WASTEWATER DISPOSAL AND THE NPS-FM 2020: WHAT DOES THE FUTURE LOOK LIKE??

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ABSTRACT

In Aotearoa New Zealand, some 45% of wastewater treatment plants (WWTP's) discharge treated effluent directly to surface water and approximately 68% of these discharges are from pond based WWTP's. In total, 108 pond-based plants with surface water discharges serve 330,000 people: treating and disposing of 50 million cubic metres of wastewater annually.

The revised National Policy Statement for Freshwater Management 2020 (NPS-FM) came into force on 3rd September 2020. This requires that freshwater be managed in a way that gives effect to Te Mana o Te Wai – a holistic concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater supports the health and well-being of the wider environment. There are two aspects of the NPS-FM which will have a particular influence on potential future wastewater discharges to surface water. Firstly, the objective of the NPS-FM is the prioritisation of the health and wellbeing of freshwater bodies above the health needs of people; and above the social, economic and cultural well being of people and communities. Secondly, there is a requirement for Local Authorities to actively involve Tangata Whenua in freshwater management, including in decision making processes, with respect to changing Regional Plans as they relate to freshwater.

Application of the NPS-FM will likely make future discharges of treated human effluent to surface water difficult to successfully consent unless a "functional need for the activity in that location" can be established. Given the scale of existing surface water discharges throughout the country, there is an immense task facing local government and the wider water infrastructure industry to move away or at least mitigate discharges of treated human effluent to surface water. This paper will consider a range of examples of irrigation, land contact systems, and treatment wetlands which successfully manage impacts on environmental and cultural values.

These systems were successfully implemented using two key processes: site specific design with investigation to understand the receiving environment and prevent harmful adverse effects on freshwater, and early and meaningfully engaging with Tangata Whenua to understand their aspirations, their definition of Te Mana o te Wai and to facilitate a collaborative design process which appreciates and protects Māori freshwater values. These two processes allow for unique and effective wastewater management solutions which both meet the obligations of communities under Te Mana o te Wai and provide for environmental, cultural, and social freshwater values.

KEYWORDS

Wastewater, Disposal, NPS-FM, Te Mana o te Wai, Mauri, Cultural Values, Te Ao Māori

PRESENTER PROFILE

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Kate is an Environmental Scientist with experience working over multiple disciplines for a range of public and private sector clients. Kate has extensive knowledge of Te Ao Māori and Tikanga Māori through personal experiences as an active member within her own Iwi, hapū and whanau groups. She is passionate about the taiao which is expressed through her work.

1 INTRODUCTION

For much of Aotearoa New Zealand's history, wastewater management in small to medium communities has relied on pond-based treatment systems (i.e., oxidation ponds) with a discharge to surface water (i.e., freshwater rivers, streams, wetlands) to dispose of treated effluent. These systems, and associated effluent, have the potential to cause harm to both environmental and cultural freshwater values. With the implementation of the new National Policy Statement for Freshwater Management 2020 (NPS-FM) there is far greater priority placed on protecting all values of freshwater and specifically cultural and environmental values. This paper will explore the potential for adverse impacts from existing wastewater systems, the future of wastewater management under the NPS-FM, consider strategies for minimising the loss of values due to wastewater disposal, and present examples where wastewater systems have provided for environmental and cultural freshwater values.

2 CURRENT WASTEWATER MANAGEMENT

2.1 CURRENT TREATMENT STRATEGIES

Wastewater throughout Aotearoa New Zealand is highly varied in terms of flowrate, strength, and location (WaterNZ, 2021). Not only do the populations served vary extremely with the smallest publicly owned plants serving less than 20 people and the largest serving over one million. The strength of influent wastewater also varies significantly with some plants receiving large volumes of high strength industrial wastewater and septage, while in other plants the influent wastewater is heavily diluted by inflow and infiltration from aging reticulation infrastructure. Further to this, the effluent quality goals of WWTPs are often very different. For instance, plants with coastal outfalls far offshore often require minimal removal of nitrogen or other nutrients while other systems must remove almost all influent nutrients to protect against adverse effects on freshwater (Williams et al., 1985).

It is no surprise then that wastewater management varies widely with a large range of treatment processes, plant designs, treatment objectives, and disposal methods. To allow for greater detail and specific examples, this paper will generally focus on small to medium scale wastewater treatment plants and associated discharges with the potential to impact freshwater.

2.2 SMALL WASTEWATER SYSTEMS

Throughout Aotearoa New Zealand there are approximately 190 WWTPs which use oxidation ponds as their main method of treatment. Approximately 100 of these plants currently discharge only to surface water. Most pond based treatment systems were constructed between 1960 and 1985 following the Ministry of Works design guidelines (Archer & Mara, 2003). These were largely single pond or primary- secondary pond systems in series. However, since the mid-1990s pond-based treatment systems have often been retrofitted to allow for increasing influent volumes and reductions in effluent quality limits. These retrofits generally involve primary and maturation pond systems consisting of four to six cells in series.

When correctly designed and constructed, pond-based systems achieve a moderate level of treatment. Typical oxidation pond effluent quality ranges are presented in Table 1 (Hickey et al., 1989). However, with water quality limits for clarity, NH_4-N, E. Coli, and DRP decreasing under the NPS-FM, the levels of dilution required to prevent harmful effects on surface water also continue to increase, making some existing discharges to small waterways difficult to justify.

Table 1: Typical oxidation pond effluent quality.

Parameter	5^{th} Percentile	Median	95^{th} Percentile
BOD (mg/L)	7	27	70
TSS (mg/L)	6	56	171
DRP (mg/L)	0.8	5.0	9.5
NH_4-N (mg/L)	0.001	7	29
NO_3-N(mg/L)	0.001	0.11	2.9
Faecal Coliforms (cfu/100 mL)	90	4,300	230,000

2.3 EXISTING EFFECTS

There are a range of methods by which wastewater discharges to surface water can result in adverse effects. These could include negative impacts on environmental values such as ecology and water quality including for recreational contact and drinking water, or negative impacts on cultural and social values. The focus of this paper will be on environmental and cultural effects.

