to start new colonies. Judged by European data seedlings of *Phragmites* establish most readily on bare, wet soil, but do not compete well with established plant cover (S.M. Haslam 1972: Biological flora of the British Isles: *Phragmites communis*. *J. of Ecology 60*, 585-610). (N.B. the name *P. communis* has been replaced by *P. australis*.) If any N.Z. plants set seeds they could be dispersed, by wind over hundreds of metres, at least.

The plants from the clone in the artificial pond at the Christchurch Botanic Gardens have not been known to flower over a period of many years. The background 2n chromosome number for samples from the clone is 96 (Dr H. Connor, pers. comm.) but in parts of the plant much higher numbers of chromosomes have been counted. It may be that peculiarities in the cytology of the clone segments prevent them from flowering. That plants cloned from this provenance never ever would flower and set viable seeds could only be confirmed beyond all doubt by long-term observation in the constructed wetland where it is to be grown. *Phragmites australis* is known to respond positively to

high amounts of phosphorus. Possibly a high nutrient load could trigger flowering of plants taken from this apparently sterile clone.

On the basis of the presently available information it is the capacity of *Phragmites australis* for vigorous and widespread vegetative spread which needs the closest scrutiny in relation to escape to the wild, vis-a-vis the present application to use the species. From what is set out in the application it appears that the type of constructed wetland that is contemplated for Southbridge is of the subsurface flow variety (cf. Tanner & Kloosterman 1997) with a series of shallow basins c.20m long and 100m wide, and c.1m deep, with a "soil" medium (? a gravel bed) and the plants growing (? hydroponically) with roots in this medium. The whole is contained by a liner of HDPE (? heavy duty polyester film) which is said to be impermeable. It is claimed that *Phragmites* plants do not escape from a lined reed bed.

Phragmites australis reproduces and migrates vegetatively by means of more or less horizontal, sharp-pointed, underground, or underwater rhizomes (undersurface specialized stems). These may be many metres long (Esler et al. 1993). Short, vertical rhizomes are produced on the horizontal ones and roots develop at the nodes. The leafy stems develop on these short rhizomes.

The horizontal rhizomes (which can extend up to 4m a year - Haslam 1970) have been known to penetrate compacted gravelly soil, beneath a concrete path (Mr A. Healy, pers. comm.). According to C.C. Tanner (Notes from presentation to Environment Waikato Biosecurity Committee, July 15, 1998) the rhizomes may occur one to two metres deep in the soil and can penetrate 1 mm thick butyl rubber, normal polypropylene film liners and tar seal. Esler et al. (1993) refer to the ability of the species to form stolons, in some conditions. Stolons are overground bare stems which arch over and take root where a node touches the ground. They can grow to over 10m long (Haslam 1972). Dr B. Sorrell, NIWA, Christchurch (pers. comm.) has observed *Phragmites* constructed wetlands in Australia where the bamboo-like upright, leafy stems of the plant at the margin of the wetland lodge (lie flat) and take root in adjacent pasture. This could lead to formation of new rhizomes or stolons. C.C. Tanner, (1996), quoting Hofman (1986) notes that *Phragmites* stems tend to lodge in nutrient-rich sewage sludge, through mechanical weakness.

These capabilities of the plant for vegetative spread and rapid multiplication (and its resistance to control measures - see next section) make *Phragmites* a very formidable weed, in water, or wet soils. It has another weapon in its arsenal as a weed, namely the ability to reproduce, vegetatively, from small pieces of broken, or cut rhizome (which are able to float). In the present circumstance (at Southbridge) unless there was physical disturbance of the constructed wetland. it seems unlikely that fragments of the plant could escape during its normal functioning. Situations can be expected, however, where the wetlands malfunctioned, through blockage, or accumulation of

nutrient-rich organic detritus. Clearing the blockage, or cleaning out the wetland for any reason (such as, for example, large accumulations of dead foliage in winter) could cause an abundance of broken-off pieces.

