IS IT A 'WETLAND'? IS IT A 'RIVER'? NO… IT'S A GREY AREA

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ABSTRACT

The Resource Management Act 1991 (RMA) protects *wetland* and *river* features through section 13. How these features are defined depends on which piece of legislation is relied upon, with slightly different definitions included in the RMA, the National Policy Statement for Freshwater Management 2020 (NPS FM) and Regional Plans. While many of these definitions are similar, small nuances can wreak havoc – both in what to call something and subsequently what the consenting implications are.

Since the introduction of the NPS FM, defining these features has become a hot topic, mostly, in our opinion, because of the prohibited activity status applied to many activities affecting *natural inland wetlands* in the original version of the National Environmental Standards for Freshwater (NES F) (September 2020).

Consequently (and despite having been subject to protection in some form since 1991), delineation of wetlands and whether something was a stock-pugged river or a degraded wetland became a point of contention. 'Is it a wetland' has become as triggering to some as the concept of nuclear power (of note as it is one of the widely recognised prohibited activities in Aotearoa New Zealand).

One theme all these definitions have in common is an implied state of mutual exclusivity and stationarity – that if something is a river, it can't be a wetland (and vice-versa) and that they will remain static through time. What these definitions, policies and rules fail to appreciate is that, in reality, rivers and wetlands are aquatic ecosystems that exist on a continuum of form and function.

From a scientific point of view, aquatic systems have significantly more nuanced characters, behaviours and values (e.g. types such as intermittent, perennial, wandering, braided, valley fill, marsh, swamp...). How these systems behave is driven not by a definition in a piece of legislation, but rather by the prevailing landscape and ecological controls. River and wetland systems may fluctuate between different forms and states depending on numerous climatic, hydraulic and landscape factors.

Policy aside, it is the science, form, and function of these aquatic systems that tells us what we need to do to maintain their ecological and morphological integrity, not the definition introduced by the government of the day. Understanding the character and behavior of these systems in their landscape context is essential to inform decision making, ensuring that water sensitive urban design and nature-based solutions are implemented in a way that respects the processes and functions of these systems, and ensures a measure of success.

Within this paper we describe the science behind the characterisation of these aquatic systems, reflecting on their ecological and morphological function, and what this means for designing nature-based stormwater and flood management solutions that work with the landscape and ecological processes and controls. We explore the implications of the statutory framework and what this means in practice in respect of stormwater management. Lastly, we highlight how wetlands and streams provide an opportunity to integrate ecological, amenity, stormwater and flood management outcomes, while enabling future development.

KEYWORDS

Nature-based solutions, science and policy, wetlands, geomorphology, ecology, river, stream

1 ARBITRARY IMPOSITIONS

In September 2020, the latest iteration[1] of the National Policy Statement for Freshwater Management (NPS FM) was released with a 'new' definition for wetlands, being that of 'natural inland wetlands'. This was accompanied by the Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-F) which made a wide range of activities in and around natural inland wetlands prohibited. It seemed that all of a sudden, wetlands were protected and more wetlands were being identified, particularly in highly modified or disturbed landscapes, leading to (sometimes major) project constraints.

This knee-jerk reaction implied that wetland protections were new, however this was not necessarily the case. Defined in the Resource Management Act 1991 (RMA) as an area that '*includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions',* the natural character of wetlands is recognised as a matter of national importance (section 6a). Wetlands are protected to some degree by interpretation of section 13, which protects the beds of rivers and lakes. Further, section 30 (amended in 2003) gave regions the ability to make and enforce rules to maintain ecosystems in water bodies[2] and to maintain indigenous biodiversity.

As of October 2020, there was a range of policy wording and rules in respect of wetlands across Aotearoa's 16 Regional Councils/Unitary Authorities explicitly recognising the importance of wetlands through protection (Denyer & Peters, 2020). Some of these protections dated back much earlier, including for example, Auckland Unitary Plan (AUP) (2013), Horizons Regional One Plan (2014), Northland Regional Water and Soil Plan (2004) and the Regional Water Plan for Southland (2010). Many of these plans had their own wetland definitions, to provide further clarity to the RMA definition, to protect only those areas deemed significant, and/or to align with regional priorities.

Given that there have been existing protections in many places, and the NPS FM definition effectively requires you to consider if something is a wetland under the RMA and then provides a pathway to 'exclude' a wetland from being considered a 'natural inland wetland',

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[1] Previous versions included 2011, 2014 and 2017. In February 2023 an updated version of the NPS FM and NES F were released however retained the same 'NPS FM 2020' moniker, and further updates have been made in January 2024 (again, retaining the same moniker).

[2] Wetlands are included in the RMA definition of a 'water body'.

it is somewhat surprising that more wetlands were being identified. This, in our opinion, reflects an industry that had been allowing wetland loss through ignorance for at least the last 30 odd years.

While the NPS FM definition was considered hard to navigate (we'll not dig into the nuances of what constitutes a pasture grass in this paper), also troubling was that the prohibited status applied to some activities affecting natural inland wetlands, but similar activities in rivers were not afforded the same level of protection. This introduced a tension in classification, that went beyond 'is it aquatic or is it terrestrial?' into 'what kind of 'wet thing' is it?', and had the potential to halt projects in their entirety. Further, in the absence of a qualifier about the value or level of ecological significance of that natural inland wetland, it effectively directed avoidance of any natural inland wetland, prioritising these above all other ecosystems, perhaps to the detriment of other, higher value features (such as rivers and terrestrial environments) (Baber et al., 2021). The potential for perverse outcomes was high.

