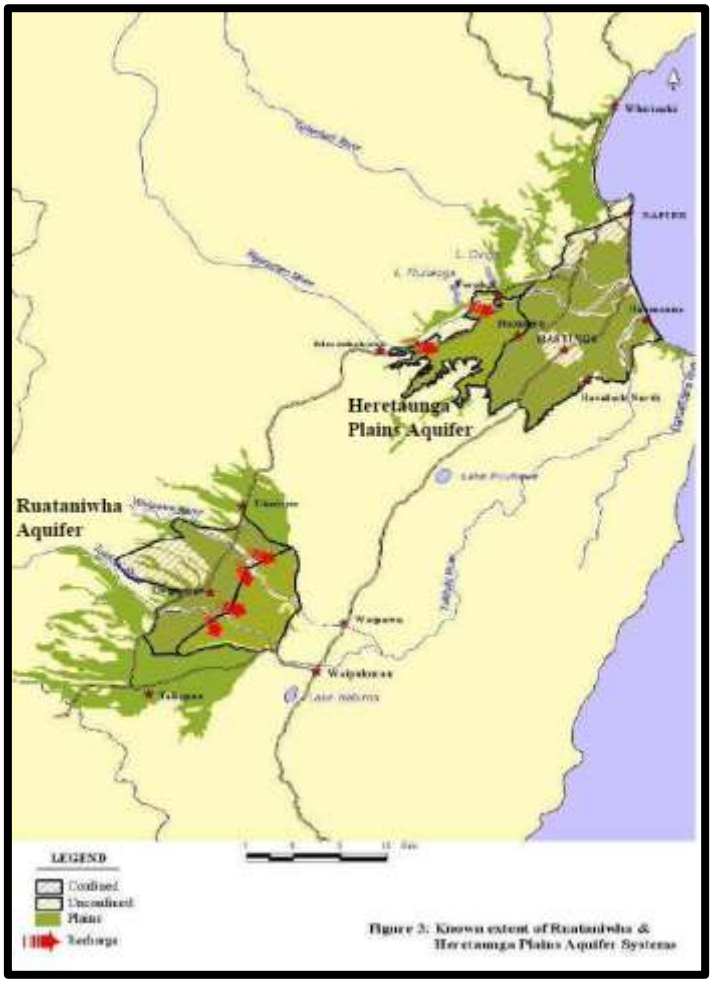
Ruataniwha Aquifer



Key Values
Cultural
Ecology
Natural characteristics

Table 1: List of publications reviewed

Year	Name	Author
2004	Lightless, Not Lifeless: New Zealand's Subterranean Biodiversity	NIWA
2009	A Review of Current Groundwater Management in Hawke's Bay and Recommendations for Protection of Groundwater Ecosystems	NIWA
2010	Cultural Impact Assessment of the Tukituki Proposed Water Storage Dams	Te Manga Māori Eastern Institute and Technology
2012	Groundwater Flow Pattern in the Ruataniwha Plains as Derived from the Isotope and Chemistry Signature of the Water	GNS science
2012	The Extent and Depth of Known East Coast Aquifers, North Island , New Zealand	NIWA
2012	Comments from Ngāti Kahungunu Iwi Incorporated on HBRC's Draft Change 5	Ngāti Kahungunu Iwi Incorporated
2012	Submission from Ngāti Kahungunu Iwi Incorporated on HBRC's Proposed Change 5	Ngāti Kahungunu Iwi Incorporated

2012	Submission from Te Taiwhenua o Heretaunga on Proposed Plan Change 5 to the RPS	Te Taiwhenua o Heretaunga
2014	Statement of Evidence by Stephen Swabey ENV-2013-WLG-000050	Hawke's Bay Regional Council
2015	Heretaunga Plains Groundwater Management and Investigations	Hawke's Bay Regional Council
2015	Location and extent of NZ's aquifers	Ministry for the Environment
2016	Groundwater Quality State of Environment: State and Trends	Hawke's Bay Regional Council
2017	Location and extent of New Zealand's Aquifers	Ministry for the Environment, Stats New Zealand
2017	Modelling Effects of Increased Groundwater Allocation on Stream Flows in the Heretaunga Plains	Hawke's Bay Regional Council
2018	Brief of Evidence of Graham David Fenwick (application for a water conservation order at Te Waikoropupu Springs)	NIWA
2018	Wetland Info Page – Aquifers and Caves	Queensland Government
2018	Cultural Values Table	Hawke's Bay Regional Council

Discussion

Purpose of report

1. The purpose of this report is to assist the RPC members to determine whether any of the values of the Ruataniwha aquifer are outstanding for the purposes of the National Policy Statement for Freshwater Management (NPSFM).