2.3.1 ENVIRONMENTAL IMPACTS

The potential for environmental effects is unique and specific to individual treatment and disposal systems. For instance, discharges into large well mixed freshwater systems such as major rivers often have less potential for adverse effects on ecology and water quality due to rapid and large dilution within the water body. The opposite true for small or poorly mixed water bodies. Furthermore, each discharge is likely to have a unique contribution to cumulative effects within a waterway or catchment. It is highly unlikely that a wastewater discharge is the only activity impacting any given water body. Agricultural land use, stormwater discharges, and onsite wastewater management in the catchment are all likely to contribute to cumulative contaminant loads within a given discharge's catchment.

One example of adverse environmental impacts was a pond-based wastewater treatment plant discharging into a hill fed fourth-order river in Canterbury (Pattle Delamore Partners, 2018). The pond had been retrofitted to include four treatment ponds in series and achieved above typical levels of BOD, TSS and nutrient removal. However, water quality sampling and ecological studies upstream and downstream of the discharge showed that increased NH_4-N and DRP concentrations were harming aquatic biodiversity downstream of the discharge. In this example the discharge also contributed to cumulative effects from agricultural run-off and poor instream values including easy stock access, sparse riparian planting, and poor bank stability.

Despite having better than average effluent concentrations, this WWTP was unable to discharge to surface water without negative impacts on the ecology of the river. The potential for environmental effects is highly dependent on-site specific factors including the nature of the discharge and the nature of the receiving environment. However, it is clear traditional methods of wastewater disposal can adversely impact freshwater values such as water quality, ecosystem health, and indigenous biodiversity.

2.3.2 CULTURAL IMPACTS

Although cultural impacts are linked to environmental impacts, managing environmental effects does not mean that cultural effects are also managed. In Te Ao Māori (Māori world views), Māori have a deep enduring relationship with the taiao (environment) - connected through whakapapa (genealogy) to the Atua (deities of Te Ao Māori). Through this genealogical link, Māori view themselves as not only part of the environment, but one in the same (spiritually and physically). It demonstrates interconnectivity between everything placing all humans in an environmental context with all other flora, fauna, and natural resources, and expresses our fundamental kinship with the atua and the natural world (Harmsworth & Roskruge, 2014; Harmsworth & Awatere, 2013).

As Māori have a spiritual and physical connection to the environment, the degradation of the environment can result in both spiritual and physical impacts on Tangata Whenua.

Tipene O'Regan, former chairman of the Ngāi Tahu Māori Trust Board, described the cultural pain of a proposed wastewater discharge in Westland (O'Regan et al., 1984):

"I have seldom felt such a wrenching in my gut as when I stood at the side of the Arahura River in Westland, at a place called Waitaiki. To us this is the place from where all pounamu comes, it is the motherlode. At the next tributary upriver, TNL Ltd. proposed to create a great big sewage plant for a land development scheme they were undertaking across at Lake Kaniere. They were going to pump sewage uphill, out of the Kaniere catchment, and across to the catchment of the Arahura. All their tutae would flow down and across the Waitaiki. The thing that hurt me more than anything was that this is one of the most tapu places anywhere, a place of inestimable value to our old people and it was going to be washed with effluent. I don't care how treated, how processed, how often it is milliscreened, they were going to pump all that sewage and let it flow down over one of the most tapu places of my own people."

2.3.3 MAURI

Mauri is the essence or life force that is passed down from the Atua to all living things (T. K. K. B. Morgan, 2006). Water too is of spiritual origin and has its own mauri. In western terms, the mauri of wai can be thought of as the life supporting capacity of a water body (Miller, 2004). Where mauri is strong, the ecosystem will flourish and where mauri is weak the ecosystem will be diseased, unhealthy and can even die.

Discharge of untreated wastewater and treated effluent directly to surface water constitutes the mixing of waters of different types (and therefore mixing of differing mauri). The wastewater effluent will contaminate and reduce the mauri of the receiving water. This practice is culturally abhorrent and causes great pain and insult to Māori who are tasked with protecting and enhancing the mauri of water under kaitiakitanga.

The cultural impact of activities may differ significantly from the environmental impact assessed under western science. Consultation with local Iwi and Hapū on the effect on mauri and Māori freshwater values is critical, particularly with the diversity in thought between different Hapū.

2.3.4 MANA

Mana is an important concept in Te Ao Māori. Mana is generally translated as authority, power, control, status, leadership and is typically based on whakapapa (Harmsworth, 2018). Mana can be referenced differently depending on the situation. Figure 1 refers to the mana as the following:

- Mana Atua – mana derived from the Atua;
- Mana Tangata – mana of people; and
- Mana Whenua – mana derived from the whenua (land) or mana over land and resources.

Mana motuhake or mana whakahaere can be described as authority or sovereignty over natural resources. It is the right of Tangata Whenua to assert mana motuhake over the natural resources within their rohe. Mana motuhake, like tikanga has been built from generations of deep spiritual and physical connections with the environment.

Cultural effects are linked to environmental effects, however, a common adverse cultural effect is the lack of opportunity for Tangata Whenua to assert their mana motuhake over their natural resources. Tangata Whenua gain and/or maintain mana by caring for the environment (sometimes referred to as mana tiaki/tieki). Including Tangata Whenua in decision making (including design) can help reduce these cultural effects).

2.3.5 TAPU AND NOA

Critical to understanding the cultural impacts of wastewater management is understanding the key constructs of tapu and noa within the complex spiritual framework of Te Ao Māori (Ataria et al., 2019). The cultural definition of tapu and noa varies throughout each Hapū and is based on the unique relationship each Hapū has with the natural ecosystems they occupy. Only the local Hapū can describe how specific wastewater management impacts their cultural values. However, as a general overview, in regard to wastewater tapu can be defined as forbidden, restricted or consequential while noa is defined as ordinary and free from restriction or tapu (Ataria et al., 2019).

