Final Report

Preliminary cost-benefit analysis: National Environmental Standard for On-site Wastewater Systems

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Ministry for the Environment

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Authorship

This document was written by Reuben Irvine and Tim Denne. For further information email reuben@covec.co.nz or phone (09) 916-1967.

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Covec Limited Level 11 Gen-i tower 66 Wyndham Street
PO Box 3224 Shortland Street Auckland New Zealand
t: (09) 916-1970 f: (09) 916-1971 w: www.covec.co.nz

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Executive Summary

This report identifies the costs and benefits that would be likely to arise from the proposed National Environmental Standard (NES) for on-site wastewater systems. The proposed NES puts forward two options for establishing a Warrant of Fitness (WOF) style inspection scheme: Option One, which would require all domestic systems to be inspected, and; Option Two, which would require the inspection of systems located in targeted areas (ie hotspots and/or sensitive areas).

The potential impacts of the proposed NES are analysed from the perspective of society as a whole. This includes all impacts regardless of whether they are incurred by, or accrue to, private inspectors, regional and territorial authorities, central government, or households. Also, this analysis measures only the additional costs and benefits that would be generated by the proposed NES and which would not occur otherwise; this means that few, if any, additional costs or benefits would be generated in those areas that already operate WOF-type inspection schemes.

There are data limitations to the analysis. For potential benefits, particularly public health effects, a paucity of data makes quantification difficult. We have provided estimates based on opinions given by a number of organisations and technical experts and these provide order of magnitude estimates of public health benefits. Some impacts, including environmental benefits, are outlined but are not quantified. Because a small number of local authorities operate inspection schemes currently;[1] data is available to assist with the estimation of administration and compliance costs, however.

Option One: Nation-wide inspections

Option One would require all on-site systems used by private domestic dwellings to be subject to WOF inspections. This is estimated to total approximately 270,000 systems, of which approximately 15,000 are excluded as they are located in areas already subject to regular performance inspections.

Costs

The present value of administrative costs is estimated to be $43.8 million over 20 years (using a 10% discount rate). This would comprise $5.1 million per year in ongoing administrative costs plus an additional $400,000 in the first year in relation to initial set-up costs. Direct inspection costs are estimated to be $3 million per year ($25.3 million over 20 years).

Compliance costs are the costs, potentially borne by the owners of septic tanks or others, such as councils, that would be incurred in bringing systems up to the required level. That is, an NES would impose maintenance and/or repair costs for work to on-site systems that would otherwise not occur. Based on previous surveys and discussions

[1] These authorities include the Far North District Council, Environment Bay of Plenty and Waitakere City Council.

with technical experts, it is estimated that 15% to 50% of systems are likely to fail a WOF-type inspection (around 10,000 to 40,000 systems).[2] The additional repair, maintenance and upgrade for failing systems are estimated to range from $13.4 million to $44.6 million per year for the first three years, after which ongoing maintenance costs would range from $3.5 million to $11.6 million per year.

The inspection scheme would also be likely to lead to an increase in general system maintenance, even for the many households whose systems would pass a WOF, for example because of increased awareness of the need for regular pump-outs. The additional maintenance costs for systems expected to pass inspections could range from $5.1 million to $8.7 million per year.

Benefits

A major benefit that would arise from nation-wide inspections would be the reduction in inadequately treated effluent being released into the environment. This would lead to reduced contamination of:

- drinking water, via groundwater or other waterways,
- recreational waterways,
- shellfish, especially those collected on a recreational basis, and
- surface water in backyards and other receiving environments.

Reduced contamination of these waterways and locations would be expected to reduce the prevalence of a range of waterborne and foodborne pathogens, including E coli 0157, camplylobacter, norovirus and others. Infection with these pathogens can typically lead to gastro-intestinal illness, although in rare cases other, more severe illnesses may be contracted, eg hepatitis A. In addition to effluent from on-site systems, major sources of these pathogens are run-off from farms and effluent from sewerage treatment plants. Boats may also generate significant levels of contamination in some areas.

Estimates of the benefits of an inspection scheme for the different components of public health benefit are:

- Reduced drinking water contamination: $1 - 4 million per year;
- Reduced contamination of shellfish: $100 - 500,000 per year;
- Reduced contamination of ground surface or surface water above or adjacent to some on-site systems—estimated to be similar to shellfish benefits;
- Reduced discomfort from gastro-intestinal and other diseases: $250 - 500,000 per year.

An inspection regime that reduces the level of pollution stemming from on-site systems would generate a number of environmental and financial benefits from reduced ecosystem damage. These include:

[2] Failure in this context refers to a failure to meet the WOF inspection standards (as discussed in the MfE's discussion document "Proposed National Environmental Standard for On-site Wastewater Systems"). This differs from that typically used by households (ie catastrophic failure) or that used by those with an environmental perspective (ie where inadequately treated effluent leaching into the environment which may go undetected by households).

- greater use of recreational areas that are prone to contamination, such as some beaches, rivers and lakes;
- reduced impacts on New Zealand's international reputation for a clean environment and natural beauty;
- reduced instances of commercial shellfish contamination.

In the absence of readily available data, the magnitude of these impacts is difficult to quantify. Other benefits would include reduced legal and administrative costs associated with the reduction in policy development costs and the number of legal challenges.

Preliminary evaluation

To evaluate the total costs of this option over time, a time-span of 20 years is used and a discount rate of 10% is applied to all future costs. The present value of total costs of this option, ranges from $197 million to $293 million, See Table 1. The largest component of estimated costs are compliance costs, which would comprise two-thirds to three quarters of the total.

To exceed these costs and generate a positive net impact for the wider community, benefits would need to average, $21 million to $31 million for each of the next 20 years. Because of the substantial uncertainty regarding many of the public health impacts (which could be in the order of $6 million annually) and environmental benefits (unquantified), there is little evidence to suggest that the annual benefits generated by this option would exceed this figure.

Option two: Targeted inspections (hotspots)

Approximately 42,000 systems would be affected by the hotspot approach, about 15% of the estimated total number of systems.

Costs

Total inspections costs would be likely to be around $470,000 per year, ongoing administrative costs would be around $800,000 (which would involve 10 FTEs) and initial set-up costs are estimated to be approximately $260,000.

Compliance costs are estimated to range from around $2.1 million to $7.8 million per year for the initial three year period, and $2 million to $3.1 million for each subsequent year.