2. This report presents the summarised findings of the values attributed to the Ruataniwha aquifer in those documents referred to in Table 1, above. In accordance with decisions made by the RPC in June 2017, economic and consumptive use values have not been discussed in detail in this report.

3. The report will focus on the cultural values associated with the aquifer system, its groundwater ecosystem and its natural characteristics, not its productive qualities.

Overview

4. The Ruataniwha aquifer is a major aquifer system located in the Ruataniwha basin, in Central Hawke's Bay. The aquifer system is an extremely valuable resource, underlying the Ruataniwha Plains, and is well known due to its productive qualities. Around 28.5 million m^3 of water is extracted from the aquifer system each year, for domestic, horticulture and agriculture use.

5. The Ruataniwha aquifer is a multi-layered alluvial system comprising a relatively shallow unconfined layer, and several deeper confined aquifers. The Ruataniwha aquifer covers an area of approximately 260 km^2, reaching depths of 200 metres at some locations. Travel time of water through the aquifer varies and in some parts it can take 25 years, whereas in others it can take more than 100 years.

6. The Waipawa River, Tukituki River and Makaretu Stream are the three major waterways which flow over the Ruataniwha basin. All rivers and streams which flow over the basin, merge into the Waipawa and Tukituki Rivers at its eastern edge, around 10 km east of Waipawa and Waipukurau towns.

7. The Ruataniwha aquifer is a living ecosystem which is hydraulically connected with a number of surface water bodies which flow over the Ruataniwha basin. These surface water ecosystems, as well as the aquifer ecosystems itself, have intrinsic value, are biologically diverse, and provide important ecosystem functions, such as water purification and flood control.

Location

8. The Ruataniwha aquifer system is located in Central Hawke's Bay, approximately 60 km south of Napier and Hastings. The boundaries of the Ruataniwha Basin are the foothills of the Ruahine Range in the west, Turiri Range and Raukawa Range in the east and rolling hills in the north.

9. Figures 1 and 2 below show the extent of the Ruataniwha aquifer and the main rivers and streams which flow through the Ruataniwha basin.

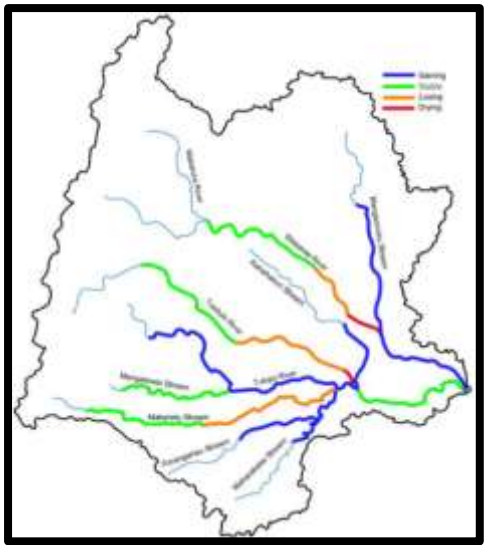


Figure 1: Ruataniwha Basin - Rivers and Streams

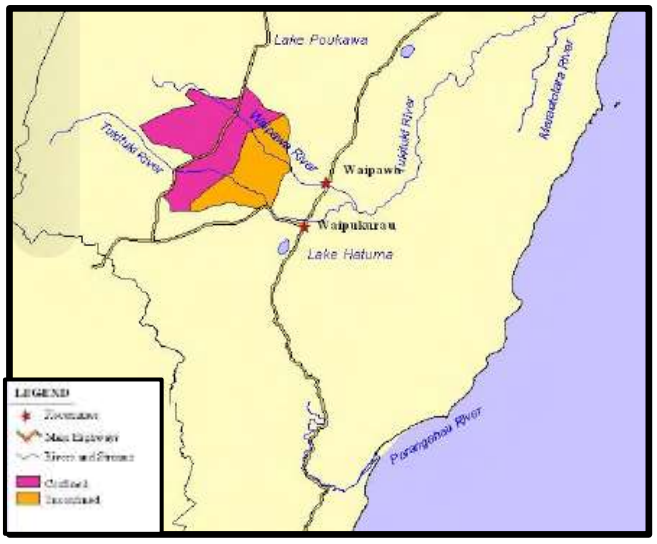


Figure 2: Ruataniwha aquifer system extent

Cultural values

10. The Ruataniwha Aquifer is part of the traditional rohe of Heretaunga Tamatea, one of six large natural groups negotiating the settlement of Ngāti Kahungunu Treaty of Waitangi claims.