This tension in respect of aquatic ecosystems and protection levels is not new. For example, within Auckland (2008) it was the difference between a Category 1 (permanent, protected) or Category 2 (intermittent, unprotected) stream (Auckland Council Regional Plan Air, Land and Water) with a permanent stream defined as: *Downstream of the uppermost reach of a river or stream which meets either of the following criteria: (a) has continual flow; or (b) has natural pools having a depth at their deepest point of not less than 150 millimetres and a total pool surface area that is 10m^2 or more per 100 metres of river or stream bed length. The boundary between Permanent and Intermittent river or stream reaches is the uppermost qualifying pool in the uppermost qualifying reach.* This definition was quite specific and there was no direction as to the time of year classification could be reliably undertaken. Classifications were often challenged by Council if undertaken in unusual conditions (i.e. at the end of a dry summer), which was equally often encouraged by developers to avoid the trouble of having a permanent stream on site.

Following the introduction of the AUP in 2013, the tension between intermittent and permanent moved to be between intermittent (protected) and ephemeral (not protected). The definitions were updated, requiring assessment of whether a stream meets three of six criteria. The assessments are intended to only be undertaken if these criteria can be assessed 'with confidence'. 'With confidence' can be challenging if the stream in question has been modified or degraded to the point that particular criteria are difficult to assess or are absent. Auckland Council has since produced a 23-page practice note to clarify 'how' to do these assessments (Auckland Council, 2021) which provides an indication of the level of complexity behind some seemingly simple criteria. Perhaps not surprisingly, classifications are still routinely challenged by Council regulatory staff despite this guidance. Conveniently within Auckland, wetlands and streams maintained the same level of protection in the plan (with reclamation being a non-complying activity), so whether something was sufficiently wet to either be a wetland or an intermittent stream, it didn't matter too much what it was called from an activity status point of view.

There are many examples in other regional plans, where the specific nomenclature of a feature has a significant bearing on the potential for the site to be developed, without necessarily a wider consideration of the geomorphic history, ecological value or significance of the feature.

Common to these situations is that practitioners are asked to classify an aquatic feature based on changing definitions with a variety of caveats, disclaimers and challenges to the assessment process. What is already tricky, becomes more complicated when dealing with highly modified or degraded systems, commonly found in greenfields areas subject to future and urban development pressures.

While the 2023 updates to the NPS FM and NES F eased a bit of pressure with updated definitions and reduced activity status for many activities, the pressure remains for practitioners to 'make a call' on which box the aquatic feature fits in.

Definitions will never be able to capture all the nuances of natural systems. Janet Hunt (2007) puts it perfectly when speaking of wetlands '*in the end, all classifications are arbitrary impositions of human order on natural phenomena'*. They are written by policy people who need to have a black and white standard to provide certainty and clarity, however these do not have the flexibility to apply to systems that change temporally and spatially. It's acknowledged that the rules still apply and there does still need to be recognition of what something 'is' to enable planners to tick the right box, however, we are of the view that this narrow approach to classifications is resulting in perverse outcomes and missed opportunities to 'do better' by the environment.

So, while necessary, legislative definitions are simply put - annoying. If we move past that (as much as we can recognising there will always be a need to have definitions in resource management law), we can instead describe an aquatic system in the way it functions, and use that to guide the next steps for what we should do to protect it, use it to our advantage and/or restore it.

This paper presents the science of rivers and wetlands, to help set the scene for the primary things we should be looking at when classifying an aquatic system – not trying to wangle our way out of applying a particular definition, or stressing about the minutiae of pasture grass species. We want to share with you the key things you should be thinking about when considering a nature-based approach to stormwater management and site design and development. Hopefully by the end of this paper, you'll see 'wet things' all around you and recognise the complexity of classifying them in a changing environment as well as how to integrate them in your projects to achieve positive environmental outcomes.

2 THE WORDS WE USE

The legislation we work with seems to imply that wetlands and rivers are sufficiently different that they can be easily distinguished, so let's explore this a bit further.

Rivers are defined in the RMA as "*a continually or intermittently flowing body of fresh water; and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal)*".

River form and function, is reflective of its position in the catchment, generally starting small in the headwaters, and then as tributaries join and flows increase, becoming wider and deeper until they reach their conclusion at a lake or the ocean (Brierley and Fryirs 2005; Gurnell & Bertoldi 2024). Some are glacially fed, drying up in winter when their source water is trapped in ice, others may dry up in summer when the water table drops and rainfall is low. But for the large majority of these cases, flowing water is responsible for forming and maintaining a channel, through erosion and deposition.

The body of peer reviewed literature spanning the last six decades, supports this supposition, suggesting the definition of a river takes its cue from the Latin ripa ("bank"), as *"any natural stream of water that flows in a channel with defined banks"* (Drury et al, 2024). It is also noted that *"Modern usage includes rivers that are multi-channelled, intermittent, or ephemeral in flow and channels that are practically bankless. The concept of channelled surface flow, however, remains central to the definition."*

The literature defining wetlands is a little less definitive in characteristic processes. However, Johnson and Gerbeaux (2004) suggest '*Wetlands are precisely that: wet lands. They are places of poor drainage or where water accumulates; sites where seepage or flooding is frequent; interfaces where land meets streams, rivers, lakes, and estuaries.'*

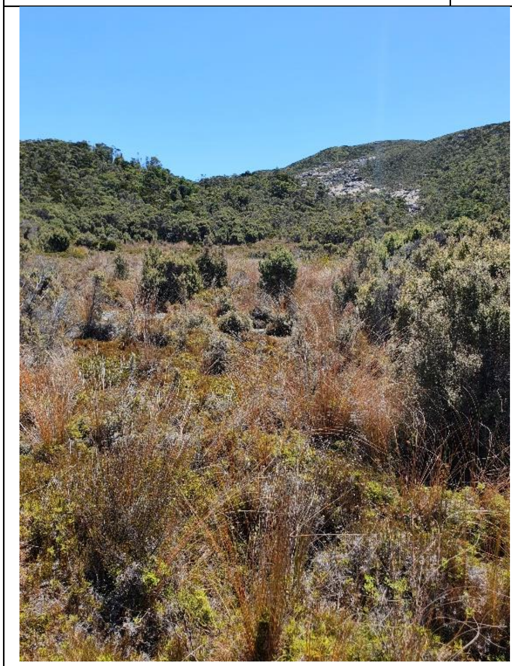
Another quite wide-ranging definition is that of the Ramsar Convention on Wetlands (1971) (to which Aotearoa New Zealand is a contracting party): *'For the purpose of this Convention wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres'*. Like Johnson and Gerbeaux's 2004 definition, the RAMSAR definition does not explicitly exclude rivers.