A likely way in which escape of *Phragmites australis* into uncontrolled wetland areas could take place is by deliberate translocation. If this happened, unnoticed by local authorities, the plant could soon become a pest of major proportions. The worry that we must have is that, if hundreds of constructed *Phragmites* wetlands should spring up, for town sewage or farm effluent treatment, eventually there would be escape by unauthorized translocation (if not in some other way). If this were to happen there would be disastrous consequences for natural ecosystems. The plant could pervade freshwater and brackish wetlands (including some mangrove areas) from North Cape to Bluff and beyond. One of the worst case scenarios is that, eventually, *Phragmites* could enter hydro-electricity lakes such as those of the Waikato River.

Various references (Haslam 1972, Esler et al. 1993, Tanner 1996) point out that in temperate localities *Phragmites australis* can live rooted on the bottom of water bodies 0.5 to 1.5m deep. Its rhizomes and roots can extend deeper in waterlogged soils. It can live in quite dry sites with deep water table. It can also extend floating mats three metres or more wide out into deep water and pieces of these mats can break away. The flotation of such "islands" (or "sudd") would have obvious adverse effects in hydro electricity lakes.

Possible control measures for *Phragmites*

In the present permit application (p.5) Mr Keating outlines a sequence of procedures to be taken if it should be necessary to abandon, or decommission the Southbridge reed beds. The proposed protocol is complex and thorough (and presumably costly).

The other kinds of situations which have been envisaged earlier in this submission are escapes into the wild, which would be into wet sites. There, *Phragmites* would be difficult to control. The experiences noted by others than Mr Keating (who seems rather complacent in this regard) are that *Phragmites* can be exceedingly difficult to control, when it is well-established, especially in standing water. Unless the water body could be drained it would be very hard to deal with the weed. Mr L. Metcalf (pers. comm.) points out that the plant in the Christchurch Botanic Gardens pond had invaded most of the space in it by the early 1950s (confirmed by Mr A. Healy, pers. comm.). A major attempt to clear it out with machinery then was not quite successful (L. Metcalf pers. comm.). More recent attempts to kill it out there have also failed (Ms S. Molloy pers. comm.).

Esler et al. (1993) note that *Phragmites* can withstand siltation, soil scouring, inundation, and cutting of leaves, while Tanner (1998) lists resistance to grazing, burning and smothering of the above-ground plant. He indicates its ability to re-grow after treatment with glyphosate, dalapon.

amitrol and quialofop, and that there are no proven biocontrol agents. He mentions continual cutting below water level as a control option. The only chemical which he indicates as providing high success in killing *Phragmites* is imazapyr. Attempts at physical control with machinery are undesirable because breakage of rhizomes would give rise to many new plants. Small seedlings would be very difficult to detect, also, if they occur.

My recommendations

My concern about the application to grow *Phragmites* arises from my interest in the ecology, management and welfare of N.Z. indigenous wetlands, in which I have some research expertise. I have studied wetlands of the South Island, especially in Canterbury, but also in Southland and Westland, with various consequent publications 1975-1997. I am deeply concerned about the possibility that, as the aftermath of deliberate introductions into the N.Z. countryside of a plant species foreign to the N.Z. flora, it could escape into the wild. If this happened widely the N.Z. wetland ecosystems would, without doubt, be irrevocably transformed, because the species, *Phragmites australis*, is so aggressive, and difficult to control.

The Regional Council will be aware that native wetland vegetation (and its dependent animal life) is a diminishing resource. Canterbury still has a few good wetland areas, along the coast, and in the high country. It would be an unmitigated disaster for the native ecosystems if *Phragmites* got away into them, whether or not it is able to set seeds. Therefore I urge the Council to take a cautious stance and decline permission to use the plant because of the potential danger of its eventual escape to the wild.

Such a decision would not jeopardise the development of a sewage treatment system for Southbridge, which could use orthodox methods (with or without secondary treatment using constructed wetlands with other, more benign, native plants).

A possible compromise

The only compromise position that I would favour would be one where the Council grants a permit to use *Phragmites* at Southbridge for a limited time period, say five years, after which the situation would be reviewed. This would be regarded as a trial of all procedures and conditions. (as well as the sustainability of effectiveness of the reed beds for the job they are meant to do). Note that, although *Phragmites* has been used elsewhere in the world for primary sewage treatment, the commoner practice is to use it as an adjunct to a settling pond system, as a secondary method of stripping nutrients from the outflow effluent (Dr B. Sorrell pers. comm. and cf. Tanner & Kloosterman 1997). Long-term experiments show (Tanner, C.C., Sukias, J.P. & Upsdell, M.P. 1998. Relationships between loading rates and pollutant removal during maturation of gravel-bed

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Date: 18 September 1998 Pages sent: 2

Dear Geoff

This note is in response to your fax of 16 September, concerning an application regarding use of *Phragmites australis* for use in constructed reed beds.