11. Ngāti Kahungunu has made submissions to the regional council requesting that the Ruataniwha Aquifer be identified and provided for as an outstanding waterbody. This is due to its exceptional water quality and significant contribution to the Hawke's Bay economy.

12. While no direct customary linkages have been established back to the Ruataniwha Aquifer in the documents reviewed in Table 1, it is recognised that all fresh water bodies have special cultural, spiritual, historical and traditional associations with freshwater. The relationship between Tāngata whenua and freshwater is founded in whakapapa, which is the foundation for an inalienable relationship between Māori and freshwater that is recorded, celebrated and perpetuated across generations. Freshwater is recognised by Māori as a taonga of paramount importance, and as such, all waterbodies have important spiritual, physical and customary value.

13. Attachment 1 contains further information on the cultural values associated with the Ruataniwha Aquifer.

Aquifer characteristics

14. The Ruataniwha Basin has an age of approximately 1.5 million years, making it relatively young in geological terms. The basin is composed mainly of alluvial gravel with intermittent clay layers, which vary in thickness from a few metres to around 200 metres in the middle of the basin.

15. The Ruataniwha aquifer system comprises a relatively shallow, unconfined aquifer and several deeper confined aquifers which are recharged in the Ruahine Ranges. None of the aquifer systems are completely isolated, however the basin itself is hydrologically closed to groundwater inputs due to the hard rock geology of its margins.

16. The aquifer is predominately recharged by rainfall in the Ruahine Ranges, with some recharge occurring indirectly from the Waipawa and Tukituki rivers. The groundwater flow is almost parallel to river flow, with the bulk of the groundwater leaving the aquifer along its eastern boundary through rivers and streams.

Recreation values

17. There are no recreational values associated with the Ruataniwha aquifer system itself, however the aquifer system does provide an important supporting function to recreational activities undertaken on rivers and streams hydraulically connected to the aquifer system.

Ecology values

18. Aquifers are living ecosystems which are dependent on the subterranean presence of water. Aquifer ecosystems provide a diversity of habitats, such as sand, gravel, fractured rock and karst systems that are home to various unseen ecological communities. Attachment 2 contains a diagram of a naturally functioning groundwater ecosystem.

19. These ecosystems include all of the life present in the physical space of the aquifer system, from microorganisms, such as bacteria, fungi and archaea, to primitive invertebrate animals (protozoa, nematoda stygofauna and troglofauna) and advanced invertebrates. These communities interact with each other and their non-living environment and perform natural ecological processes in the absence of light.

20. Groundwater life is rarely seen. This is because access is difficult and bores are usually designed to exclude all but water. This means there is limited understanding of aquifer ecosystems. Despite this, literature suggests that most aquifers support significant biodiversity with complex life persisting to substantial depths.

21. The different components of the Ruataniwha aquifer's ecosystem are discussed in more detail below.

Microorganisms

22. Microscopic organisms are commonly known as microorganisms or microbes and are an important part of an aquifers ecosystem. The microbial communities generally have significant biodiversity and can adapt to living in nutrient-poor and anaerobic conditions found in deep and/or confined aquifer systems. Because of this, some microbial communities found in aquifers grow slowly and have a low tolerance to rapid changes.

Stygofauna and troglofauna

23. Subterranean life is divided into two classes of animals, stygofauna and troglofauna. Stygofauna refers to all aquatic fauna in a groundwater environment, and troglofauna are associated with caves and spaces above the water table, but still part of the aquifer system. There are no known cave or karst systems associated with the Ruataniwha aquifer system so it in unknown if troglofauna are present in this aquifer system.

24. Stygofauna are aquatic animals which live in groundwater. They have adapted to life underground (i.e. no body pigments, no or very small eyes, elongated bodies, elongated antennae), survive on a limited food supply and are extremely energy efficient. Stygofauna feed on plankton, bacteria and plants found in streams and are thought to live longer than other terrestrial species.