Included in Figure 1 are a range of images of relatively simple to classify rivers and wetlands – these fit into the 'box' reasonably well.

Hard-bottom stream in upper South Island, flowing through National Park. (Source: JQuinn)

Small, permanently flowing stream in agricultural landuse in South Auckland. (Source: JQuinn)

Small, intermittent stream in agricultural landuse, Waikato. (Source: SConn)



Wetland area at Mackay Downs, Kahurangi National Park. (Source: JQuinn)

Seepage wetland typical of headwater systems in agricultural settings. (Source: JQuinn)

Figure 1: Examples of typical river and wetland environments

There is significant cross-over in the definition of river and wetland, which also plays out in the real world when trying to distinguish between a wetland and river.

Acknowledging that a river system is 'likely' to have an identifiable channel, is a great start in identifying differentiating features between rivers and wetlands. With some exceptions, it is also generally accepted that rivers display longitudinal connectivity. That being, by and large, while stream form may change throughout the catchment, these different forms of the system are often connected to each other (Vannote et al, 1980). The 'wet bits' of our landscapes exist on an energy continuum, continually adjusting to a range of flow, sediment (loads and caliber) and vegetation interactions and the associated balance of impelling and resisting forces. These forces are controlled by the landscape (tectonic setting, valley confinement, catchment geology, slope/relief, landuse) as well as the climatic regime and hydrology (rainfall intensity and duration, flood history, hydrological alterations) (Fryirs and Brierley, 2013; Johnson and Gerbeaux, 2004; Gurnell & Bertoldi 2024).

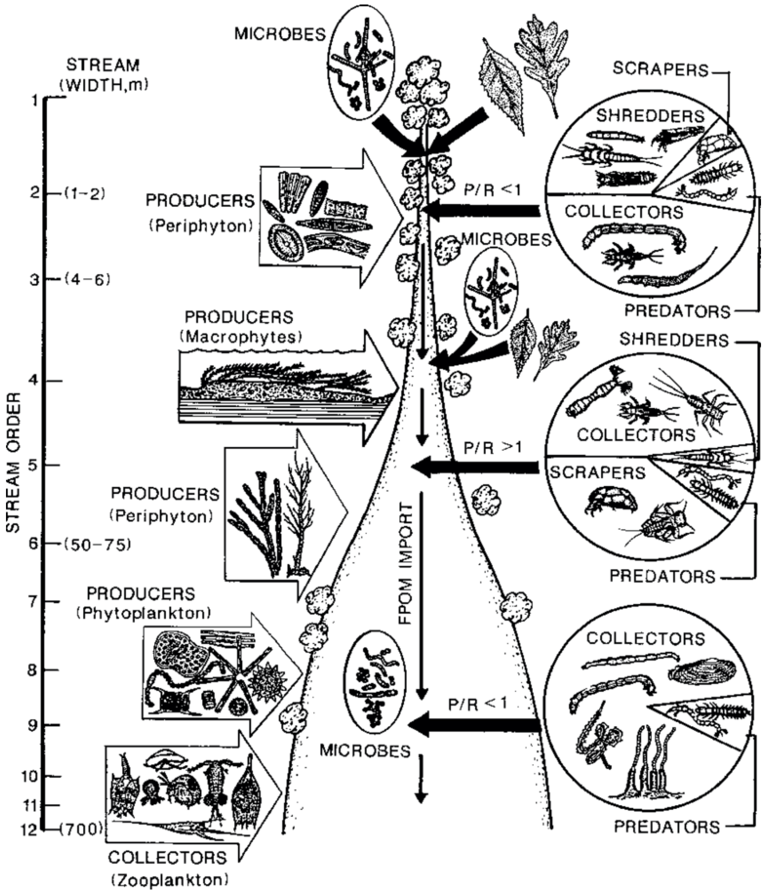


Figure 2: Longitudinal relationship between stream size and ecological structure and function (Source: Hicks, 2002, from Vannote, 1980).

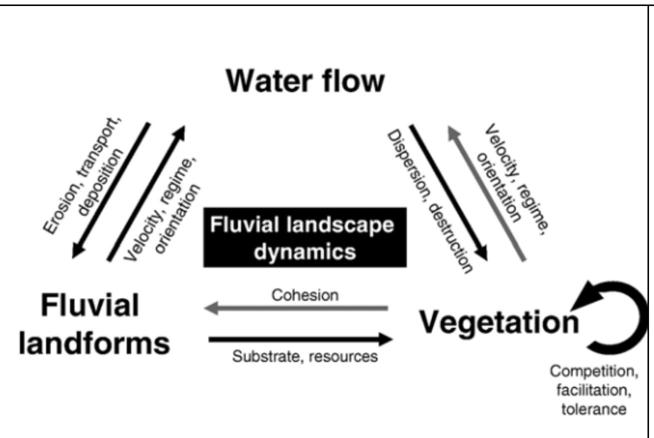
It is also reasonably well accepted that riverine ecology, is likewise on a continuum, reflecting the prevailing geomorphic structure of the system, at any point along the longitudinal gradient (Vannote et al, 1980). The morphological-behavioural adaptations of macroinvertebrates and freshwater fauna reflects the changing state of the river, driven in part by type and availability of food resources (Figure 2).