Benefits

Because Option Two targets areas where the benefits would be greater, benefits will be more than 15% of those in Option One. The actual effects are highly uncertain; we scale down the benefits by 50%, rather than 85%. This suggests that the public health benefits of this option could potentially be in the vicinity of $750,000 to $3 million per year. Similarly, environmental benefits would be smaller in magnitude, but greater than 15% of those under Option One.

Preliminary evaluation

Applying the scheme only to hotspots results in an estimated total cost, in current dollars, ranging from $31.9 million to $48.9 million; the largest component would be compliance costs. See Table 1 below.

To generate a positive net impact for the wider community, Option Two would need to create annual benefits of, on average, $3.4 million to $5.2 million. Given that the public health benefits alone could be in the vicinity of up to $3 million per year, a targeted inspection scheme appears more likely to be able to provide a net benefit to society.

Table 1: Preliminary evaluation of Options One & Two (approximate estimates)

Option	Systems affected	Average annual total costs	Potential annual public health benefits	Annual environmental benefits
One	255,000	$21m – 31m	$1.5m – 6m	Unquantified
Two	42,000	$3.4m – 5.2m	$0.75m – 3m	Unquantified

1. Introduction

1.1. Background

This report provides a preliminary cost-benefit analysis of the proposed National Environmental Standard (NES) for on-site wastewater systems (referred to as either 'on-site systems, or 'systems'). It is intended to be read in conjunction with the Ministry for the Environment's discussion document: 'Proposed National Environmental Standard for On-site Wastewater Systems'. MfE's discussion document provides background information regarding on-site systems, details the existing regulatory environment and explains the proposed NES.

The cost-benefit analysis also draws on a report produced by Environmental Management Services Limited (EMS).[3] The EMS report uses information from sanitary assessments carried out by territorial authorities as well as other sources; it outlines the environmental effects of on-site systems in New Zealand.

The proposed NES includes two options for regulating on-site systems, which involve implementing a Warrant of Fitness or WOF-type inspection scheme for domestic households. The options are to apply the inspection scheme to either:

- all systems throughout New Zealand; or
- only systems in targeted areas (ie 'hotspots' and/or sensitive areas).

Hotspots would be determined by regional councils, in conjunction with territorial authorities, and would be areas with known problems and/or areas where there are risks to sensitive receiving environments. Detail regarding the proposed NES, and more general background information, is contained in MfE's discussion document.

1.2. Analytical framework

To ensure an accurate cost-benefit analysis of the proposed NES, all of the likely impacts that would result from its introduction need to be identified. Once the likely impacts have been identified, the net effect of these impacts on society as a whole can be determined.

Because cost-benefit analysis is applied from the perspective of society as whole, only those costs imposed on (or benefits received by) one party that are not offset by benefits (or costs) to another party are included. 'Transfers' from one party to another do not generate a net impact on the overall welfare of society and so are not included in the analysis. Despite having no net impact on welfare, such transfers can raise equity concerns, however. For this reason, any potentially significant equity concerns arising from the proposed NES are highlighted.

[3] Environmental Management Services Limited (EMS) "Incidence and Effects of On-Site Wastewater Treatment System Failures in New Zealand" October 2007.

In accordance with conventional economic analysis, costs include resources that would be utilised or expended in the course of implementing the proposed NES. The use of such resources in this manner constitute 'opportunity costs' to society if these resources could otherwise be put to an alternative use.

1.2.1. Limitations

Quantifying many of the impacts of a WOF inspection scheme is difficult because of the uncertainty regarding many of the effects of on-site systems and the shortage of useful data. This uncertainty is especially acute in relation to the public health and environmental impacts of effluent, particularly as the same pathogens found in this effluent also originate from a number of other sources, including farms, wastewater treatment plants and boats.

Because of a shortage of available data or studies, opinions and information was obtained from a range of organisations and individuals, including the Ministry of Health, Regional and Territorial Authorities, the New Zealand Food Safety Authority, Northland District Health Board and various other experts in the fields of microbiology and waterborne diseases, water quality and on-site waster system design, installation and maintenance. Information from these sources was used as the basis for many of the assumptions used in this analysis.

Despite obtaining a wide range of expert input, there is an inherent degree of uncertainty involved in estimating the size of potential effects, particularly public health impacts. Consequently, many of the estimates produced in this analysis are intended to be indicative of the potential magnitude of likely impacts, rather than precise estimates.

Other impacts, such as environmental effects, are not possible to quantify to any degree of precision. For example, the impact that a negative occurrence, say a disease outbreak, stemming from on-site system contamination could have on any international reputation of New Zealand being a 'clean, green' environment is difficult to determine. Although this image, used in the '100% Pure' international marketing campaign, is used to promote tourism and trade, it is not possible to determine the extent to which revenues from these sources would be affected by such an occurrence.

1.3. Status quo

The cost and benefits included in this analysis are those that would only occur if either NES option were implemented. Any impacts that would occur under the status quo, ie without an NES, are not analysed. For example, two regional authorities and three territorial authorities have already instituted mandatory inspection schemes and/or system pump-out requirements.[4] Consequently, areas that already have a WOF inspection scheme are unlikely to incur any significant additional administration and/or compliance costs or obtain any additional public health and environmental benefits from the proposed NES. In contrast, this analysis assumes that areas that do not

[4] See MfE discussion document "Proposed National Environmental Standard for On-site Wastewater Systems".

currently impose any WOF-type requirements would not do without the implementation of the proposed NES.

For a description of the status quo, including an overview of the current regulatory environment, see MfE's discussion document and the EMS report regarding on-site system performance.

2. Costs of Option One: Nation-wide scheme

This section outlines the major cost components that would arise from Option One: applying a WOF scheme to all domestic on-site systems throughout New Zealand. The main costs include:

- administration and inspection costs, and
- compliance costs.

2.1. Cost reduction measure

The actual costs of an inspection would depend on many variables, such as the precise nature of the inspections (ie simple or sophisticated) and the accessibility of systems. One design aspect that could reduce the costs of the proposed NES is the degree to which inspections, and system maintenance which is likely to be carried out simultaneously, is organised and purchased centrally (ie by a local authority) rather than by each individual affected household.