You ask whether, if *Phragmites australis* is considered to be a biosecurity risk, particularly to indigenous ecosystems, and if it is non-indigenous, the eradication of the plant in New Zealand would pose a contravention of the biodiversity principle of the Rio Earth Summit.

As I understand it, you are asking me to assume that the reed is a biosecurity risk and non-indigenous. On this basis, the answer to your question is No – eradication would not contravene the Convention on Biological Diversity agreed in 1992 at the Rio Earth Summit. That Convention does not endorse the spread of a non-indigenous species that may pose a threat to indigenous species or natural ecosystems. On the contrary, the Convention specifically mandates the eradication of such a species:

> Article 8:
> Each Contracting Party shall, as far as possible and as appropriate:
> ... (h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.

An exception would emerge if the non-indigenous species was rare, and the population in New Zealand contributed critically to the species' global survival. This does not appear to be the case.

The applicant's suggestion that a species should be maintained at any cost to indigenous or valued introduced species or natural ecosystems is ill-founded, and could not be supported under the Convention. Where increased numbers of any species present a threat to other species, ecosystems, or habitats, they should of course be contained. Although increased

diversity may be the initial result of wider use of *Phragmites australis*, resulting homogeneity of species is not an outcome that the Convention would endorse.

I would note also that both the Convention and *Environment 2010* – the Government's strategy on the environment – call for the precautionary principle to be employed where there is a threat of significant or irreversible damage to natural ecosystems or the risk of extinction of indigenous species: lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimise such a threat. I understand from a brief chat with Paul Champion at NIWA (who seems to have been closely involved with you so far) that such a threat may well exist in this case.

I hope these comments help. Don't hesitate to contact me again if I can be of further assistance.

Bugit

SUBMISSION CONCERNING AN APPLICATION FOR AN EXEMPTION FROM A RULE (7.1) IN THE REGIONAL PEST MANAGEMENT STRAGETY (1998)

re: The use of *Phragmites australis*
in the Proposed Southbridge Sewage Treatment Plant

SUBMITTOR:
Lawrence James Metcalf

ADDESS:
"Greenwood",
Stringers Creek,
R.D.1,
Richmond 7031

OCCUPATION:
Currently retired. Formerly Assistant Director, Christchurch Botanic Gardens and Director of Parks and Recreation, Invercargill.

SUBMISSION:

I wish to register my opposition to the above proposal. *Phragmites australis* is a most pernicious plant and, if it by any chance escaped from the proposed site and became established in other waterways it has the potential to become a major problem. In view of the fact that the proposal is to confine within an impermeable plastic, that may be considered an unlikely event. What is more likely however, is that it could be released and distributed by human agency. The application states that the treatment plant would not be accessible by the public but that is not to say that some determined person could not obtain a sample and deliberately establish it in an uncontrolled situation. There have been enough examples, in New Zealand, of unscrupulous persons illegally liberating noxoius organisms in this country because of misguided beliefs. The liberation of RCV by farmer groups is the most recent and most pertinent such example.

Phragmites australis was probably introduced into the Christchurch Botanic Gardens some time in the late 1940s where it was planted in the large pond, in the native section. I do not remember it being there prior to 1947 but when I returned to the Botanic Gardens in 1955, after a sojourn overseas, it was well established in and threatening to take over the whole pond.

At that stage it was decided to remove it and excavating machinery was brought in, by the Council's Works Department. The sludge containing the root system of the *Phragmites* was removed from the pond and it was apparently eradicated. What was not apparent at the time was the fact that some of the plant's twitch-like rhizomes had grown into the bank of the pond. They have been remarkably persistent and to this day have resisted mowing and various attempts to eradicate them..