This ecological and geomorphic continuum makes it challenging to clearly and concisely differentiate between 'wetlands' and low energy 'streams' environments that may sit very close to each other on that continuum.

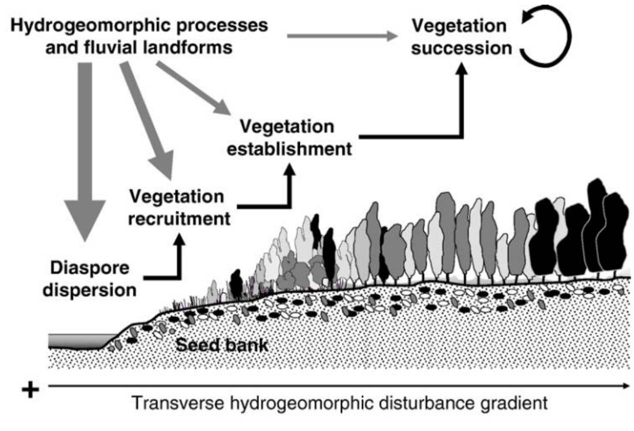
Currently, we are directed to apply the Wetland Delineation Protocols (WDP) (Ministry for the Environment (MfE), 2022) to work out if the 'wet thing' is a wetland, if it is not clearly a channelised river environment. The New Zealand WDPs are based on a US method (Environmental Laboratory 1987), and they rely primarily on vegetation, with supporting hydrology and hydric soils tools. Currently, the guidance suggests that the WDP's are best applied in unmodified systems, with the original US protocols applied if any of the three components (vegetation, hydrology, soils) are modified or disturbed. Despite the three-pronged approach, it is quite a two-dimensional assessment of what is a complex ecosystem feature. In essence, the WDP just determines if the land is wet or not – but doesn't help us understand whether the 'wet thing' is a river or a wetland…or something in between.

For instance, a WDP vegetation assessment undertaken in a riparian margin will often come up as a wetland, when really it is a functional part of a river system. This is because plants that are adapted to wet conditions ('hydrophytes') also exist within and alongside river channels. Clarkson (2014) in her vegetation tool describes plants as: obligate wetland (occurs almost always in wetlands), facultative wetland (occurs usually in wetlands), facultative (equally likely in wetlands or non-wetlands) and then facultative upland and obligate upland (usually, or almost always in non-wetlands). Many of the species identified as obligate wetland or facultative wetland can also be found in stream margins, or within streams themselves as the primary requirement of a hydrophyte is to grow in, or on, water or waterlogged soil – a feature common to both rivers, river margins and wetlands.

A detailed review of riparian and aquatic plant adaptations to riverine environments has recently been undertaken (Gurnell and Bertoldi 2024). Interestingly, the literature seems to liken the dispersal and propagation of riparian and aquatic species to sediment transport, with commonalities in species likely in micro and macro environments with similar depositional regimes (be that wetland or river bank). River processes and their riparian vegetation are implicitly interlinked, with river processes modified by vegetation, but equally the vegetation itself can be modified by the river, (Corenblit et al 2007; Gurnell & Bertoldi 2024). The transverse hydrogeomorphic disturbance gradient suggests that riparian vegetation types reflect the frequency of disturbance (Figure 3). In Aotearoa New Zealand, this often translates to river banks which are regularly disturbed by flood flows (and subsequent erosion and depositional processes) may have riparian vegetation that does not progress past the stage of low lying 'primary colonisers' which are often 'hydrophytic' or 'adapted to wet conditions' and can commonly be found in wetlands. This regular disturbance regime may also prevent the formation of 'hydric' soils, typically associated with wetlands.



Conceptual diagram of the interactions between fluvial processes and vegetation dyanmics. Taken from Corenblit et al (2007).



Conceptual diagram of the hydrogeomorphic controls on vegetation dynamics in river systems. Taken from Corenblit et al (2007)

Figure 3: Conceptualisations from Corenblit et al (2007) showing the relationships between fluvial processes and vegetation dynamics.

Applying the WDP in a macrophyte laden stream channel (see for example Figure 4), a common feature of streams with high nutrient inputs and low shading, will therefore key out as a wetland under the WDP vegetation tests. Is a highly degraded, modified stream channel really a wetland? Or should it instead be considered a river with high macrophyte abundance. Reducing macrophyte cover and restoring the channel to a river may be as simple as planting the channel margins with a riparian buffer to improve shading. But is this allowed or frowned upon under the rules?

	
Macrophyte dominated channel in urban catchment, Te Ararata Creek, Mangere Auckland. (Source: JQuinn)	*Macrophyte dominated stream channel in horticultural catchment, Levin. (Source: JQuinn)*

Figure 4: Examples of streams with high macrophyte coverage.

Agricultural landuse can fundamentally alter the integrity of aquatic systems (see Figure 5). Naturally channelised streams can exhibit wetland characteristics where unrestricted stock access results in pugging and modification or destruction of the characteristic 'channelised' stream form, which in turn alters the sediment transport capacity/capability of these low energy stream systems. Simply applying the WDP where a clear channel does not exist, will likely result in a wetland classification. Conversely, protection of the area from stock will likely allow that system to return to a more natural stream state. Would protection of the wet area from stock and allowing it to naturally find its equilibrium be acceptable under the rules? What about actively engaging in restoration work to return it to a more natural equilibrium, which may be seen as modification of 'extent' (which would go against the direction of Policy 6 of the NPS-FM). Should we assess on past, current or future state in a highly transitional and impacted environment (and where perhaps basic good practice measures like stock exclusion have not been followed)?