Inspections and associated system maintenance could be centrally purchased for a large area, for example a district or region. This would allow the inspection firm to take advantage of 'economies of density'. That is, inspectors/pumpers would be able plan the timing of individual inspections across particular areas to minimise the travel required between properties and ensure that they do not have extended periods of 'down-time' when they are not able to carry out inspections/pump-outs.

By offering such contracts out on competitive tender basis, these cost savings could be passed on to buyers. This approach also reduces the 'transactions costs' in contrast to a scenario where each individual household would be required to select, contact and contract an inspector/pumper.

2.2. Total number of systems

To estimate the costs that would arise from a nation-wide WOF inspection regime, an estimate of the total number of domestic on-site systems in New Zealand is required. Because there is no existing estimate of systems, and because many regional councils and local authorities have not published specific information on systems, we have used several different methods for estimating the prevalence of on-site systems. These different approaches suggest that the total number is between 210,000 and 330,000. The Appendix provides a description of these different methods.

The midpoint of this range, 270,000, is used as the estimate of the total number of systems throughout New Zealand.

2.2.1. Exclusions

Because only the incremental impacts of an NES are included in this cost-benefit analysis, it is necessary to subtract those systems that are already subject to a similar WOF-type inspection schemes from the total number. Environment Bay of Plenty,

Waitakere City Council and Far North District Council all operate similar schemes. Similarly, those systems that would be replaced by reticulated sewerage systems in the near future would also need to be removed from the analysis. However, because of the uncertainty surrounding the extent and timing of replacement, this analysis adopts a conservative approach and assumes that no further significant reticulation will occur in the near future. In any case, reticulation would not only reduce the costs of the proposed NES but would also reduce the expected benefits. Additionally, any increase in the degree of reticulation may be offset to some extent by the installation of new on-site systems in areas of increased development.

Based on figures obtained from councils that already institute inspection regimes, around 15,000 systems may be unaffected by a NES. Consequently, the number of systems used to calculate cost estimates is 255,000.

2.3. Administration and inspection costs

Inspections, whether undertaken by councils or private contractors, would result in a range of costs, including labour costs, vehicle and transport costs and other materials. Estimates of inspection costs are based on information from Environment Bay of Plenty, Far North District Council and Waitakere City Council, which already operate inspection schemes. Although similar in a number of respects, these inspection schemes are not identical to the proposed NES. For instance, the proposed NES would not require pump-outs to be carried out in conjunction with inspections, as some systems will not require pump-outs every three years.

However, it is likely that in most cases inspections of tanks require tanks would occur at the same time that pump-outs are undertaken. Consequently, this analysis assumes that inspections would in most cases be carried out by private contractors hired to undertake this maintenance. The cost per inspection, excluding any pump-out costs, is estimated to be approximately $35.[5] If each system must be inspected once every three years, the cost of inspections would be in the vicinity of $3 million per year.

Regional councils responsible for administering the WOF requirement would also incur costs. These would be a mix of one-off, initial set-up costs and ongoing administrative costs. Set-up costs would include the time and resources required to identify the location of all on-site systems within each region and contact each affected property owner. Based on discussions with local authorities that have already established WOF inspection regimes, this analysis assumes that these tasks would require the equivalent of one FTE for two months for each of the 16 remaining regional councils that do not have inspection schemes. In total, these set-up costs could equate to approximately $210,000.

[5] This is based on fees paid in Bay of Plenty Region and is exclusive of GST. This charge would cover all costs, including staff wages, vehicle depreciation, fuel, materials, etc. This analysis assumes that inspections would take an average of 30 minutes.

Costs would also be incurred in the process of training and certifying inspectors. Individuals who would receive training would most likely consist of those who currently provide pump-outs and other system maintenance. These individuals would require additional training to allow them to carry out inspections. Assuming that around four inspectors are required for every 1,000 systems,[6] approximately 1,000 individuals may require training. Based on a full day training for each of these individuals at a rate of $21 per hour,[7] the total labour cost of this initial training would be around $140,000 incurred in the first year of the scheme. There would also need to be occasional additional training courses over time as new individuals enter the industry and as new on-site systems become more widespread. However, as the additional costs of such additional training courses would be immaterial given the magnitude of other administrative costs (ie less than $10,000 per year), these costs are not estimated.

This training is likely to be organised by MfE. Based on information from MfE, this analysis assumes that it would take two staff approximately two months to design and provide training. As a result, the total administrative cost would be less than $30,000, including overheads and travel expenses.

Administering a WOF scheme would require regional councils to carry out several ongoing tasks, such as following-up failures, undertaking audits of inspections and, in some cases, carrying out enforcement action against non-complying households. Data from councils and authorities that already administer such schemes suggest that, on average, the equivalent of one FTE is required in relation to every 4,000 systems. This indicates that an additional 64 FTEs may be required nation-wide for ongoing administration. Using an average annual salary cost of $50,000 and associated overhead costs of $30,000 for each FTE,[8] ongoing general administrative costs could be around $5.1 million per year.

2.4. Compliance costs

The introduction of a nation-wide inspection scheme would result in compliance costs for some households that would otherwise not undertake repairs and maintenance of systems. To estimate the number of households that could be affected in this manner, results from previous surveys of specific locations are used to identify potential failure rates. The rates of system failure can vary considerably across different areas and according to different definitions of 'failure'.[9] For instance, a survey in the Bay of Plenty (Graham and Futter, 2002) found that 64% of 3,251 surveyed septic tanks failed inspection. Responses to another recent survey indicated that 73% of the surveyed

[6] This is based on information regarding on-site system maintenance operators and inspectors in the Bay of Plenty Region and Waitakere City. This information suggests that, depending on the sophistication of the inspection regime and the degree of centralisation in purchasing maintenance services (see Section 2.1), between one to eight staff per 1,000 systems would be required.

[7] Based on discussions with industry operators.

[8] These figures are based on information from local authorities and MfE.

[9] Households that do not experience any major system difficulties may not consider systems to be 'failing' despite the fact that surrounding environments may be being contaminated with inadequately treated effluent, ie 'out of sight, out of mind'.

communities stated that systems perform satisfactorily at least sometimes, 40% of communities stated systems worked all of the time.[10] Recent inspections of 2,000 properties on Waiheke Island by the Auckland City Council indicated that 74% had no actual or likely problems, 11% had minor problems and 3% had major problems. A further 13% of systems could not be located for inspection. A similar survey in Manukau City found that nearly 47% of systems displayed evidence of current or recent failure.