Although generally wastewater cannot be fully converted from tapu to noa, the inclusion of Tangata Whenua in wastewater management could identify what treatment options have the potential to transition wastewater from tapu to noa.

2.3.6 KAITIAKITANGA

Kaitiakitanga (also referred to as 'kaitiekitanga') is the practice of carrying guardianship over the natural environment. Māori believe it is their responsibility to implement kaitiakitanga out of respect to their tīpuna (ancestors), the atua and to the future generations. It is important to note that kaitiakitanga is not just limited to the guardianship of natural environment, it is linked to the cultural, spiritual, social and economic associations with the natural environment. Kaitiakitanga is about ensuring that the environment is managed in a way that can sustain future generations, it is up to Tangata Whenua to determine how kaitiakitanga is carried out.

Māori are obligated to carry out kaitiakitanga and ensure the environment/natural resources are left in a better condition (or as a minimum left in the same condition) for future generations. Not achieving this results in a significant cultural impact that needs to be considered when treating wastewater.

3 REGULATORY CHANGE

National policy statements are issued under the RMA and provide national direction for matters of national significance relevant to sustainable management. The National Policy Statement for Freshwater Management (NPS-FM) directs local authorities on how they should manage freshwater under the RMA.

The changes to the NPS-FM have a large potential impact on wastewater management and disposal. Critically, they provide strong incentives and requirements to avoid environmentally harmful and/or culturally abhorrent discharges to surface water. Specific impacts of the major changes are discussed in further detail below.

3.1 EVOLUTION OF THE NPS-FM

3.1.1 NPS-FM 2011 - 2017

The NPS-FM first took effect in July 2011. Regarding freshwater quality, the NPS-FM 2011 sought to manage freshwater resources "to safeguard the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, in sustainably managing the use and development of land, and of discharges of contaminants." The original NPS-FM 2011 was criticised for a lack of clarity on how to manage water to protect community and Iwi values, requiring duplication of scientific resources by councils, a lack of national consistency for acceptable states of water quality, and unclear definitions of Tangata Whenua values (Ministry for the Environment, 2013). As a result, the NPS-FM 2011 was replaced in 2014.

The NPS-FM 2014 introduced the National Objectives Framework (NOF) to define national values for fresh water and attributes to be managed for each value. It also implemented compulsory national values for ecosystem health and human health for secondary contact. Each of these compulsory values came with national bottom lines for minimum acceptable values. The NPS-FM 2014 also introduced the concept of Te Mana o te Wai to articulate Tangata Whenua values for fresh water more clearly.

The NPS-FM 2014 was amended in 2017. The changes were limited with the focus of the amendments on incorporating the government's goal of 90% of specified waterways suitable for primary contact. Other changes included refining the definition of Te Mana o te Wai, clarifying bottom line values were not standards to aim for but minimums to achieved, and requiring regional councils to set regional targets for DIN and DRP while noting that these were likely to be lower than the toxicity bottom lines set out in the NOF.

The first three iterations of the NPS-FM steadily required more focus on Tangata Whenua values and Te Mana o te Wai while imposing and implementing stricter environmental attribute limits and targets. However, the NPS-FM throughout this period maintained a focus on protecting environmental, cultural, and social freshwater values while allowing for economic wellbeing. Objective A1 of the NPS-FM always related to achieving these goals by sustainably managing the use and development of land, and discharge contaminants. The 2017 amendments went further than previous versions of the NPS-FM to establish objectives and policies to "enable communities to provide for their economic wellbeing, including productive economic opportunities".

3.1.2 NPS-FM 2020

On 3 September 2020, the new NPS-FM came into effect. The NPS-FM 2020 was a substantial change to the previous national objectives and policies for freshwater management in Aotearoa New Zealand. The most important fundamental changes from 2017 to 2020 are:

- Te Mana o Te Wai becomes the fundamental concept of the NPS-FM;
- The hierarchy of obligations under Te Mana o te Wai and the new objective of the NPS-FM require the health and well-being of freshwater be prioritised over economic, social and cultural well-being;

- Tangata Whenua must now be actively involved in freshwater management including decision making compared to the previous requirement to reflect Tangata Whenua values when managing and making decisions regarding freshwater;
- Introduction of a large range of new bottom lines for river and lake attributes; and,
- Reduced time frames for regional councils to incorporate the NPS-FM into their plans.

At its core, the NPS-FM 2020 is a fundamental shift in the priorities of freshwater and land use management in Aotearoa New Zealand. The goal of the policy is shifting away from economic development, with sustainable resource use, to the prioritisation of the health and well-being of water bodies over all other matters.

3.2 WHAT IS TE MANA O TE WAI?

The NPS-FM 2020 is much more explicit than previous versions as it states freshwater must be managed in a way that gives effect to Te Mana o te Wai. Under previous versions of the NPS-FM, there was only a need *"To consider and recognise Te Mana o te Wai in the management of fresh water".*

Te Mana o te Wai is the fundamental concept of the NPS-FM 2020 that protects the mauri of the wai and focuses on restoring and preserving the balance between the water, the wider environment, and the community.

3.2.1 PRINCIPLES OF TE MANA O TE WAI

The definition of Te Mana o te Wai has also been updated to now include six principles relating to the roles of Tangata Whenua and other Aotearoa New Zealanders (e.g. Crown authorities, Community etc.) in the management of freshwater. These principles are:

- *Mana whakahaere*: the power, authority, and obligations of Tangata Whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater;
- *Kaitiakitanga*: the obligation of Tangata Whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations;
- *Manaakitanga*: the process by which Tangata Whenua show respect, generosity, and care for freshwater and for others
- *Governance*: the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future;
- *Stewardship*: the obligation of all Aotearoa New Zealanders to manage freshwater in a way that ensures it sustains present and future generations; and
- *Care and respect*: the responsibility of all Aotearoa New Zealanders to care for freshwater in providing for the health of the nation.