		
Short intermittent catchment, seepage source, modified by stock access and exhibiting wetland characteristics, North Auckland. (Source: JQuinn)	*Evidence of stock pugging in a clearly wet area, where vegetation has been grazed/destroyed by stock damage. (Source: JQuinn)*	*Small, intermittent headwater stream, showing a definable channel with banks. (Source: SConn)*

Figure 5: Examples of modified aquatic systems in agricultural landscapes

Similarly, a river can flow through the centre of a wetland and they can occur together. The images in Figure 6 below show a clearly defined channel, meeting the definition of a river, surrounded by wetland vegetation and hydric soils. In these situations, the aquatic system could be called a 'riverine wetland' and ecosystem in its own right, which encompasses two RMA definitions – so which prevails?

	
The Taieri River scroll plains are possibly the most iconic example of a river and extensive riparian wetlands. Sourced from LINZ	*Clearly defined flowing channelised river section, through the centre of a wetland in agricultural landuse in South Auckland. (Source: JQuinn)*

Figure 6: Examples of transverse river/wetland complexes

In some less modified areas, naturally occurring seeps can result in saturated soils, with some areas of flow on or near slopes draining towards streams. Sometimes these features can be very small, just at the point of intersection between the water table and the soil surface (Figure 7). In addition, stream environments can turn into wetland environments as the energy of the system changes. This is most commonly seen in steep sub-catchments, with reasonably high sediment loads, that may be ‘disconnected’ from the main trunk river by a large floodplain (Figure 7). The energy is sufficient for sediment transport and channel maintenance in the upper catchment with confined valleys and steep gradients, but the rapid grade change to a flat and unconfined valley floor results in a dramatic loss of energy, to the point the stream can no longer transport the sediment, or maintain its channel form. Longitudinally these features are part of a continuous network, however the label assigned could change spatially (according to the definitions).

	
Areas of seep adjacent to defined stream in vegetated catchment, with stock access. South Auckland. (Source: JQuinn)	*Landscape scale examples of small tributaries with high sediment loads maintaining a channelised stream form through confined steep gradient hillslopes (blue arrows), that rapidly turn into wetland environments on the valley floor (white arrows), before joining the Turipoto River.*

Figure 7: Examples of longitudinal river/wetland complexes

If the presence of water and wet adapted vegetation isn’t definitive, how about fauna? Many of the animals that live in rivers can also live in wetlands being that they’re wet. For those degraded wetlands with minimal vegetation, or which are subject to on-going grazing pressures, fauna such as wetland birds may only periodically visit the site. Many aquatic macroinvertebrates common to wetlands may also be found in rivers (Suren & Sorrell, 2010) so are not useful to determine if the ‘wet thing’ is a wetland or river. Some macroinvertebrates are adapted to aquatic systems that experience periodic drying so communities may differ between permanent and ephemeral wetlands. Fish can move between areas of habitat, but only where fish passage is available. So while there are some species that are more likely to be found in a wetland than a river, if that wetland is disconnected from other habitats or flow paths, then it is unlikely that fish will frequent the wetland. Equally, if it is highly degraded, there may be insufficient habitat for fish to utilise.

With all of this in mind, it is clearly necessary to understand how these wet features formed, and what is driving them to change form. Understanding this, is central to then understanding how they will behave in a natural environment and what changes the landuse modification proposed may cause, regardless of the label given to them.

3 ANTITHESIS OF MUTUAL EXCLUSIVITY AND STATIONARITY

As we have established, the 'wet bits' in our landscape exist on an energy and ecological continuum. What we are calling 'wetlands' exist at the far end of the energy continuum, being low energy environments, where the discharge regime is insufficient to meaningfully mobilise and transport the sediment within the system. Therefore, they typically can't form and maintain a channel. Low energy stream environments also sit down this end of the continuum, perilously close to 'wetlands'. The balance between the impelling and resisting forces responsible for the maintenance of a 'channelised' or 'non-channelised' form.

Alteration to the balance between impelling (e.g. slope, discharge) and resisting (e.g. vegetation type, sediment caliber, valley confinement) forces may therefore induce a shift in the behavioural regime of a system, which may then evolve to have a different characteristic form. Willows invading a low energy stream environment, for example, will likely result in reduced channel capacity, increased deposition, channel infill and loss of channel form, and become characteristically a 'wetland'.

But here is the catch, these impelling and resisting forces are not static, and changes to the forces are not necessarily predictable (e.g. large magnitude disturbance events such as cyclone Gabrielle). Therefore, system adjustments can occur across a range of timescales and may be gradual or episodic. This means a one-off assessment of what we see on site now, might not capture the full envelope of forms that might be characteristic of our aquatic system. What we call a 'willow wetland' today, might have been a stream 50 years ago, and might readily become a stream again following willow control and removal (Figure 8).

Mangaonua Stream under willow canopy. Multiple poorly defined channels, wetland characteristics. (Source: SConn)	*Mangaonua Stream immediately following willow removal, rapidly incising, single thread channel forming. (Source: SConn)*	*Mangaonua Stream several years following willow removal, with a single incised channel, and mass wasting processes occurring as the channel naturally widens. (Source: SConn)*

Figure 8: Example of the 'real time' evolution of a 'willow wetland; back to a stream following restoration.