Based on these surveys as well as discussions with industry participants, and given the nature of the proposed inspections, we assume that 15% to 50% of all current systems would fail to obtain a WOF. For this analysis, system failure is defined as the failure of systems to meet the requirements of the proposed WOF inspection scheme.

Of the approximately 40,000 to 130,000 systems that would fail a WOF inspection over the first three years (13,000 to 43,000 per year), discussions with those within the sector suggest that only a small proportion of these systems (say 15%)[11] would be repaired in the absence of inspections. This suggests that around 11,000 to 38,000 systems would have some form of repairs or maintenance carried out that would not have otherwise occurred in the absence of inspections. This is because many households would not notice a system is failing unless there is a catastrophic failure, such as where a tank is blocked and there is an obvious overflow of effluent.

After this initial three year period, within which all existing systems would be inspected, only a small, relatively insignificant, proportion of systems would fail to obtain a WOF in each subsequent year. This is because all systems would then be subject to routine maintenance which is the main reasons why systems would fail a WOF in the first place. As the rates of occurrence of the other causes of failures listed above are relatively low and relate to the entire lifespan of systems, the rate of new failures in each year should be low. Additionally, an increasing proportion of systems installed in the future will be subject to more rigorous regulations. This should avoid some of the causes of failure in older systems.

Of those systems that would fail a WOF inspection, the overwhelming majority are likely to do so because of insufficient maintenance, ie a lack of 'de-sludging' or 'pump-outs'. The other likely causes are: poorly located disposal field; tank damage, broken system components or lack of filters, and; malfunctioning disposal system, for example damaged disposal pipes caused by tree roots. Estimates of the relative prevalence of each of these types of failures, as well as the average cost of the associated repairs or maintenance are included in Table 2.

[10] This is the Community Sewerage survey (CoSINZ) carried out in 2000 for the Ministry of Health and reported in Beca Steven, 2001. Of note is that this survey did not cover communities with fewer than 100 people, almost all of which would be likely to use on-site systems.

[11] This estimate is based upon discussions with Dave Miller, Environmental Engineer, and various territorial and regional authorities.

These figures are approximate estimates of typical costs, as actual costs could vary considerably from system to system. For instance, re-designing or replacing an on-site system could cost as little as $4,000 or as much as $14,000 depending on the applicable regulations, which can vary across regions. Similarly, repairs or upgrades to disposal system structures may be as little as $1,000, particularly if the on-site system is located within 'lighter' soils that allow for greater dispersement of effluent than 'heavier' soils. Pump-outs typically cost between $200 to $400 depending on the area, tank access and other variables.

Applying these estimated typical costs to the number of systems that could fail a WOF suggests that the total costs of repairs and upgrades could range between $13.4 million to $44.6 million per year for the first three years.

Table 2: Assumed causes of failure and repair costs for individual systems?

Cause of failure	% (estimate)	Repair cost $ (estimate)
Insufficient maintenance/pump-outs	80	400
Minor system damage/upgrade (eg filter)	5	300
Poorly located disposal field	5	8,000
Malfunctioning disposal system/tank	10	5,000

After the initial three year period, during which failing systems would be expected to be brought up to the necessary standard, the majority of ongoing compliance costs for these systems would comprise the increased maintenance (ie periodic pump-outs) which would not otherwise occur. Assuming that none of the systems that would initially fail a WOF would have routine maintenance in the absence of an inspection system, the annual compliance costs for these systems would range from $3.5 million to $11.6 million for each year after the initial three year period (ie assuming failure rates were to range from 15% to 50%).

The inspection scheme also would be likely to lead to a substantial increase in maintenance (ie pump-outs) for many systems that would pass a WOF inspection.[12] This is because there are many areas where maintenance is not already mandatory[13] and many households typically do not adhere to recommended maintenance schedules. Implementation of a regular inspection scheme is likely to result in an increase in regular maintenance in these areas, for example because of the increased awareness of the need for such maintenance. Consequently, increased maintenance costs would be likely to arise because of this WOF inspection scheme. Assuming that that around a third of the 50% to 85% of systems expected to pass a WOF would be pumped-out because of a new inspection scheme, the estimated annual cost of these 'new' pump-outs that would not occur in the absence of a NES would be around $5.1 million to $8.7 million.

[12] Note that, because some systems may not require a pump-out in order to pass a WOF inspection, additional maintenance costs would not necessarily be incurred in relation to all systems.

[13] Although some councils enforce mandatory pump-outs on a regular basis, for example Auckland City Council, many others do not require such maintenance.

An additional compliance cost would be the time spent by households organising repairs, maintenance or system upgrades as a result of the inspection regime. Assuming that households would not spend much time to make the necessary arrangements for organising repairs, maintenance, etc, this annual cost is likely to be insignificant (ie less than $10,000).

2.5. Total costs

Based on the assumptions discussed above, the total cost of Option One is estimated to range from $197 million to $293 million in present value terms. This equates to an average cost of $21 million to $31 million per year for the next 20 years.

Table 3: Total costs, Option One (current dollars, 20 year period)

Cost type	Cost ($million)	
Failure Rate:	15%	50%
Inspection	25.3	25.3
Administration	43.8	43.8
Compliance	128.0	224.0
Total	**197.1**	**293.1**
Average (per year)	**21**	**31**

2.5.1. Distribution of costs

Although it does not affect the total economic cost of the proposed NES, the issue of how much different parties should contribute towards the burden of the administrative and compliance costs (ie households, local government or central government) can create concerns regarding equity and fairness. If a large proportion of the compliance costs were to be faced by households, they may consider such expenses to be inequitable, particularly households that were required to make expensive repairs or replace entire systems. This response may be exaggerated by two factors. First, many households would not have foreseen the need for such upgrades or repairs as they may, mistakenly, consider that their systems are functioning adequately. Second, in some cases the benefits from this expenditure may accrue to others in the community but not the household itself, depending on the existing impact of any contamination.

However, these do not appear to be strong arguments. Any requirement that households must fund maintenance, repairs or upgrades is consistent with the 'polluter pays' principle. This approach ensures that those responsible for the operation of these systems account for the full cost of their wastewater system decisions. The government routinely adopts this approach to correct for negative externalities across a range of sectors.