25. Stygofauna are important for several reasons. They are intrinsically significant as individual species, particularly where they have a restricted geographical range. These species are known as short-range endemics, which provide insights into evolutionary processes. Stygofauna also cycle nutrients within groundwater systems, and assist with keeping the finer pore spaces in the aquifer open, by ingesting and digesting bacteria, allowing water to flow through these tiny spaces.

26. While few studies have been undertaken looking into aquifer ecosystems in New Zealand, it is believed that New Zealand's stygofauna is widespread and diverse, with high endemism. This is largely because New Zealand's geological past has led to long term separation of habitats and populations, which drives high diversity particularly when many species are confined to very restricted geographical ranges.

27. In isolated aquifers and geological units stygofauna have no opportunity to migrate to another location which results in high diversity. In the Ruataniwha aquifer system, none of the aquifers appear to be totally isolated, which suggests stygofauna species distributions, including any short range endemics, will be relatively widespread through the whole aquifer system.

Karst and spring systems

28. Studies indicate that major karst and spring systems associated with underground aquifers generally provide a very large habitat for complex, interconnected interstices ideal for the bacteria and invertebrates.

29. Notable examples, include the major karst systems under Mounts Owens and Arthur in Tasman, which are the longest and deepest cave systems in the southern hemisphere, and the Te Waikoropupū Springs which are the largest and clearest freshwater springs in New Zealand. Both areas have significant hydro-geological features which provide for extremely high and unique biodiversity values in these areas.

30. While, a number of rivers, streams, springs and wetlands are hydraulically connected to the Ruataniwha aquifer system, there are no known large freshwater 'blue' springs, such as the Te Waikoropupū Springs, or major karst systems in this area.

Water age

31. Groundwater generally moves from a recharge area to a discharge area. The course taken by water moving through the aquifer is called a flow path and varies depending on the thickness and the spatial extent of the aquifer system. The age and flow path of groundwater plays an important ecological role in supporting the aquifer's ecosystem.

32. Groundwater gets older along a flow path, with groundwater quality varying with depth. In most aquifer systems, groundwater flows faster horizontally than vertically. This means groundwater typically flows more rapidly through the upper parts of an aquifer, and groundwater gets older with depth.

33. Monitoring indicates that groundwater in the Ruataniwha aquifer system is mostly over 25 years, getting progressively older with depth. The south east area of the Ruataniwha plains has groundwater older than 100 years, indicating slow movement and slow recharge of groundwater in this area.

Groundwater dependant ecosystems (rivers, streams, wetlands and springs)

34. Groundwater dependent ecosystems are those ecosystems which need inputs of groundwater to maintain their current structure and functions and can include rivers, streams, wetlands and springs.

35. Three main rivers flow over the Ruataniwha basin from west to east. The Waipawa River in the north, Tukituki River in the middle, and the Makaretu Stream in the south. In addition, there are a number of small streams which cross the basin, such as the Makaroro, Tukipo, and Mangaonuku Rivers and the Porangahau and Kahahakuri Streams. All rivers merge into the Waipawa and Tukituki Rivers at the basins eastern edge.

36. There is clear interaction between the groundwater and surface water bodies in the Ruataniwha basin, with flow patterns varying according to a loss gain relationship between aquifers and streams. Of note, are the Waipawa and Tukituki Rivers which lose water for most of their riverbed across the Ruataniwha Plains. Groundwater rises again to the east of the basin, discharging as surface water in the Tukituki River.

37. The water quality and quantity and the ecology of the Ruataniwha aquifer system is important to the ecological health of those surface water bodies with strong hydraulic connections to the aquifer system. i.e. poor aquifer health, or decreased water quantity, may impact on water levels or water quality in highly connected surface water bodies.

Water Quality

38. Groundwater quality in aquifers across New Zealand varies, and depends on a range of factors such as nearby land uses, the soil composition above the water table, the geology of the aquifer and the groundwater residence time.

39. Hawke's Bay Regional Council regularly monitors the quality of groundwater in the Ruataniwha aquifer at eight sites. The primary aim of this monitoring is to ensure the groundwater meets health and aesthetic based standards, as opposed to protecting biodiversity values of the aquifer ecosystems.