Some systems are more sensitive to form changes than others. While we may not be able to predict when and where large magnitude disturbance events occur, we can assess the sensitivity of our fluvial systems to change, by understanding their capacity for adjustment. We can do this by identifying the range and extent of geomorphic adjustments that can occur in our system, and the ease with which the system can adjust its form in the vertical, lateral and wholescale dimensions (Brierley and Fryirs, 2005). Systems that can adjust in all three dimensions and have a broad behavioural regime have greatest capacity to adjust and are considered to be the most sensitive to adjustment.

A great example of this, are the valley fill, or cut and fill stream types which were likely to have been extremely common in Aotearoa New Zealand. These systems are typically associated with small catchments, often in low rolling hill environments, but can also be associated with catchments with erodible geology and high sediment loads (such as the tributaries of the Turipoto River Figure 7). The envelope of forms and behaviour of these systems include non-channelised 'wetland' systems on valley floors which incise vertically and horizontally through unconsolidated alluvial deposits (Figure 9). The trigger of 'cut' or 'fill' phases is usually in response to flood events (delivery of large pulses of sediment which overwhelm the channel, or raising discharge sufficiently to trigger incision). The channel will often form in a different place on the valley floor each time, creating characteristic bank stratigraphy which may contain layers of 'hydric' soils in between layers of coarser alluvium.

As these low rolling hill environments are preferred for greenfields development, we have urbanised many of the catchments these systems occupy. With a resulting increase in stormwater inputs into these valley fill/cut and fill systems, the balance has swung towards the erosional, where discharges have increased and the sediment loads decreased. It is now no longer possible for these systems to revert back to their more 'wetland' forms.

	
Unnamed Stream near Kaiteriteri underlain by erodible separation point granites, at the start of a 'cut' phase. (Source: SConn)	*Same stream near Kaiteriteri well into the 'cut' phase. (Source: SConn)*
	
Unnamed stream near Rotorua, which has infilled and lost its channelised form due to stock access, and possibly from poplars altering the hydrology. (Source: SConn)	*Same stream near Rotorua further downstream, channelised and flowing. Note slopes are steeper, and a small head-cut was present at the inflection point, suggesting upstream propagating incision. (Source: SConn)*

Figure 9: Examples of valley fill and cut and fill stream types

3.1 WHY DOES IT MATTER?

Understanding system character and behaviour through time allows us to put what we see in the field, into a much broader context of evolutionary sequence, envelope of forms/character, as well as landscape change (Figure 10). This allows us to see the system as a function of the landscape, not a sterile definition in policy. It also allows us to have realistic expectations for how we can use these systems in our developments, and what we can expect from them as we change the surrounding landscape processes.

When naturalising or daylighting a stream, you may think you are designing a delightful babbling brook, which tiptoes around stepping stones and plays hide and seek in the overhanging vegetation, but your system might have other ideas. What you may have inadvertently designed is a channel unable to transport the contributing sediment loads, which evolves in no time at all, into a wetland.

When urbanising a greenfields site, the introduction of impervious surface changes not only the hydrograph, but also the source and distribution of sediment, nutrients and organic matter to the receiving environment – all of which is essential to maintain its form, function and ability to support aquatic flora and fauna.

It also highlights the importance of understanding the 'disturbance' history, of not only the site, but also the system in general. The disturbance regime doesn't just affect system form, it can also modify the vegetation associated with the system. Even in low to moderate energy stream environments, repeat flood disturbance can suppress vegetation succession, keeping vegetation limited to fast growing riparian colonisers, which are also commonly found in low energy wetland environments, rather than allowing a transition through to a more woody riparian mix (which would be less common in wetland environments).