A further impact of any requirement for households to account for the actual costs to the wider society of their on-site systems is that households may be more willing to fund reticulated sewerage systems.

3. Benefits of Option One: Nation-wide scheme

The major benefits from a nation-wide WOF-type inspection scheme would stem from the reduced contamination of receiving environments by effluent. This is likely to reduce public health costs and also provide environmental benefits.

Other potential benefits from reduced contamination include:

- greater production from commercial shellfish farms,
- increased use of marine recreational areas, such as beaches, and
- reductions in costs of disputes between developers, councils and district health boards regarding the negative impacts of on-site systems.

3.1. Public health impacts

A major benefit that would arise from nation-wide inspections would be the reduction in inadequately treated effluent being released into the environment. In some areas this would lead to reduced contamination of:

- drinking water, via groundwater or other waterways,
- recreational waterways,
- shellfish, collected on a recreational basis, and
- ground and surface-water next to systems (eg backyards) and other receiving environments.

For a discussion of the risks of contamination in various receiving environments, see the report by EMS referred to in Section 1.1.

Implementing a WOF scheme would be expected to reduce the prevalence of a range of waterborne and foodborne pathogens. These pathogens include:

- Bacteria, such as E coli 0157, campylobacter, yersinia and shigella;
- Viruses, such as norovirus and hepatitis A; and
- Protozoa, such as cryptosporidium and giardia.

The predominant negative impact from infection with one of these pathogens is the contraction of gastro-intestinal disease, although in a minority of cases the impacts may be more severe. In extreme cases infection with E coli can cause serious illness requiring ongoing dialysis or, in some rare cases, death.

Once present within a community, some of these pathogens may spread through person-to-person- and foodborne-contact. Illness caused by infection can impose costs on society in the form of medical treatment and/or time off work. To the extent that children contract these diseases, costs can include time taken off work by principal caregivers. A further cost is the pain and suffering experienced by those who contract gastro-intestinal, or other, diseases.

Because the majority of those who contract these diseases do not seek medical treatment, it is not possible to determine the precise incidence of these diseases. Even

many of those who do seek medical assistance are not tested. This means that the pathogens responsible for much gastro-intestinal illness are not determined. It is also difficult to determine the source of infection unless there is a significant outbreak in a specific location. However, this information is necessary to determine the public health impacts that are attributable to on-site systems compared to other sources. These sources include animal effluent (eg from water fowl or run-off from farms), effluent from municipal sewerage treatment plants and from boats.

Consequently, to provide speculative estimates of the potential magnitude of public health impacts in the absence of data, this analysis makes several simplifying assumptions regarding the sources of contamination leading to infection. Unless stated otherwise, the assumptions below are based on information and opinions obtained from various organisations, including the Ministry of Health, various Regional and Territorial Authorities, the New Zealand Food Safety Authority, Northland District Health Board, NIWA, and various experts who have carried out studies of infections from waterborne and foodborne pathogens.

3.1.1. Drinking water

A recent study (Rosevear, 2004) estimated the combined public health cost of treatment along with the value of lost productivity (ie from time off work) from waterborne diseases contracted from contaminated drinking water.[14] Excluding contamination of roof water, the cost was estimated at around $11 million per year.[15] This figure is based on approximately 12,000 cases of disease.

A subsequent study (Ball, 2006) estimated that the number of cases of waterborne diseases contracted from drinking water is likely to be much higher, ie in the vicinity of 34,000 per year.[16] Reducing this number to account for cases attributed to roof-sourced drinking (6,000 according to Rosevear), this more recent study suggests that the actual number of cases annually is around 28,000. This suggests that the public health costs of contaminated drinking water could be around $20 to $25 million.

Assuming that contamination from on-site systems accounts for one quarter of all cases of waterborne disease contracted from drinking water, the public health costs from this source could be in the vicinity of $6 million per year.[17] If the WOF inspection scheme had the effect of reducing the public health costs of a substantial proportion of the worst polluting systems, the value of these public health cost reduction benefits could perhaps be in the order of $1 million to $4 million per year.

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[14] Rosevear M. "Drinking Water Cost/Benefit Study" July 2004.

[15] This figure excludes the costs associated with roof-sourced contaminated drinking water as this would not be affected by the proposed NES. This figure also excludes an estimate of the expected costs of a serious outbreak, which is a rare occurrence.

[16] Ball A. "Estimation of the Burden of Water-borne Disease in New Zealand: Preliminary Report" Prepared for the Ministry of Health, November 2006.

[17] Groundwater sources supply drinking water for approximately 40% of the New Zealand population. Groundwater may be more likely to suffer from contamination sourced from on-site systems than supplies from surface (catchment) water. See Ministry of Social Development "The Social Report 2005".

To the extent that an increasing proportion of households are connected to reticulated drinking water supplies, or other regulations that lead to quality improvements in drinking water are implemented, this benefit would be reduced. This is because fewer households would face the risk of consuming drinking water that is contaminated by effluent from on-site systems. Without knowing the extent of future expansion of reticulated systems, it is not possible to determine the effect that such change would have on the magnitude of the potential public health benefits. To the extent that reticulated systems expand at a relatively slow rate over the next few years, this benefit would not be substantially reduced.

3.1.2. Recreational waterways

Effluent from on-site systems can also contaminate rivers, lakes, estuaries and beaches that are water used for bathing and other recreational activities, such as waterskiing, snorkelling, kayaking, etc. In these types of receiving environments the dilution of contaminants would tend to be higher, and risk of infection lower, than for groundwater used for drinking water supplies. However, it is possible that total exposure to this risk could be greater because of the extensive use of these environments for recreational activity: each year there may be several million instances of bathing in marine waters, lakes and rivers.[18]

Absent any detailed information regarding the incidence of gastro-intestinal disease contracted from recreational water-based activities, it is not possible to determine the public health costs from this form of infection across all recreational areas. However, an estimate from one study suggests that around 5,000 cases of campylobacteriosis may result from infection from freshwater recreational activity.[19]

Based on the average cost of a case estimated by Rosevear ($533), and assuming around one quarter of these cases were the result of contamination from on-site systems, the annual public health impact could be in the vicinity of $700,000. Consequently, the magnitude of public health benefits of the inspection scheme in relation to freshwater recreational activities could be in the order of $100,000 to $500,000 per year, although there is substantial uncertainty surrounding this estimate.