The concept of Te Mana o te Wai, including the six principles, is summarised in **Error! Reference source not found.**.

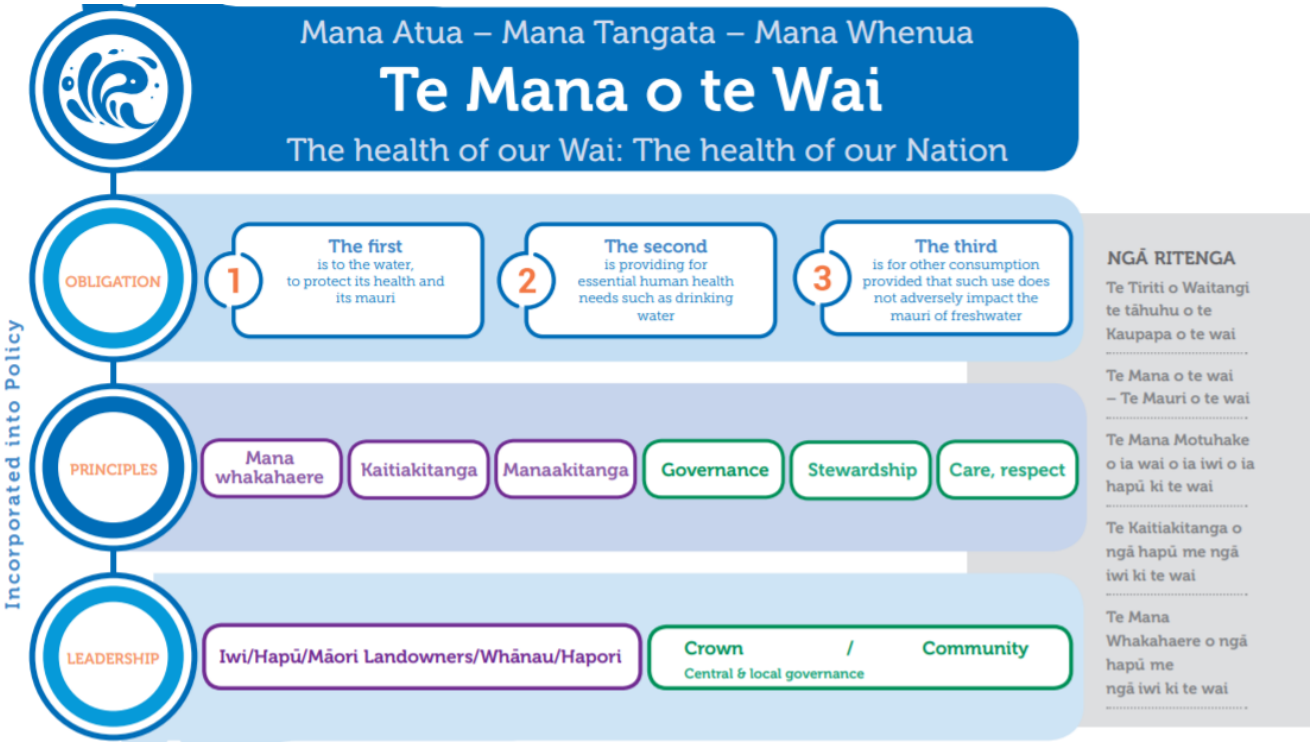

Figure 1: Obligations and Principles of te Mana o te Wai (Kāhui Wai Māori, 2019)

By setting roles for Tangata Whenua and other Aotearoa New Zealanders (Crown/communities), Te Mana o te Wai cannot be given effect to without the inclusion of Tangata Whenua. This means there is a greater responsibility for recognition of Tangata Whenua as Treaty Partners and their right to be included in decision making. The inclusion of Tangata Whenua in freshwater management is provided for throughout the NPS-FM 2020.

Although Te Mana o te Wai must be determined at a local scale by Tangata Whenua, the concept of Te Mana o te Wai incorporates some common Māori values and principles that are relevant to freshwater management (Figure 1).

Although the principles of Mana Whakahaere, Kaitiakitanga and Manaakitanga are defined in the NPS-FM 2020, it is up to Tangata Whenua to determine how these principles are implemented in accordance with their own tikanga and kawa (cultural customs/practices).

Including and implementing these principles in freshwater management will not only lead to better environmental outcomes, but it will also give effect to the artilces and principles of Te Tiriti o Waitangi.

3.2.2 HEIRACHY OF OBLIGATIONS

The objective of the NPS-FM 2020 is to ensure that natural and physical resources are managed in a way that prioritises:

a) first, the health and well-being of water bodies and freshwater ecosystems
b) second, the health needs of the people (such as drinking water)

c) third, the ability of people and communities to provide for their social, economic and cultural well-being, now and in the future.

This hierarchy clearly places economic benefit below environmental protection of water bodies. Previously, many wastewater discharges have been planned and designed under a 'best practicable option' method and in some cases is mandated by regional plans. This approach balanced the cost effectiveness of potential discharges against the potential and actual effects of the discharge. Under this regime, discharges where it was not practicable to fund less environmentally impactful wastewater systems could be permitted as a best practicable option. However, with the prioritisation of the health and well-being of the water body the best practicable option may no longer provide sufficient justification for a discharge.

3.3 LOSS OF VALUES AND FUNCTIONAL NEED

The NPS-FM sets out specific provisions for rivers and wetlands under Subpart 3 which aims to prevent the loss of extent and values of natural inland wetlands and rivers. Specifically, any activity which will result in a decrease in the extent or values of a river or wetland must demonstrate there is a 'functional need' for the activity to occur in those locations and that the effects are managed under the prescribed effects management hierarchy.