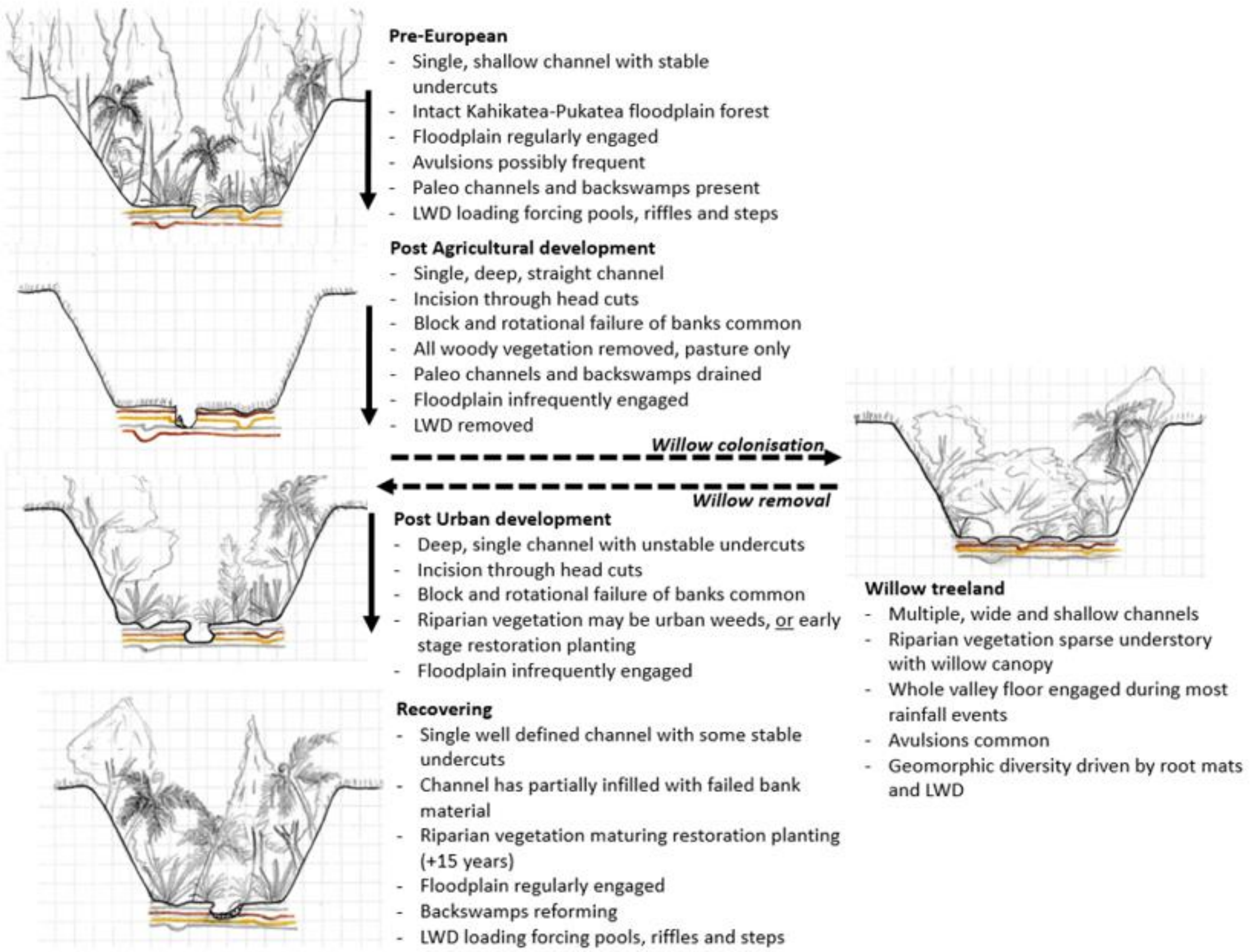


Figure 10: Example of a conceptual evolutionary trajectory for the Mangaonua Stream, showing probably pre-vegetation clearance condition, response to agricultural development, response to willow colonisation, and then expected response to restoration. (Source: SConn)

Knowing what the feature is beyond its label, is necessary to understand how it can fit into a development design, how it can be protected, enhanced and utilised and how it may respond to landscape changes.

4 CONSIDERATIONS FOR NATURE-BASED DESIGN

One of the themes of this conference is nature-based solutions. Nature-based solutions are described by the International Union for the Conservation of Nature (IUCN) as those which "*address societal challenges through actions to protect, sustainably manage, and restore natural and modified ecosystems, benefiting people and nature at the same time".* Nature-based solutions are also one of the approaches anticipated to assist with climate change (see for example Action area N3 in the Auckland Climate Plan, Auckland Council 2020)

In respect of stormwater management, this terminology is the latest in a long line of 'nature' themed approaches to stormwater management, including low impact design and water sensitive urban design. For example, Auckland Council's Guideline Document 004 (GD04) describes water sensitive design as '*inter-disciplinary design approach, which considers stormwater management in parallel with the ecology of a site, best practice urban design, and community values*' resulting in *'an effective balance of protected and enhanced natural environments and associated ecosystem services to support the proposed development, and more broadly the life-supporting capacity of our communities*' (Lewis et al, 2015), listing similar themes and ideals as the concept of 'nature-based solutions'.

Incorporating 'nature' into developments (whether greenfield or brownfield) is central to this concept and it is clear is that no matter the label, the approach remains something that stormwater practitioners aspire to achieve. How can we 'restore natural and modified ecosystems' while also enabling development without understanding the way the aquatic system functions. The two-dimensional approach to delineating or classifying features according to simplistic legislative definitions does not provide the level of detail required to enable a comprehensive understanding of form and function and therefore ongoing management and outcomes.

Take for example those areas where stream and wetland merge/transition. There are different rules applying to rivers and wetlands, but where does the river end and the wetland begin? According to the NPS FM, modification of the river is more permissible than modification of the wetland[3] – but to modify the river in these systems would be to modify the wetland. They cannot be easily delineated and separated or treated independently.

In the event that something is truly a wetland – there are many types of wetlands, which the WDP's do not direct you to consider. Johnson & Gerbeaux (2004) grouped wetlands using a semi-hierarchical system with four levels:

- Level 1 is based on differences in hydrosystems (i.e. the broad hydrological and landform setting, and salinity and temperature regimes)
- Level 2 is based on wetland classes, circumscribed by different combinations of substrate, water regime, nutrients and pH

[3] Depending on the activity within the NES F and recognizing that different regional councils have their own rules which also apply

- Level 3 deals with structural classes of the vegetation (e.g. forest, rush land, herbfield) or ground surface (rockfield or mudflat)
- Level 4 deals with species composition of the vegetation

A central tenet to the Johnson & Gerbeaux (2004) classification is whether the wetland is ombrogenous (fed by the sky (e.g. rain)) or soligenous (fed by ground or surface water). Each wetland type has different ecology, capacity to assimilate contaminants, flow and sediment regime. The water chemistry of a wetland is driven by the contributing catchment, plants, sediment, flow regime which consequently affects the way contaminants are treated and which fauna will be present.

All of this is essential to understanding the system, and to know how to best incorporate and integrate the aquatic features of the site into the development. When undertaking urban development, Auckland Council's Design Manual includes some useful guidance:

- *"The development preserves existing topographic and natural features to help manage stormwater"*
- *"Protect, enhance and work with the natural hydrological conditions of a site"*
- *"Mimic natural systems and processes for stormwater management".*

Alongside this guidance is GD01 (Cunningham et al, 2017), which provides "*detailed design considerations aligned with the Auckland Council philosophy of stormwater management – where cultural values, social needs and natural features are considered as part of the functional design of the stormwater network – to achieve a resilient and sustainable outcome under the principles of water sensitive design*". Many developers/designers consider that merely incorporating a GD01 device is commensurate to demonstrating a water sensitive or nature-based approach. Application of GD01 devices without consideration of the wider system, have the potential for unintended adverse consequences on our aquatic systems, when often it would just take some small tweaks to result in beneficial aquatic outcomes. Here are some prompts to consider when developing a stormwater management approach;