3.1.3. Shellfish

Shellfish are filter feeders and can filter many litres of water every hour. If the water filtered by shellfish contains effluent from on-site systems, shellfish can themselves

[18] Patronage at Auckland surf beaches alone is in the vicinity of 400,000 people during the principal bathing season (October to March). Vaughan R. 1997 referred to at: http://www.adhb.govt.nz/downloads/publications/reports/2001/healthneedsdocs/part-iiic.pdf

[19] McBride et al "Freshwater Microbiology Research Programme Report: Pathogen Occurrence and Human Health Risk Assessment Analysis" November 2002. This figure corresponds to around 4% of the 120,000 annual cases of campylobacteriosis estimated by Rosevear, 2004.

become contaminated.[20] Although bacteria may be expelled after a couple of days, viruses, especially noroviruses, can become concentrated within shellfish and remain there for long periods, often weeks. Contaminated shellfish may cause infection when eaten.

Because water quality is tested in areas of commercial shellfish farming, contamination of commercial shellfish is much less likely than contamination of wild shellfish. If testing indicates unsatisfactory levels of contamination, harvesting commercial shellfish in affected marine areas is not carried out. This also creates negative impacts in the form of reduced commercial harvests, discussed in Section 3.2.4.

Additionally, although current water monitoring tests detect bacteria in areas where testing occurs, in some areas the presence of viruses is not tested.[21] As a result, some shellfish may be deemed to be free of bacterial contamination, but may be contaminated with noroviruses and other enteric viruses sourced from human effluent.

In contrast to commercial marine farms, water quality is not tested in many areas where wild shellfish are gathered. Although in some areas wild shellfish are gathered on a regular basis by local communities, they are typically collected on a small-scale and on an intermittent, recreational basis. Because the rate of gastro-intestinal disease from wild shellfish is unknown, it is not possible to quantify the public health impacts of infection from this source, nor determine the proportion of shellfish-sourced cases which are the result of contamination from on-site systems. Anecdotal evidence suggests that the annual rate of disease in some affected communities may be significant, perhaps in the thousands.[22] This suggests the public health benefits in relation to shellfish consumption could be similar in magnitude to that for recreational activities, ie perhaps in the vicinity of $100,000 to $500,000 per year, although there is substantial uncertainty surrounding this estimate.

3.1.4. Ground surrounding on-site systems

The areas surrounding on-site systems can create risks of infection if system failures result in the inadequate treatment of effluent. Because systems are often located in the backyards of private properties, residents and neighbours can be exposed to risks of infection. This risk of infection may be especially pronounced for children who are more likely to play in and around contaminated areas.

Although there are no data concerning the rate of infection from this source, information from various sources suggests that the number of cases could be similar in magnitude to either shellfish consumption or recreational activity.

[20] Because shellfish concentrate such contaminants they themselves are often a good indicator of water contamination in a particular location.

[21] http://www.esr.cri.nz/competencies/foodsafety/Viral+Contamination+of+Shellfish.htm

[22] This is based on discussions with the New Zealand Food Safety Authority and the Northland District health Board.

3.1.5. Discomfort

As well as the direct medical costs and lost productivity arising from infection caused by environmental contamination from on-site systems, those who suffer gastro-intestinal and other diseases incur a reduced quality of life during the period which symptoms are experienced. This discomfort constitutes a cost.

In the absence of any data regarding peoples' willingness to avoid infection, it is not possible to determine the extent of this benefit that reduced contamination could bring. However, some rough figures may provide an indication of the potential magnitude of any benefits. For instance, if people were willing to pay on average, say $50, to avoid a bout of gastro-intestinal disease,[23] a reduction of between 5,000 to 10,000 cases per year because of an inspection regime could provide an annual benefit of around $250,000 to $500,000.

3.2. Environmental effects

Waterways and ecosystems that become polluted with effluent can suffer adverse effects. For instance, oxygen taken by the pollutants can deprive waterways of oxygen. Consequently, fish and other aquatic life can die. Reduced contamination from on-site systems as a result of a WOF scheme would also provide various other benefits, such as increased water-based recreational activity or reduced risk of closure of commercial shellfish farms.

3.2.1. Preferences for reduced environmental damage

As outlined in the EMS report, very few studies have identified significant environmental effects on receiving waters because of nutrient inputs from effluent from on-site systems. These nutrient inputs are generally not in high enough concentrations, at least in comparison with other catchment sources, to cause substantial adverse impacts. However, on-site systems may generate negative environmental impacts in some cases, such as for enclosed, sensitive water bodies with a high input of nutrients from on-site systems in comparison to other sources. Any reduction of this environmental damage would constitute a benefit.

This benefit would arise because many people within society have a preference for reduced pollution and less environmental damage. This preference may exist even if the benefits of a cleaner environment are not enjoyed directly. Thus, to the extent that some within society are aware of the scale of environmental contamination from on-site systems, the introduction of a WOF inspection scheme could generate benefits to these individuals because they would be happier in the knowledge that such measures are being introduced.

[23] This amount is based on estimates of willingness to pay to avoid one day of illness as calculated by Alberini and Krupnick, "Air Quality and Episodes of Acute Respiratory Illness in Taiwan Cities: Evidence from Survey Data" Journal of Urban Economics 44, pp 68-92 (1998).

3.2.2. Reduced risk to national image

New Zealand attempts to foster an international reputation for having a clean environment and natural beauty evidenced by the extensive "100% Pure" branding campaign. This image provides benefits in terms of increased tourism and trade. For example, receipts from international tourists are in excess of $8 billion per year.

To the extent that contamination from on-site systems could harm this image, eg if there were a large-scale outbreak of disease or substantial reduction in water quality in areas frequented by tourists, there could be losses for the New Zealand economy. An inspection scheme would provide a benefit in terms of reducing the risk of such harmful occurrences.

3.2.3. Increased recreational activity

Where recreational areas, such as beaches and lakes, become contaminated, councils may place signs warning the public of the risks of using these areas. In some cases, beaches may be closed. Even if there is no formal action taken by councils or authorities, communities may become aware of the level of contamination of certain beaches and lakes over time.