Functional need is defined as "the need for a proposal or activity to traverse, locate or operate in a particular environment because the activity can only occur in that environment". From a wastewater management perspective, this appears to imply that any discharge causing a loss of value to a river or wetland, including ecosystem health, indigenous biodiversity, hydrological function, Māori freshwater values or amenity values, may only occur in that environment if there is no other option available.

As discussed above, many wastewater treatment and disposal systems have been designed and consented under a 'best practicable option' method where the cost of systems was weighed against the potential loss of ecological, social and cultural values. The requirement to demonstrate a functional need if a discharge will result in loss of values is a substantial change and suggests that consenting of wastewater discharges which adversely impact on ecological, amenity or Māori freshwater values will be significantly more difficult in the future.

Principally, this section of the NPS-FM is a strong driver for treatment and disposal methods which do not cause loss of values. The implications of this will depend on the specific location, environmental setting, and the local interpretation of Te Mana o te Wai.

4 WHAT DOES THE FUTURE LOOK LIKE?

It is clear the NPS-FM 2020 makes pond treatment/surface water discharge systems more difficult to consent due to strengthened protections for environmental values and a new focus on Tangata Whenua involvement and protecting Māori freshwater values.

What options are there for disposing of treated wastewater? The following section will highlight strategies for environmentally and culturally successful outcomes, a

number of traditional and contemporary solutions, the benefits, risks and the key processes for implementing these solutions to provide improved social, cultural and environmental outcomes.

4.1 COLLABORATIVE DESIGN

Fundamental to the restoration and/or protection of Māori freshwater values is to involve Tangata Whenua through a collaborative planning, design, and construction process. At the core of this process is understanding the differences between Te Ao Māori/Mātauranga Mäori and western science and how they can be reconciled to achieve practical, sustainable, and culturally sensitive solutions. The implementation of the NPS-FM 2020 requires "*the application of a diversity of systems of values and knowledge, such as mātauranga Māori, to the management of freshwater".* Providing for mātauranga Māori in wastewater treatment and management (including design and monitoring) can assist with this.

4.1.1 MĀTAURANGA MĀORI

Mātauranga Māori comes from observation of the environment through continued occupation (ahi kaa) over multiple generations. This knowledge is commonly manifested through place names (of both water and land resources) and tikanga or cultural customs that are practiced by Tangata Whenua. This mātauranga Māori which has been developed over multiple generations of practicing kaitiakitanga, is crucial in the sustainable management of natural resources.

Tangata Whenua should determine if and how they want to incorporate mātauranga Māori into wastewater treatment design and associated monitoring. Rainforth and Harmsworth (2019) summarise a range of Iwi and Hapū-based tools for assessing freshwater management. These are typically mauri-based tools for quantifying cultural effects. These tools are generally not a one-size fits all, and may require adjustments to fit the environment it is to be applied in. As stated previously, Tangata Whenua should determine if these tools are suitable.

4.1.2 MEANINGFUL ENGAGEMENT

Discharge of waste to water significantly impacts the mauri of the wai thereby destroying the life supporting capacity of the water and adversely affecting all those who use the water (T. K. K. Morgan, 2006). Conversely, sustainability is only a relatively modern addition to western thinking and to the management of resources (T. K. K. Morgan, 2006). Historically, western society has often viewed resources as materials to be exploited for economic gain. Even today, economic drivers often remain far ahead of other considerations in many water infrastructure and environmental decision making processes. The recent growth of sustainability principals has been driven by widespread environmental damage and by the scarcity of resources available to our society.

The challenge to developing successful outcomes requires amalgamation of these differing world views into a solution which provides for environment, cultural and social wellbeing. However, asset owners and designers can take a number of steps to ensure their design and planning processes are inclusive of Te Ao Māori in addition to traditional western principles (Ataria et al., 2019):

1. *Develop a long-term relationship with the mandated Tangata Whenua organisation for your area. Only they will be able to define what these Māori concepts mean and how they manifest for particular issues.*
2. *Engage with Tangata Whenua in a meaningful way that is timely, equitable, transparent and reciprocal.*
3. *Promote and support raising internal capability and capacity of Māori cultural values – but not as a substitute for Tangata Whenua engagement.*

With Te Mana o Te Wai as the guiding principle of freshwater management in Aotearoa New Zealand, these steps will be critical for successfully providing for environmental and cultural wellbeing. Early and thorough engagement with Tangata Whenua is crucial, as only Iwi can determine what Te Mana o Te Wai means within their rohe and only through meaningful engagement can Iwi provide important design input to ensure the solutions reflect and protect the environmental and cultural value of freshwater.

Recognising and providing for limited capacity and/or capability that some Iwi/Hapū may have to participate in collaborative processes is essential in order to collaborate successfully. Early engagement is key, however thought should be put into what could contribute to meaningful engagement. Prior to engagement, asset owners and designers should consider:

- Early and frequent engagement is generally required so Tangata Whenua can gain an understanding of the current state/conditions before being able to contribute to future solutions;
- Identifying gaps in knowledge that relate to existing cultural issues and provide opportunities gain further understanding e.g. environmental and/or cultural monitoring, feasibility studies etc;
- Tangata Whenua who contribute in collaborative processes are commonly present on a voluntarily basis, this often limits the ability for Tangata Whenua to contribute meaningfully. Resourcing Tangata Whenua time to contribute could result in meaningful engagement; and
- Even if Tangata Whenua are resourced by asset owners, they are still entitled to express their Tangata Whenua views.

4.2 POTENTIAL SOLUTIONS

In the first instance, the best outcome is to eliminate and avoid the need to discharge any wastewater effluent to land, sea, or surface water. This is the best option to eliminate/reduce effects on Tangata Whenua values. This may be achieved by combining and centralising wastewater treatment to limit discharge points in a network, such as the Eastern Selwyn Sewerage System or the proposed centralisation of the Fielding WWTP to treat wastewater from six currently independent Manawatu townships, or via effluent re-use. In the second instance, the emphasis should be on reducing the discharge of any wastewater effluent to land, sea, or surface water.