- Reuse tanks ultimately direct rainwater to wastewater systems, which prevents water from roofed areas entering the aquatic systems.
- How will baseflows (mentioned only once in GD01), being those that exist in aquatic systems in the absence of rainfall, in streams and wetlands be maintained - not just the 95th percentile storm or 'flood flows'.
- Communal devices, such as treatment wetlands, collect all run off from a development area and discharging it at a single point at the downslope part of the site – is this appropriate on a site with multiple tributaries or wetlands.
- Raingardens and treepits allow infiltration, but to novacoil and piped systems, which slows the flows but often discharges to a single source.
- Any design where a single point of discharge is proposed, to the detriment of provision of flows to multiple aquatic systems/flow paths within a site.
- 'Passing it forward' manages flood risk, but modifies the way that the environment could manage and assimilate these flows.
- Landform modification changes the size of contributing catchments which influences inputs of sediment and flows.
- Ability of the aquatic systems to deal with temperature effects of warmer treatment devices (like ponds, or poorly maintained treatment wetlands), dissolved oxygen effects of water taken from highly vegetated, poorly managed devices (ponds, wetlands).

- What will the proposed device do to the natural sediment regime requirements of the aquatic systems, will it be supportive of the sediment requirements or detrimental to.
- Can the existing features of the site provide support in slowing the flow, managing contaminants? Can the existing features of the site withstand modification to the flow regime, can they be given room to move.

Understanding the features beyond just the basic 'wetland' or 'river' classification will help identify the limitations of the environment to assimilate contaminants, its capacity to withstand changes in flow and its ability to be a resilient system with appropriate habitat and fauna complexes. Second to this is understanding, is how this feature can interact with amenity and recreational opportunities within the development, what infrastructure benefit it can provide, what 'space' for the feature should be provided.

5 HOW TO DO 'BETTER'

Building on the words of Brierley & Fryirs (2009), 'don't fight the site'. To enable a true nature-based approach to development, you need to understand the form, function and evolution of the aquatic system in front of you, rather than relying on legislative definitions and regulatory tools to 'classify' parts of a broader system in isolation.

There are a few things that need to be done to ensure this works in practice. Here are some of our top tips – things you should be considering when thinking about a water sensitive design or nature-based solution approach to development and stormwater management.

- Spend some time up front understanding and identifying the entire aquatic network within the site, and how the are connected to each other and the wider system (outside of the site boundaries) – this includes overland flow paths, ephemeral streams, wetlands, seepages, streams and rivers. Use this knowledge to determine interactions and what the opportunities and constraints might be prior to defining development layout and stormwater design commencing.
- The current features of the site are only part of the story – understand the history of the site, and what aquatic features may have previously been present prior to anthropogenic modification, landuse changes and responses to flood events. Look to the history of the site, the system and the evolutionary and ecological trajectory that could occur with or in the absence of the development proposed.
- Undertake assessments of the site more than once, and several times across the year to recognise the changing wetting and drying regime of the features present. Ask for more than just a 'natural inland wetland', or 'river' classification. Ask for information about the form and function of these features – what is the source of the water, what is the wetting/drying regime, how susceptible will it be to peak flows and reductions in sediment, would planting change its form, will the 'type' of feature change through time.
- Ensure that you seek expert input, from suitably qualified and experienced practitioners who can provide you with more than just a delineation of one ecosystem feature – you may need multiple experts to input into an assessment of the features and its response to modification. Do not leave this too late.
- Think about the function of the system, how it behaves, what are the key drivers of its form and what ecosystem services does it currently provide – or could it provide. These are all valuable components of a stormwater management approach and are

central to being able to apply a water sensitive urban design/ nature-based approach.
- Purposefully incorporate the aquatic ecosystems into your stormwater management approach. Recognise that these features will move and change through time, understand the drivers of change so you can manage the effects appropriately and provide for a resilient stormwater network.
- Is there local knowledge from community or is there mātauranga Māori that can help understand the features and their history, behaviours, the values and features expected to be present.

These tips aren't just for developers and their agents to consider. In our opinion, regulators are equally responsible for seeing and managing these systems holistically to prevent adverse outcomes. While regulators may be bound by somewhat prescriptive rules and definitions, this shouldn't be a barrier to a 'systems' approach and educated reasoning while undertaking their regulatory duties.

In simple terms, if it's wet, it's something that is part of an aquatic system. In our view that should be the focus rather than getting bogged down in the interpretation of definitions. Seeing the 'system' and not just the 'feature' will ensure we all undertake the right assessments to collect the right evidence to make the right decisions for resilient systems outcomes, regardless of where we sit in the regulatory process.

Clearly, working in resource management means the consent triggers can't be ignored – and for all the frustration with the definitions, we know it is still necessary to give things a 'label'. However, to genuinely protect these features and incorporate them into the stormwater approach for a development, then the triggers shouldn't be a deal breaker as the positive narrative should speak for itself.

6 CONCLUSION

No matter how wet features are defined in legislation, it will always be difficult to fit nature into a perfectly defined box. The science behind rivers and wetlands remains the same as it has for decades, regardless of changing policy and legislative definitions. Applying a two-dimensional word to label a highly complex and evolving aquatic system observed at a point in time is insufficient to then build a true nature-based stormwater management approach. What is important for stormwater management, is to instead understand the form and function of these features and to manage with this in mind. Central to this is having quality information from suitably qualified and experienced practitioners prior to commencing any design and development on site. Forearmed with good information, there is greater likelihood of good outcomes across multiple areas including reduced loss of critical ecosystem function, more resilient stormwater management and improved benefits for community.

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