The effect of these measures, and increased awareness of contamination, is to reduce the recreational use of these areas. The inability, or unwillingness, of people to use the areas constitutes a cost to society. This cost may manifest itself in the form of additional time and expense incurred in travelling to alternative areas or, if there are no nearby alternatives, there is a cost in the form of lost enjoyment from not being able to carry out water-based recreational activities at all. To the extent that contamination of these areas were to be reduced and recreational activities increased, this would constitute a benefit of an inspection scheme.

3.2.4. Increased commercial shellfish production

A reduction in contamination of marine waters used to farm shellfish would reduce the likelihood of that the harvesting of shellfish crops is prohibited in affected areas. In some cases contamination may cause delays in harvests, in other cases entire marine farms may be closed or may be prevented from being established. An example of farm closure has occurred at Waikare Inlet in the Bay of Islands. In this case, nine oyster farmers were forced to close their farms in 2001 after traces of the norovirus, carried in human effluent, were discovered.[24] These farms accounted for 30% of New Zealand's oyster production, a significant proportion of which is exported.[25]

The farmers subsequently sued the Far North District Council for $12 million in damages, largely lost output, blaming a nearby treatment plant for the contamination. During the case, the Council suggested that nearby on-site systems could be a major contributing factor to the level of contamination. Subsequently, the court found that the treatment plant could not be proved as the source of the contamination.

[24] Northern Advocate, "No appeal by oyster farmers", 14 November 2006.

[25] New Zealand Herald, "Pollution hit oyster-growers hoping to re-open farms", 20 November 2006.

Another example is the contamination of the marine area of Papanui Inlet in Dunedin City has resulted in the council prohibiting this area from being used for commercial marine farming.

To the extent that an inspection scheme allowed for greater production from marine farms, the benefit could be substantial, perhaps in the millions of dollars.

3.3. Other benefits

Implementing an inspection scheme may reduce costs that would otherwise be incurred.

3.3.1. Reduction in disputes

As well as disputes regarding contamination of marine farms, disputes have also occurred between developers, councils and/or district health boards regarding contamination from on-site systems. Because of the occasional difficulties in gathering sufficient evidence that on-site systems are responsible for public health impacts in specific areas, actions by district health boards and/or councils may be challenged in court, for instance by developers.

To the extent that a NES provides support for the actions or policies of district health boards and/or councils and reduces the scope for challenge, expensive legal action may be avoided.

3.3.2. Avoidance of alternative regulatory approaches

In the absence of an inspection scheme, some local authorities may implement by-laws or other regulatory mechanisms to reduce environmental contamination from on-site systems. Should the proposed NES be implemented this inspection scheme be could eliminate the costs associated with undertaking these alternative regulatory approaches.

3.4. Total benefits

Because of the uncertainty surrounding the environmental and public health impacts of on-site systems, it is not possible to accurately estimate the likely benefit from a WOF inspection scheme. However, the available data and information from various sources within the sector suggests that the magnitude of public health benefits could be in the vicinity of $1.5 million to $6 million annually. This would equate to a total present value of between $12.8 million to $51 million over a period of 20 years. The unquantified environmental and other benefits would be in addition to these amounts.

4. Costs and benefits of Option Two: Hotspots

Option Two for the proposed NES is identical to Option One except that the WOF inspection scheme would apply only to private households within specific defined areas, rather than all private households. Consequently, while the types of costs and benefits are identical, the magnitude of many of these impacts would be smaller because fewer systems would be subject to the inspection scheme.

4.1. Number of systems in hotspots

Based on analysis carried out by EMS, as documented in the report on the effects of on-site system failures, approximately 42,000 systems would be subject to the inspection scheme. Of these systems, around 2,000 are likely to be located in areas where there is already an inspection system. Consequently, the number of systems used to calculate cost estimates is 40,000. This is approximately 15% of the total number of private household on-site systems.

4.2. Costs

With the exception of some initial set-up costs, which are assumed to be similar to set-up costs for Option One, all other costs are smaller because fewer systems would be subject to inspections. Unless stated otherwise, all estimates below are based on the same assumptions as for Option One, see Section 2.

4.2.1. Administration and inspection costs

The cost of inspecting 13,000 systems per year is estimated to be around $470,000. The initial set-up costs are assumed to be similar to Option One. Although fewer households would need to be contacted, local authorities would need to undertake additional work to determine hotspots and sensitive areas. Thus, the initial administrative cost for all councils is estimated to total $210,000 in the first year of the scheme. Similarly, the one-off costs of establishing training and certification for inspectors is estimated to be around $30,000. Because fewer inspectors would need training, the labour costs incurred in training 300 inspectors would be approximately $22,000. Approximately 10 FTEs would be required for ongoing administration by councils, costing $800,000 per year.

4.2.2. Compliance costs

Compliance costs include the costs of repair, maintenance and system upgrades that would not occur without the implementation of the NES. Assuming that 15% to 50% of all systems in hotspots fail a WOF inspection, the total estimated compliance costs imposed by this scheme could be around $2.1 million to $7.8 million per year for the first three years. These estimates account for the fact that some proportion of systems would need one-off repairs or upgrades to bring them up to the required level. After this initial three year period during which all the systems in the targeted areas would be inspected at least once, ongoing compliance would be expected to fall to around to between $2 million to $3.1 million per year.

4.2.3. Total costs

Based on the assumptions discussed above, the total cost of Option Two is estimated to range from $31.9 million to $48.9 million in current dollars. This equates to an average cost of $3.4 million to $5.2 million annually for the next 20 years.

Table 4: Total costs, Option Two (current dollars, 20 year period)

Cost type	Cost ($million)	
Failure Rate:	15%	50%
Inspection	4.0	4.0
Administration	7.0	7.0
Compliance	20.9	37.9
Total	**31.9**	**48.9**
Average (per year)	**3.4**	**5.2**

4.3. Benefits

Although systems located in hotspots are only around 15% of the total, these systems are likely to account for a much larger proportion of the public health and environmental impacts. This is because locations have been selected as hotspots because of the relatively significant negative impacts caused by on-site systems. See the EMS report for further detail.

Because these hotspots are likely to account for a disproportionate level of negative impacts, applying a WOF inspection scheme to this 15% of all systems is estimated to lead to a 30% to 50% reduction in the public health costs and environmental damage arising from on-site systems.