There are three primary receiving environments for wastewater disposal, freshwater, land and marine. For the purposes of this paper, we will focus largely on discharges to freshwater and to land where contaminants have the potential to impact freshwater as these are regulated by the NPS-FM.

There are a large range of potential methods to dispose of wastewater. All designs need to be selected based on site specific conditions, and as described above, selected with meaningful input from Tangata Whenua. Disposal systems can range from simple devices such as rock filters or rock channels, to complex solutions such as full pivot irrigation cut and carry systems. Some typical systems which may provide for freshwater values include:

- Indirect outfalls including rip rap channels, rock filters, and surface flow wetlands.
- Land passage systems including sub-surface flow wetlands and diffuse filtration trenches/beds.
- Groundwater disposal including deep bore injection and high-rate soakage systems.
- Irrigation systems including to pasture, fodder crop, native and exotic forest via a variety of means such as pivot, k-line, sprinklers, and dripline.
- Vermifiltration systems which allow for suitable contact with land in the filter.

Each solution is nuanced by the specific application and setting with a range of benefits and risks to each option. The following sections will cover examples for a range of systems including how consultation with Tangata Whenua shaped the optioneering and design process. These samples presented are a mixture of projects that PDP have been involved in and notable examples by others which have been reported on previously.

4.2.1 IRRIRGATION

Irrigation of wastewater to land is an option in many cases for reducing environmental and cultural impacts on freshwater. The irrigation method, hydraulic loading rate, nutrient loading rate, and crop/planting must all be determined using site specific factors. However, well designed and managed wastewater irrigation is likely to reduce the impacts on freshwater due to contaminant attenuation and removal within the soil structure. Particularly, the concentrations of pathogens and phosphorus in water leached from the irrigation area are likely to be substantially lower. Irrigation also allows for contact with Papatūānuku and the potential for conversion of highly tapu wastewater to noa (however this can only be determined by Tangata Whenua). This helps limit the damage to the mauri of any receiving water.

An example of improving environmental and social outcomes is the recent upgrade to the Hanmer Springs WWTP discharge by Hurunui District Council. Previously, the method of disposal was a direct discharge to the Chatterton River. The original discharge was piped to the river where it flowed through a short overland flow path/manmade channel before mixing with the river. The discharge had measurable adverse effects both on the river water quality including DRP and NH_4-N concentrations as well as the ecology of the river downstream of the discharge. Notably, the effects of the discharge were not detectable following the confluence of the Chatterton River and Percival River, 1 km downstream of the discharge. More so, the treatment and discharge process provided no opportunity for contact with Papatūānuku resulting in discharge of tapu wastewater.

From the outset, consultation with Te Rūnanga o Ngāi Tahu and Te Rūnanga o Kaikōura around the available options for disposal indicated that their preferred

outcome was for complete removal of the discharge from surface water to protect the cultural values of the Chatterton and the Waiau Rivers. Early engagement with Tangata Whenua gave clear direction for protecting the mauri of the Waiau River and protecting the cultural value of the wai. This desire from Tangata Whenua to stop discharging to surface water was matched by the wider Hanmer Springs community. A public consultation process indicated a preference for a more expensive discharge to land solution over maintaining a river discharge with significant treatment upgrades and land passage systems.

In 2020, a new system was commissioned to irrigate Hanmer Springs' treated wastewater to a mixture of native and exotic forest on the Hanmer Plains. The system results in an estimated decrease in nitrogen load from Hanmer Springs' wastewater to the Waiau River of 48% and an essentially 100% reduction in pathogens and phosphorus entering the river from wastewater. Critically, the year-round land disposal system allows for all Hanmer Springs' wastewater to be cleansed by Papatūānuku.

However, the selected site is an example of site well suited to land disposal. There was land readily available for purchase and the combination of well-draining soils, deep groundwater, and a relatively dry climate result in minimal risk of saturated soils allowing for year-round irrigation. However, the free draining gravels underlying the site have a high nitrogen leaching potential. The risk of nitrogen was appropriately mitigated with a low loading rate (average of 120 kg N/ha/year). Not all locations in Aotearoa New Zealand possess these characteristics and there are a range of risks which must be mitigated when planning and design land disposal systems.

Irrigation systems need to be designed with appropriate hydraulic loading rates. Excessive loading to poorly drained soils can create risks of ponding or runoff of wastewater. Precautions need to be taken to ensure suitable storage or alternative disposal methods are in place for extended wet weather periods. Even in well drained soils, excess loading rates can prevent proper drainage of the soils by gleying due to high sodicity in the wastewater or due to the build-up of biofilm in the pores of the saturated soils. Both are likely to inhibit drainage causing ponding and/or overland flow problems.

Nutrient loading rates also need to be appropriate for the site. Irrigation with wastewater in areas with domestic or public supply bores risks potential contamination of groundwater with pathogens and/or nitrogen resulting in breaches of the Drinking Water Standards New Zealand 2005 (Revised 2018). The potential for seasonal uptake by pasture/fodder crops/trees must be considered as well as the smaller potential for denitrification and mineralisation of nitrogen applied from wastewater. OVERSEER FM or proprietary soil moisture models can provide predictions of the nitrogen leaching from a given design. It is critical that the designer ensure the nitrogen leaching will not adversely impact groundwater or surface water. This requires a detailed understanding of the hydrological and hydrogeological environment.

Another unusual risk of irrigation of wastewater is increasing contaminant loads on spring fed streams and rivers. In areas such as Canterbury and Hawkes Bay, large mountain/hill fed rivers typically have low concentrations of nutrients while low land/spring fed rivers and streams show high levels of nutrients due to

contamination of groundwater by surrounding land uses. Removing discharges from these large, relatively healthy rivers and applying the nutrients to land can inadvertently increase the nutrient load on streams which may be already significantly impacted by nutrients. It is important that thorough investigation of the local hydrology and hydrogeology is completed prior to design and consenting of the system to ensure the impacts of the irrigation are well understood and can be well managed.