A number of native plants (*Typha orientalis, Schoenoplectus validus, S, pungens, Baumea articulata* and *Carex geminata* are suitable species) which could be, and are, used for the treatment of waste water rather than resorting to the use of such a potentially dangerous species as *Phragmites australis.*

I would be most concerned if approval was given to use this plant for the stated purpose. Even though the application states that it would be planted in a "bunded shallow basin, lined with impermeable plasitic (HDPE)", the power and ability of the large, twitch-like rhizomes, of this species and other similar grass-like plants, to pierce and penetrate materials such as a supposedly impermeable plastic have to be seen to be believed. They have very sharp and tough points which enable them to penetrate all manner of materials.

It is felt that the correct action for the Regional Council to take would be to reject the application, request that the applicant destroys all stock of *Phragmites* in his possession and encourage the Christchurch City Council to completely eradicate all remnants of *Phragmites* from the Christchurch Botanic Gardens. This would ensure that there is absolutely no possibility of this species becoming established as a feral population in any part of New Zealand.

Signed Laurie Metcalf.

Date 25.8.98.

Address for service

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NIWA
Taihoro Nukurangi

Guidelines for Constructed Wetland Treatment of Farm Dairy Wastewaters in New Zealand

Chris C. Tanner
Vivian C. Kloosterman

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Disclaimer
Constructed wetlands are a rapidly developing area of wastewater treatment technology and information on treatment of agricultural wastes is still limited. Although all reasonable care has been taken to present accurate information in these guidelines, neither NIWA nor its employees, collaborators and funding providers have any control over their application and accept no responsibility or liability for the consequences of their use.

wetland plantings

The proper functioning of constructed wetland is dependant on the establishment and maintenance of a dense cover of emergent wetland plants. Plants perform a diversity of roles including:

- promoting the settling of suspended solids,
- providing surfaces for the development of biofilms,
- shading the water surface to reduce algal growth,
- releasing oxygen into their root-zone,
- taking-up and cycling nutrients,
- improving wildlife and aesthetic values.

Wetland plant establishment can be relatively rapid and simple if it is carried out correctly. However, problems can multiply and operation be significantly delayed where plant establishment is compromised by planting too late in the season, provision of insufficient or excessive water levels, use of inappropriate soils or gravels, plant damage by livestock or pukeko, or suppression by weeds. Weeds, in particular, can be difficult to selectively remove from a partially vegetated wetland once established. The aim should be to "get it right the first time", promoting the rapid development of suitable tall-growing wetland species by optimising the planting time and growth conditions, and adequately controlling weeds and pests before and during establishment

Table 5 lists the key species recommended for constructed wetlands treating farm dairy wastewaters. These species which can form tall, stable growths within the wetland may be supplemented by a range of other species that will tolerate growth around the shallow margins and on the embankments of the wetland (Table 5). These supplementary plantings help to stabilise the embankment slopes, reduce weed ingression, and enhance plant and habitat diversity. Plant species chosen need to :

1. Tolerate environmental conditions in the wetland, including local climate, water depths and wastewater strength.
2. Establish and spread readily to form a dense stable vegetation cover with high pollutant removal capacity and resistance to weed invasion.

3. Not pose a significant weed risk elsewhere in the surrounding catchment or region.

Further guidance on landscaping areas surrounding constructed wetlands is given in the later section on landscaping for wildlife and aesthetic enhancement. For further information on New Zealand wetland plants see Johnson & Brooke (1989).

Planting

Wetland species can be either obtained as small plants established from seed (e.g. 1 year-old root-trainer grade) or as bare-root rhizome cuttings with shoots trimmed to 200-300 mm. Both generally establish well if in good condition and planted in the right conditions. Plants can be sourced from nursery cultures or, in the case of bare-rooted cuttings, from wild populations on private land. In this latter case, care should be taken to safeguard the viability of natural populations. Plants are generally best obtained from established and reputable suppliers (see Appendix) and, where possible, should be sourced from local populations or from regions with similar climatic conditions. All plants brought onto the site should be free of weeds especially any potentially troublesome species (see Table 8).