40. The water quality of the Ruataniwha aquifer system with regard to 'health and aesthetics' and 'ecosystem health' is discussed further below.

Water quality – health and aesthetics

41. The quality of groundwater in the Ruataniwha aquifer system is measured against the New Zealand Drinking water standards to ensure the water is suitable for human consumption.

42. Overall, most monitoring sites comply with the New Zealand drinking water standards (DWSNZ) for the key chemical water quality parameters[1]. The exceptions are elevated concentrations of manganese and iron, which appear to be naturally occurring, and nitrite-nitrogen which is exceeded at one monitoring site.

[1] HBRC does not monitor for all chemical water quality parameters in the NZDWS.

Additionally, one monitoring site had microbiological non-compliance for *E.coli* in the 5-year monitoring period between 2009 and 2014.

43. Each of the water quality parameters measured as part of HBRC's programme are summarised in more detail in Table 2, below. This data was obtained directly from the 5 yearly State of the Environment Report 2009 – 2014.

Table 2: Water Quality data– Ruataniwha aquifer (2009 – 2014)

Water quality parameter	Compliance /non-compliance with DWSNZ guidelines
pH	Groundwater at all sites falls within the optimum guideline pH range of 7 to 8
Total Dissolved Solids (TDS)	The TDS concentrations at all sites are below the guideline value of 1000 mg/L.
Total Hardness	All sites have total hardness levels below the guideline value of 200 mg/L.
Iron and Manganese	Fifty percent of the sites comply with the guideline value for manganese, and seventy five percent of sites comply with the guideline value for iron. Those sites with elevated concentrations of manganese and iron are thought to be naturally occurring. Elevated iron and manganese levels are a characteristic of aquifer systems where reducing (oxygen-poor) conditions exist naturally. The combined effects of reducing conditions and a long residence time of the groundwater in the aquifer encourage dissolution of iron and manganese present in aquifer materials. Monitoring indicates that most of the deeper groundwater has mean residence times of greater than 25 years, with longer residence times of 100+ years existed at sites in the southern area of the Ruataniwha aquifer system. These age distributions are consistent with elevated manganese and iron concentrations. Those sites which have elevated iron and manganese levels, also have water age residence times ranging from 57 to over 210 years.
Nitrate-Nitrogen	The majority of sites have low to moderate levels of nitrate-N. One site has elevated nitrite-N, which exceeds the long-term exposure standard.
Ammoniacal-N	All sites comply with the aesthetic guideline of 1.5 mg/L in the DWSNZ.
Phosphorus (Soluble Reactive Phosphorus - SRP)	Phosphorus levels at sites are generally less than 0.05 mg/L. However, several monitoring bores have elevated phosphorus, which is likely to be related to the area geology, because the groundwater at this depth has a mean residence time of 149 years.
Sulphate	All sites have sulphate levels below guideline levels of 200 mg/L.
Sodium and Chloride	All sites have sodium and chloride levels below guideline levels for sodium and chloride.
Microbiological Indicator (*E. coli*)	87.5% of monitoring sites complied with the DWSNZ level. One site monitoring bore had 1 cfu/100 mL in the 5-year period of monitoring.

Water quality – ecosystem health

44. The geology of an aquifer has a significant effect on the natural water chemistry within an aquifer system. This means the 'natural water quality' within each aquifer system varies. For example, if dominant rock types present in the aquifer have soluble materials, such as limestone, the groundwater will have higher concentrations of ions, than in aquifers with less soluble materials such as insoluble quartz pebbles. Additionally, the chemical makeup of groundwater with longer residence time will be completely different to that of water with low residence time.

45. Over a period of time the fauna and microbial communities living in an aquifer become highly adapted to its living space and its quality of water. This means the 'optimal' state of water quality required to protect each aquifer system is different, and might not necessarily correlate with the New Zealand Drinking Water Standards. For example, the water quality parameters for ecosystems with aquifers with brackish water will be completely different to that of freshwater aquifers.

46. To date, no monitoring or investigations have taken place looking into the standard of water quality required to protect the biodiversity value of the ecosystems living within the Ruataniwha aquifer system.