4.2.2 LAND PASSAGE/WETLANDS

There are a range of systems which allow for polishing of wastewater prior to discharge. These systems may allow for minor reductions in nutrients via further plant uptake or for destruction of pathogens via natural sunlight (UV) disinfection, natural die off, or soil filtering. Of greater intangible benefit is the ability to allow for contact with Papatūānuku. These systems can include designs such as rock filters, rock passages, overland flow systems, and surface flow or subsurface flow wetlands. The environmental treatment effectiveness of these systems can vary from negligible for rock passages to highly effective removal of TSS, BOD and nutrients for wetlands (United States Environmental Protection Agency, 2000).

Like all wastewater systems, land passage systems and wetlands need to be designed and constructed appropriately based on site specific factors and input from communities and Tangata Whenua. If the goal of the treatment is improvement of the effluent quality, in addition to providing for Māori freshwater values, then the design must take into account additional factors including the expected effluent quality from the upstream treatment processes, and the final effluent quality required to mitigate the risk of adverse environmental impacts on the receiving environment. Two examples of land passage systems for small WWTPs are the Cheviot WWTP in North Canterbury and the Anakiwa Outward Bound WWTP in Marlborough.

The Cheviot WWTP treats wastewater from approximately 370 people using a two-pond treatment plant. This system is typical of many throughout the country with treatment provided by a primary oxidation pond followed by a maturation pond. During the summer wastewater is irrigated to pasture using k-line sprinklers. However, the poorly drained soils near the WWTP result in extended periods of saturation throughout winter. During this period, wastewater is instead irrigated over a series of constructed 'furrows' at a high rate. Run-off from the 'furrows' undergoes minor further treatment and contact with Papatūānuku as it flows away from the furrows. The wastewater is collected into a manmade drain and flows through an overland flow path before merging with the Crystal Brook and eventually the Jed River, refer **Error! Reference source not found.**.

Collaboration and consultation with Tangata Whenua allowed consideration of the cultural value of the receiving environment. The Jed River is valued by Te Rūnanga o Ngāi Tahu and Te Rūnanga o Kaikōura for a number of reasons (Kirk, 2013):

- water is a taonga;
- its role as an indicator for the health of the entire catchment;
- its important environmental function as an interface between the fresh water and coastal marine habitat;
- for its eel (tuna), flounder and other mahinga kai;

- for the intergenerational transfer of knowledge, cultural significance and ongoing kaitiakitanga responsibilities for Ngāti Kurī and Ngāi Tahu Whānui;
- the mauri of freshwater resources needs to be protected, maintained, and restored if impacted upon by human activities.

Investigation of the receiving environment showed the Jed River is significantly adversely affected by land use activities within its catchment and as such the contribution to the nutrient load from the WWTP is relatively small (Pattle Delamore Partners, 2014). The Cheviot WWTP achieves a moderately high level of treatment which is further enhanced by land treatment (irrigation) when possible. The discharge to surface water only occurs when no other reasonable option is available and ensures further treatment and dilution before mixing with surface water. Engagement with Tangata Whenua during the concept and planning stage ensured an acceptable outcome with effects on environmental and Māori freshwater values minimised.

Figure 2: Cheviot wastewater disposal system.

The Anakiwa Outward Bound wastewater system serves approximately 200 people at the Outward Bound Camp. The treatment system consists of a basic activated sludge plant where raw wastewater is feed into a two-zone aerobic system followed by a clarifier with sludge wasting and return facilities. The clarifier supernatant is piped to a subsurface flow wetland before discharge to an unnamed stream via filtration beds. A clay lining prevents seepage from the wetland while the gravel sub soils allow for aeration of the wastewater and removal of nutrients via plant uptake. The polished effluent is expected to have BOD, TSS, TN and TP concentrations below 10 mg/L with faecal coliforms approximately 100 cfu/100 mL.

The combination of a subsurface wetland and indirect disposal to surface water via filtration beds allows for significant contact with Papatūānuku. The processes have been designed to minimise the impact from an environmental perspective by

providing a high level of treatment, and from a Te Ao Māori perspective by cleansing the wastewater and reducing the tapu associated with the discharge.

4.2.3 GISBORNE MORTUARY WASTEWATER

All humans possess spiritual tapu which extends to our waste products and especially to our body parts. In Te Ao Māori, it is common have separate tikanga/kawa (cultural customs/practices) for waste management depending on the type of waste. Waste associated with tūpāpaku (deceased) is extremely tapu. Domestic wastewater mixed with mortuary waste has a higher degree of tapu compared to domestic wastewater alone.

The Tūranganui-a-Kiwa (Gisborne) Tangata Whenua have long opposed the direct discharge of treated wastewater containing mortuary waste into the ocean (Tūranganui-a-Kiwa/Poverty Bay). The direct discharge of treated domestic wastewater has a significant cultural effect on Tūranganui-a-Kiwa Tangata Whenua, however they consider the discharge of highly tapu mortuary waste culturally abhorrent (Palmer, 2015).

It is a common practice in Te Ao Māori to place a rāhui over coastal areas when there has been a death at sea. The rāhui is put in place to prohibit the use of the coastal area for food gathering and recreational activities. A rāhui is put in place to recognise the tapu associated with tūpāpaku (deceased) which could lead to physical and/or spiritual harm. Discharging mortuary waste into Tūranganui-a-Kiwa/Poverty Bay leads to potential physical and spiritual harm to people who may use the bay for food gathering and/or recreational activities.