Wetland planting is best carried out in spring or early summer– generally before Christmas and the earlier the better. Growing seasons are generally longer in northern and coastal areas of the country allowing more leeway. Any weed growth should be controlled before planting (see later section). The planting surface should be level (± 20 mm) to allow suitable water depths to be maintained during establishment. Topsoils used in the wetland should be of reasonable agricultural quality without excessive clay, peat or sand content, and should be evenly spread (150 mm depth) and lightly compacted. The surficial 150 mm of planted gravel-bed zones should be of appropriate particle size (12/20 mm) to ensure good plant root development and spread.

Plants should be ordered well in advance, with final dispatch to the site arranged to coincide as closely as possible with the time of planting (generally within 1 or 2 days of receipt). The wetland plant propagules should be carefully maintained up until the time of planting, following the suppliers recommendations; generally involving keeping them well-watered in cool, semi-shaded conditions.

At planting time, water levels should be at or near the soil or gravel surface. Planting should be carried out at a density of at least 4 plants per square metre (i.e. at 0.5 m centres). It is best carried out by a team of planters (3 or more) working together in a line. Each planter can carry a bucket of plants which they periodically replenish or plants can be laid out in advance by one person, taking care they don't become desiccated. A small area of the wetland (say 3 by 3 m) should initially be accurately marked out and planted to provide a visual guide for planting the remainder of the wetland. Long-handled trowels, narrow shovels or spades and grubbers are the commonest tools used for planting. Their comparative success depends on the soil or gravel type being planted into and the preferred technique of the planter, so some initial experimentation is recommended. Plants should be planted to 40-60 mm depth in the growth medium and be well firmed so they are less prone to uprooting and do not float out when water levels are raised.

Aftercare

Immediately after planting water levels in surface-flow wetlands should be raised to 50-100 mm above the soil surface to optimise conditions for the wetland plants and suppress weed growth. It is important that the water level is not raised above the height of the plant shoots, as these act much like a snorkel, providing a passage for oxygen to diffuse down to the growing plant. As the plants grow the water level can gradually be raised. In subsurface-flow wetlands, water levels should be maintained within ± 20 mm of the gravel surface during plant establishment. If there are reliable wastewater flows of effluent from the upstream ponds then this should be used, adjusting the outlet water level as appropriate. Where

insufficient effluent is available at the time of planting, supplementation from the farm water supply or by siphoning or pumping from the ponds or nearby watercourses may be required. If water supply is a problem, flooding every 2 or 3 days may be used to maintain the water level as near to the sediment surface as possible.

When the plants in surface-flow wetlands have established sufficiently, water levels can be raised in stages over a period of 12 to 18 months. For example, assuming good growth, water levels should be able to be raised to 200-250 mm after a full seasons growth, then to a final depth of 300-400 mm half-way through the 2nd growth season (October/November). Once fully established (generally after 2 growth seasons) plants growing in surface-flow wetlands with water retentive soils should be able to survive short periods of drought. In more severe drought conditions the above-ground parts of plants may die off, but providing conditions haven't been too severe, should regrow again from buried rhizomes (and possibly also seed banks) in the following spring. Weed invasion is likely to be enhanced during such episodes requiring additional control and possibly also replanting of badly affected areas.

Plants growing in gravel-bed wetlands are much more dependant on careful maintenance of water levels because of the low water retention capacity of the gravel. Once well established (generally after 2 seasons growth) plants in gravel-bed wetlands should be able to survive periods of several weeks of low water levels (up to 150 mm below the gravel surface), but normal operational water levels should be maintained at 10-30 mm below the gravel surface. Levels can be fluctuated to up to 300 mm above the gravel-surface for short periods (1-2 weeks) if required, to facilitate control of susceptible weed species. Treatment performance may be reduced somewhat during such periods, due to short-circuting of the effluent via surface-waters.

Weed management

If left unmanaged, weeds can compete with and suppress establishment of the desirable wetland and embankment species planted. Maintenance of proper water levels combined with occasional deeper flooding of the wetlands can control many non-aquatic weed species which may colonise wetland sediments. Exclusion of creeping and sprawling weeds such as mercer grass (*Paspalum distichum*) and kikuyu (*Pennisetum clandestinum*) grass that can form floating mats across the wetlands, and control of embankment weeds more generally, is best achieved by dense plantings around the wetland margins using hardy species such as flax and non-invasive native varieties of toetoe. This also has the advantage of stabilising the wetland embankments and providing cover for wildlife.