Values Summary

Overarching Value	Sub-value	Description	Outstanding Yes/no	Comments
Cultural	TBC	TBC	TBC	TBC
Recreational	TBC	TBC	TBC	TBC
Ecological	TBC	TBC	TBC	TBC
Landscape	TBC	TBC	TBC	TBC
Natural Character	TBC	TBC	TBC	TBC

4. *Resource Management Plans*

The following tables list any relevant resource management plans developed by iwi/hapū, the regional council or territorial authorities. The tables include any specific provisions that apply to the Ruataniwha Aquifer. They do not include all of the general policies or rules that may apply. Water quality and water quantity provisions have been included as it is recognised that these aspects can significantly impact on cultural values.

Iwi and Hapū	Resource Management Plans
Kahungunu ki Uta, Kahungunu ki Tai	Marine & Freshwater Fisheries Strategic Plan
Mana Ake – An Expression of Kaitiakitanga, Te Taiwhenua o Heretaunga	

Regional Resource Management Plan
Schedule 4: Known Productive Aquifer Systems in the Hawke's Bay Region
Schedule 6: Ground Water Management Zones
Schedule 6b: Catchments sensitive to animal effluent discharges

Attachment 2: Typical Groundwater Ecosystem

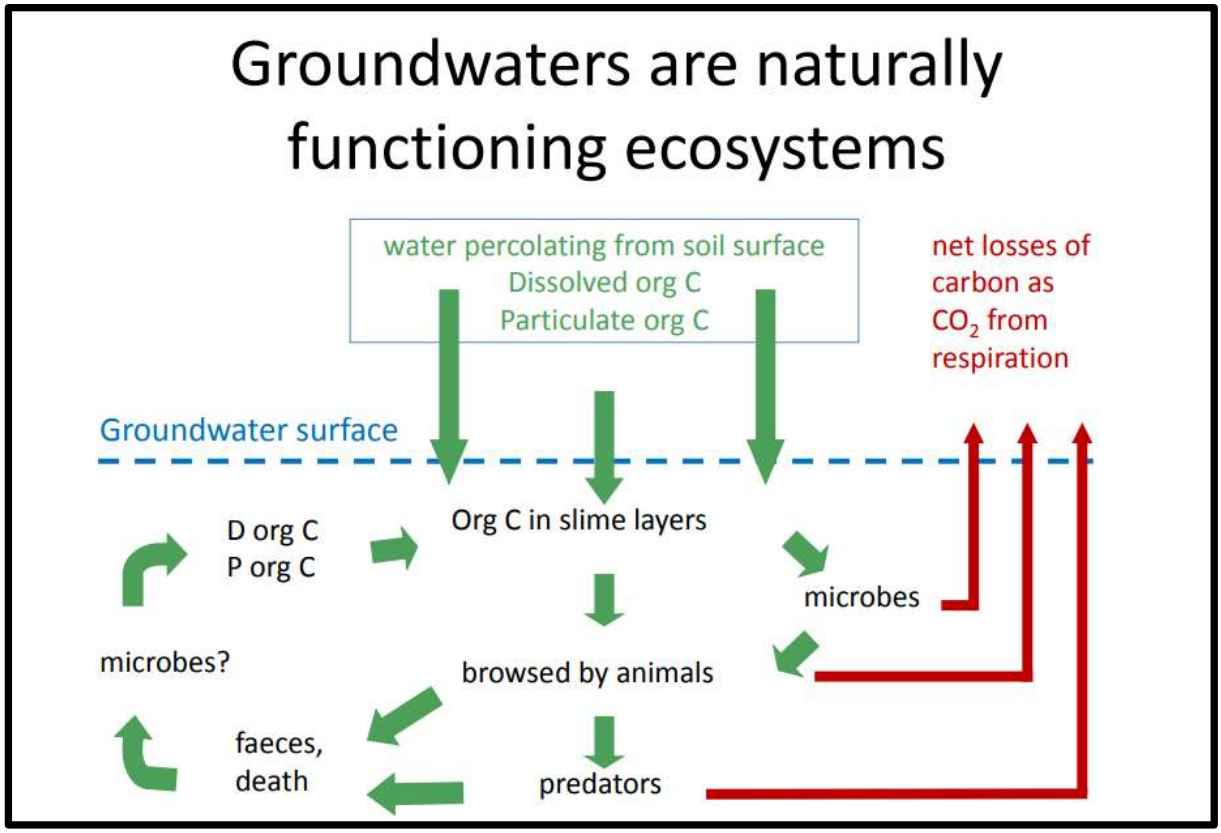


Figure 1: Typical groundwater ecosystem