Tangata Whenua are also of the view that wastewater containing mortuary waste cannot be recycled. Therefore, separating mortuary waste from domestic wastewater would enable culturally appropriate options for recycling of wastewater (Palmer, 2015). Tangata Whenua have long advocated for the separation of mortuary waste from domestic wastewater and land-based treatment for mortuary waste.

Gisborne District Council has worked with Tangata Whenua on a solution that is now enabled by changes to the Gisborne Trade Waste Bylaw. Mortuary waste is no longer discharged to the sewer, instead it is treated at the local cemetery via a Wisconsin mound land disposal system. A typical system is shown in Figure 3. The system is fundamentally an above ground bottomless sand filter, which in a below ground arrangement are commonly used as a cost-effective means of providing secondary treatment for on-site wastewater systems. This example provides unique insight into managing cultural impacts in systems where environmental impacts are already relatively well managed. A similar approach could be applied to smaller systems where there are limited contributors of highly tapu wastewater. This would allow for culturally sensitive reuse of the wastewater.

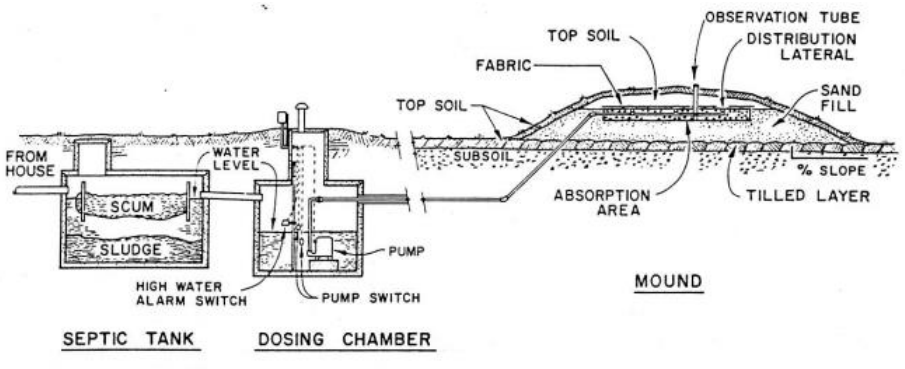

Figure 3: Typical Wisconsin mound design (Converse, 2000).

4.2.4 HASTINGS BIOLOGICAL TRICKLING FILTER SYSTEM

The Hastings WWTP and disposal system is a unique approach to managing wastewater in an environmentally and culturally appropriate manner. The plant feeds screened raw wastewater to a low organic loading biologically trickling filter (BTF) (Bradley et al., 2012). Wastewater then flows through a rock passage before being pumped to a coastal outfall 2.75 km offshore. While not specifically related to protecting freshwater, this example provides both excellent insight into the benefits of engaging with Tangata Whenua and guidance on the principals of the holistic view of the environment and water under Te Mana o te Wai.

The BTF was designed with extensive consultation with Tangata Whenua to replicate traditional Māori waste management strategies (Hermens et al., 2014). Traditionally, waste was buried where contact with Papatūānuku transformed the waste into a safe material. The low loading rate of the trickling filter (< 0.5 kg BOD/m³ media/day) resulted in a process termed 'biotransformation' where both the contaminant loading was reduced to be suitable for far offshore coastal discharge, and the treated wastewater/sludge combination was transformed from tapu to noa. This transformation is further accentuated by use of a rock passage system prior to discharge to the coastal outfall (Bradley et al., 2012).

Through highly collaborative design a wastewater system was produced which satisfied both environmental and cultural concerns in an affordable and sustainable manner.

5 CONCLUSIONS

The NPS-FM 2020 places much higher importance on the protection the environmental and cultural freshwater values. The inclusion of Te Mana o te Wai as the fundamental concept of the NPS-FM, and the requirement for regional authorities to include Tangata Whenua in decision making, places far greater importance on Māori freshwater values than in previous iterations of the NPS-FM. Fundamentally, the NPS-FM makes consenting discharges which adversely impact freshwater values, including cultural values, far more challenging.

To provide for Māori freshwater values, wastewater systems must be planned, designed, and constructed with meaningful engagement and contribution with/by

Tangata Whenua. Māori freshwater values are specific to local Iwi and Hapū and only they can define Te Mana o te Wai within their rohe.

A collaborative design approach not only streamlines the process, comparative to engagement at the end of the design process, but also allows for the development of unique and effective wastewater management solutions.

While Māori freshwater values are unique to Iwi and hapū, the overarching concept of Te Mana o te Wai is the protection of the mauri of the wai. Mauri is damaged by discharging tapu wastewater to water without appropriate contact with Papatūānuku or any other further measures determined by Tangata Whenua. There are range of methods which can be designed in conjunction with Iwi to protect these values. These include land contact systems such as rock filters/rock passages and wetlands through to full year-round irrigation systems. No matter the proposed solution to manage wastewater, there are two key processes which all designers must follow:

- Firstly, designers and asset owners must engage early and meaningfully with Tangata Whenua to understand their interpretation of Te Mana o te Wai and to provide for a collaborative design process which appreciates and protects Māori freshwater values.

- Secondly, wastewater treatment systems must be designed according to site specific conditions with sufficient investigation and understanding of the receiving environment to prevent harmful adverse effects on freshwater.

Following these two processes will allow for unique and effective wastewater management solutions which meet the obligations of communities under Te Mana o te Wai and which provide for environmental, cultural, and social freshwater values.

While not specifically covered in this paper, asset owners must also be prepared to take a holistic approach to not only waste management but overall water management. Options should be explored with Tangata Whenua to determine how water can be managed in accordance with the Water Management Hierarchy; eliminate use, reduce use, reuse, and recycle water before considering disposal. Discussions with Tangata Whenua on waste minimisation will be crucial to any future attempts to implement wastewater reuse and recycling and will help to align any proposed systems with Māori cultural values and tikanga. A holistic approach to water management may promote freshwater values more effectively than discharge management by reducing the overall volume and number of wastewater discharges to freshwater.

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