Pre-planting applications of a non-residual systematic herbicide such as Glyphosate (e.g. Roundup G2 or similar, at recommended label rates) are advised to ensure weed-free conditions at the time of planting. Thereafter spot applications and/or hand-weeding should be used to control weeds around and within the wetlands. Water levels should be dropped before herbicide applications are made in the wetlands and left down for at least 48 hrs before being re-flooded. Care should be taken where large areas of weed growth are being sprayed to avoid deoxygenation problems associated with the decay of large masses of plant material in the wetland waters. It is always best to keep weeds at low levels, rather than let them get to the stage where they have become a serious problem. Monthly inspections are advised during the first 6 months of plant establishment, with appropriate weed control undertaken as required. Three-monthly inspections and weed control should then be made for a further 12 months after the initial plant establishment period, reducing to twice yearly weed control thereafter.

Table 5: Key constructed wetland plants

Tall-growing, hardy species suitable for main constructed wetland plantings

Plant species	Common name	Geographic range in NZ	General growth characteristics[1]	Depth range[2] (m)	Comments
Baumea articulata	jointed twig-rush	Nthld. S to Manawatu R.	1.8-2 m tall. Green year-round. Dark green, "leafless", cylindrical shoots with "joints". Red-brown pendulous seed heads bourne on separate fertile shoots.	0-0.3	Relatively slow to establish. Best planted in association with *S. tabernaemontani* as nurse-crop at ratio of 3:2 *Baumea*. Generally takes two growth seasons for plants to develop fully.
**Glyceria maxima*	reed sweetgrass (formally widely known in NZ as Poa aquatica)	common in all except E of N Is.; scattered in S Is. locally common in S Otago and Sthld.	0.5-1.5 m tall. Green year-round apart from superficial frost damage. Bright green, broad-bladed grass with hollow lower stems/rhizomes, bearing erect feathery seed-heads during summer and autumn. Often forms floating intertwinned mats over shallow openwater.	0-0.4	Quick to establish. Common weed of drainage channels and wet ground in many areas. Do not introduce into new catchments. Often grazed by cattle, but high cyanide levels in new spring and autumn growth can cause poisoning of unaccustomed livestock (Sharman, 1967, 1968; Barton et al. 1983). Tends to overgrow and outcompete other species.
Eleocharis sphacelata	kuta, tall spike-rush or spike-sedge	throughout, most common in the Nthld. and uncommon in Cant.	0.8-1.3 m tall above water level. Stout, bright green,"leafless", hollow shoots with transverse septa, arising from thick rhizome. Seed heads forming at tip of shoots. Thick rhizome.	0-0.4	Moderately quick to establish. Not suitable for use in gravel-beds, but excellent for surface-flow wetlands. Traditionally used by Maori for weaving.
†*Schoenoplectus tabernaemontani* (=*Schoenoplectus validus*)	kapungawha, soft-stem bulrush or lake clubrush	Nthld. S to Wld. and Cant.	0.6-1.8 m tall. Shoots die back over winter, except in northern coastal areas. Erect green to blue-green, "leafless", cylindrical shoots with white central pith, arising from horizontal rhizome. Brown seed heads form a tuft just below the shoot tip.	0-0.3	Quick to establish in spring and early summer. Probably the most common wetland plant used in NZ constructed wetlands. Best used in combination with other species that do not die back strongly in winter.
**Schoenoplectus californicus*	giant bulrush or giant clubrush	Waikato Heads, Kaipara, and scattered constructed wetlands in Nthld., Auck. & Waik.	1-2 m tall. Shoots remain green year-round. Very similar growth form to *S. validus*, but shoots are triangular in cross-section near their base, and taller.	0-0.4	Only recently identified in NZ. Forms taller, deeper-growing, more robust growths than *S. validus*, with much reduced winter die-back. Overall weed risk believed to be low, but advisable not to spread into new catchments (refer to notes on present geographic distribution)