4.3.1. Public health impacts

The same benefits would arise as for Option One, albeit on a smaller scale. Although it is not possible to accurately determine the precise impact of reduced contamination of drinking water, recreational water bodies, shellfish and ground surfaces surrounding systems in targeted areas, the potential magnitude of these impacts could be around half the size of those for Option One. This would entail a potential reduction in public health costs of perhaps around $500,000 to $2.5 million per year.

4.3.2. Environmental benefits

As with Option One, the environmental benefits are largely unquantifiable. However, Table 5 below provides estimates of the number of waterways that are located near to the potential hotspots that have been identified by EMS.

Table 5: Estimate of waterways in hotpots affected by failing systems[26]

Localised area around systems & nearby stormwater drains	Total number
Groundwater sites	c. 10
Streams	100-120
Rivers	10-20
Lakes	c. 10
Estuaries	10-20
Sheltered marine	40-60
Open coastal	30-50

Source: EMS

[26] The figures in this table need to be regarded with some caution, and should be considered approximate estimates only. These figures are likely to underestimate the number of water bodies potentially affected, because of under-reporting by local authorities. This is especially the case for effects on groundwater.

5. Preliminary conclusions

Because of a shortage of relevant data and a high degree of uncertainty regarding many of the impacts of the proposed NES, it is not possible at this stage to provide a definitive conclusion on whether either option would generate a net benefit for society as a whole.

Where useful data are not available, this analysis attempts to indicate the potential magnitude of specific impacts, although these estimates are subject to substantial uncertainty. Additionally, feedback received in the upcoming consultation process may provide useful information that allows for more robust estimates to be calculated.

5.1. Option One: Nation-wide scheme

To evaluate the total costs of this option over time, a time-span of 20 years is used and a discount rate of 10% is applied to all future costs. Based on these assumptions, the total cost of this option, in current dollars, ranges from $197 million to $293 million. The largest component of estimated costs are compliance costs, which comprise of two-thirds to three quarters of total estimated costs.

To exceed these costs and generate a positive net impact for the wider community, Option One would need to create benefits of, on average, $21 million to $31 million for each of the next 20 years. Despite the substantial uncertainty regarding many of the public health impacts (which could be in the order of $6 million annually) and environmental benefits (unquantified), it would appear unlikely that the annual benefits generated by this option would exceed this figure.

5.2. Option Two: Hotspots

Applying the scheme only to hotspots results in an estimated total cost, in current dollars, ranging from $31.9 million to $48.9 million. The largest component would be compliance costs.

To generate a positive net impact for the wider community, Option Two would need to create annual benefits of, on average, $3.4 million to $5.2 million. Given that the public health benefits alone could be in the vicinity of up to $3 million per year, a targeted inspection scheme appears more likely to be able to provide a net benefit to society.

Appendix

A.1 Total number of on-site systems

Several methods were used to estimate the total number of systems.

Method 1

A report by BECA regarding greenhouse gas emissions from wastewater indicates that the total population served by on-site systems is 411,000.[27] Assuming an average of 2.8 individuals per household, this suggests that there may be around 150,000 occupied dwellings with on-site systems.

Additionally, there are around 159,273 unoccupied dwellings within New Zealand, just under two thirds of which are in rural areas.[28] Statistics New Zealand estimates that around 60,000 of these dwellings are holiday homes, located throughout New Zealand. Assuming that all of these holiday homes are located in areas without reticulated sewerage systems, the total number of systems could be around 210,000.

Method 2

The Community Sewerage study of sewerage systems completed by the Ministry of Health in 2000 obtained survey information from communities with more than 100 residents in 67 of the 74 territorial authorities.[29] The sample surveyed represented around 80% of the total population. This survey found that an average of 4% of the surveyed population were not served by reticulated sewerage systems, and so would be reliant on on-site systems (45,000 systems). Of the remaining 800,000 individuals (consisting of approximately 290,000 households) many would comprise of communities of less than 100 people. These communities are likely to be rural areas and use on-site systems. Assuming that, say 50% to 80%, of this remaining 290,000 households use on-site systems, and incorporating the estimate of holiday dwellings with on-site systems (60,000), the total number of systems could be between 250,000 to 330,000.

Method 3

According to Ministry of Health estimates, at least 15% to almost 20% of the population is not served by reticulated drinking water. Given that reticulated drinking water is typically more prevalent than reticulated sewerage, this suggests that the number of households that use on-site systems is larger than 220,000, perhaps up to 270,000.

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[27] Beca Infrastructure Ltd "National Greenhouse Gas Inventory from Wastewater Treatment and Discharge" August 2007.

[28] Statistics New Zealand.

[29] Community Sewerage survey (CoSINZ) carried out in 2000 for the Ministry of Health and reported in Beca Steven, 2001.

Accounting for unoccupied dwellings used as holiday homes (60,000), this approach indicates that the total number of systems could range from 280,000 to 330,000.

Method 4

Actual figures for on-site systems have been obtained from some regional councils and territorial authorities that account for around 37% of all households (ie 70,000).[30] Scaling these figures up based on the proportion of total households covered suggests that the total number of systems may be around 240,000.

Similarly, some estimates of system numbers in various regions and territories are provided in a recent MfE report. The estimated total (170,000) relates to areas that account for around half of all households.[31] Scaling these figures up based on the proportion of total households covered suggests that the total number of systems may be 330,000. Consequently, this method indicates that the total number of systems could be between 240,000 to 330,000.

A.2 Consultation

The following individuals and organisations have been contacted in the process of carrying out this analysis:

- David Ray (EMS Limited)
- David Miller (Environmental Engineer)
- Mike Wright (Far North District Council)
- Paul Futter, John Whale (Environment Bay of Plenty)
- Graham Leonard (Waitakere City Council)
- Helen Codlin (Hawke's Bay Regional Council)
- Jim Sim (NZ Food Safety Authority)
- Gillian Lewis (University of Auckland)
- Elizabeth Watts (Northland District Health Board)
- Brian Smith (Liquid Waste Ltd)
- Michael Taylor, Paul Prendergast, John Harding, Don Bandaranayake (Ministry of Health)
- Graham McBride (NIWA)
- Barry Johnson, Glenn Wigley, Marcela Markland, Amanda Hunt (Ministry for the Environment)

[30] These have been obtained either from councils' Sanitary Assessments or in response to direct contact. Many Regional Councils in particular do not have figures regarding the number of on-site systems.

[31] Sourced from "Issues and Options for the Management of On-site Wastewater Systems in New Zealand" MfE.