Table 5 continued: Key constructed wetland plants

Plant species	Common name	Geographic range in NZ	General growth characteristics[1]	Depth range[2] (m)	Comments
Typha orientalis	raupo, bulrush equivalent to: cumbungi (Aust.), reed mace (UK) & cattail (US)	throughout	1.5-3 m tall. Tall, dull blue-green, erect leaves arising in clumps from stout spongy rhizomes. Thick, cylindrical brown seed heads borne on tall shoots. Shoots die back strongly in winter.	0-0.3	Generally the dominant emergent wetland plant in fertile lowland NZ swamps. Although closely related species are used widely in constructed wetlands overseas, this plant is generally regarded as inferior to other species in New Zealand. It tends to produce large accumulations of standing and decomposing litter, and can be invasive in high nutrient conditions, excluding other more desirable species. However, it is common in many areas of the country and will readily establish and florish in surface-flow constructed wetlands. It is not recommended for growth in gravel-bed wetlands because of its thick rhizome. Its leaves have been traditionally used by maori for thatching etc. and its pollen and rhizome eaten.

1. Consult Johnson & Brooke (1989) for detailed description and illustration.
2. Suggested final operational depth range for constructed wetlands treating dairy farm wastewaters. Deeper depths may be possible for more highly treated or lower strength wastewaters.

* Introduced species

† Revised name for species formerly referred to in New Zealand (in order of precedence) as *Schoenoplectus validus*, *Scirpus validus*, and *S. lacustris*

Table 7: Weed species to avoid

Ensure plants brought onto the site are not contaminated with propagules of these species. Invasive weeds that pose unacceptable weed risks in New Zealand and should not be planted or allowed to spread.

Plant species	Common name	Geographic range in NZ	Growth form[1]	Comments
**Alternanthera philoxoides*	alligator weed	Nthld. S to N Waikato, abundant in localised areas	sprawling emergent	Small clover-like white flowers. Very invasive and difficult to control. Capable of excluding other species and spreading into pastures and cropping areas. High risk plant pest banned from sale, propagation and distribution.
**Myriophyllum aquaticum*	parrot's feather	Nth Is. and N Sth Is.	sprawling emergent	Perenial herb with whorls of feather-like leaves emerging from the water. Can completely choke waterways, excluding other species. High risk plant pest banned from sale, propagation and distribution.
***Eichhornia crassipes*	water hyacinth	N half of Nth Is., generally very limited distribution in wild	free-floating	Distinctive mauve flower spikes and spongy leaf bases. Known as the world's worst aquatic weed. A notifiable plant subject to a National Pest Management Strategy under the Biosecurity Act 1993. Often used in waste treatment systems in tropical areas of the world where it is widespread in the wild.
**Iris pseudacorus*	yellow flag iris	Locally common in areas of central and S Nth Is., and Cant. to Sthld.	emergent	Tall yellow-flowered iris. High risk plant pest banned from sale, propagation and distribution.
**Lythrum salicaria*	purple loosestrife	Horowhenua and Cant. to Sthld.	emergent	Perenial herb with distinctive purple flowers. Capable of invading pasture and drainage channels. Presently of limited distribution in NZ, but has shown high weed potential in areas where present, and is a serious weed in North America. Presently banned from sale, propagation and distribution in the Manawatu-Wanganui Region, but restrictions likely to be extended.
**Phragmites australis*	common reed	Hawkes Bay and Murchison	tall emergent	Tall bamboo-like reed with feathery flowers. High risk plant pest banned from sale, propagation and distribution. Widely used in constructed wetlands in many other parts of the world where it occurs naturally.
***Salvinia molesta*	salvinia	N half of Nth Is., generally very limited distribution in wild	free-floating	A water fern capable of forming thick floating mats that can choke waterways. A notifiable plant subject to a National Pest Management Strategy under the Biosecurity Act 1993.
**Hydrodicton reticulatum*	water net	N half of Nth Is., abundant in localised areas	net-forming algae	Can form dense filamentous nets that choke waterways. Can be spread by water fowl and amongst plant material from infected areas.
**Zizania latifolia*	Manchurian wild rice	Nth Is., abundant in localised areas, particularly Nthld	tall emergent	Forms very tall growths (> 3m) capable of invading pasture, drainage channels, and natural wetlands and lake margins. High risk plant pest banned from sale, propagation and distribution.

1. Consult Johnson & Brooke (1989) for detailed description and illustration.

* Introduced species

** Classified as National Surveillance Plant Pests under the Biosecurity Act 1993, as at October 1, 1996.