determination of a soil, other requirements being:

(a) where the soil is forming—on a river flat, terrace or hillside,

(b) what are the moisture and temperature conditions of the site,

(c) what plants are providing the organic matter and how is this material decomposing, and

(d) how long have the various processes been operating.

These requirements demonstrate that soil is a product of the natural forces of climate and plant life acting on surface materials. Soil development is slow but it records the effects of climate and plant life more fully than any other natural body. Hence, soil gives an expression of the environment that is invaluable in the study of ecology.

Aspects of Hydrology in the Hutt Valley

J. K. Johannesson

The Hutt river originates in what is known as the Hutt catchment where the eastern and western branches arise in the Tararuas from high country exceeding 4,000 feet. This catchment has an area of nearly 30 square miles. Further south the main river is joined by the streams from the other catchments which are—

Pakuratahi:	31.87 sq. mls.
Akatarawa:	44.10 sq. mls.
Wakatikei:	31.26 sq. mls.
Mangaroa:	40.69 sq. mls.

The total Hutt catchment area comprising the lower valley of the main Hutt river and the area in the Tararuas is 96.22 sq. mls.; the combined area of the catchment is 244.14 sq. mls. There are a number of small streams such as that from Stokes Valley; on the eastern side of the lower Hutt valley is a sluggish stream, the Waiwhetu, which empties into the estuary of the Hutt river. The water from the Korokoro catchment enters the harbour at the extreme western edge of the Hutt Valley, but it is in places dammed and the impounded water is used domestically by Petone Borough and hence discharged via the sewage system to the Hutt river estuary.

The Hutt valley narrows at Taita and here, just above Belmont, a considerable amount of water enters the permeable strata and becomes contained in this aquifer by an impervious layer. This forms the artesian supply which is used by Lower Hutt City, Petone Borough and some of the eastern bays. Some industrial organisations such as Lever Brothers and the Gear Meat Company have their own wells sunk into the artesian strata. The Wellington City Council also has wells at Gear Island to provide an emergency supply if so required. These wells are 70 to 100 feet deep.

The artesian water supply extends out under the harbour bed and there is a well on Somes Island. The pressure of the water in the artesian strata varies with the tide and the operation of the wells. The W.C.C. has a recording pressure guage at Gear Island and these pressure changes are very well shown. From the variation of the pressure with the tide it has been calculated that the water enters the sea at the Wellington end of the Harbour.

In dealing with underground water supplies near the sea, care must be taken not to pump excessively lest a salt-water intrusion take place, which process is liable to become irreversible. Salt-water intrusion has been met in California and the water from the deep wells in the chalks near London is becoming increasingly saline.

The time for the water to travel underground has been thought to take many months. It is my intention to make some further studies of this by regular analysis of the chloride content of the water entering the underground layers and to compare this with regular analysis of artesian water at Lower Hutt and observe the times of coincidence of successive peaks. After

Belmont the river passes through Lower Hutt at the lower end of which the tidal influence is noticed on the river. The mouth of the river is a typical tidal estuary with mudflats exposed at low water. The river at this point receives sewage effluents and industrial wastes; these result in the mudflats releasing hydrogen sulphide in hot weather as happens at Mangere inlet at Auckland. This is almost certainly due to the bacterium *Vibrio desulphuricans*.

The Hutt Valley Drainage Board is in the process of constructing a pipe-line to provide an ocean outfall at Pencarrow.

The Water Board takes water at Kaitoke just above the junction of the Hutt River and the Pakuratahi stream and supplies it to Upper Hutt, Stokes Valley, Plimmerton, Paremata, Porirua, Titahi Bay, Tawa Flat, and Wellington City. (11 million gals. per day.) This water is treated with sand traps, strained through rotary self-washing strainers and then chlorinated. The chlorination is controlled electrochemically by means of an amperometric cell operating at pH 4 with added iodide to measure total chlorine. This control allows for both variations in flow and changes in the chlorine demand of the water.

Rainfall:

Rain gauges have been established in a number of these catchments. Typical results, both for 1957, are—

Akatarawa	(680 ft.):	78 in.
Wakatikei	(805 ft.):	76 in.

Rain Water:

A programme of rain water analysis has been commenced but is as yet not quite out of its growing pains. The methods of analysis normally used for analysing water are not of sufficient sensitivity to provide the accuracy needed for these figures to be used effectively.

	Hardness	Na	K	Cl	SO_4	HCO_3	SiO_2	NO_3	Alb. N
Akatarawa	3.0	5.0	0.3	3.5	1.0	2.0	0	0	0.3
Wakatikei	4.0	4.0	0.4	5.0	1.0	5.0	0	0	0.2

TABLE 1.—*Typical results of analysis of the main constituents of rainwater, expressed as p.p.m.*

Analysis of the stream water flowing from the catchments reveals that apparently all of the chloride is derived from the cyclic salt of the rain together with an appreciable amount of the sulphate. There is a leaching from the rocks of sodium, potassium, calcium and magnesium, and silica. The position with respect to iron, aluminium, manganese and titanium is obscure due to the very insoluble nature of the oxides of these metals at the pH values found in the waters of these streams.

The nature of the SiO_2 is of interest; in well waters it appears to be ionised and in the upland water it is unionised.

Assuming a rainfall of 100 in. as average for that portion of the Hutt catchment above the Kaitoke headlands, the loss of minerals from the approximate 30 sq. miles per year is—

Nitrogen	16 tons.
PO_4	4 tons.
SiO_2 (dissolved)	1,500 tons.
$CaCO_3$	2,000 tons.
$MgCO_3$	1,200 tons.

Biological:

The Hutt river is shallow and fast flowing and there is little development of planktonic life in the upper reaches. What there is, is restricted to diatoms such as *Navicula* sp. and they are only in small numbers i.e. 10^4 per litre at the

Source	pH.	Temp.	NO_2	NO_3	Free NH_3	Alb. NH_3	Total Solids.	O_2 Cons.	Cl	Na	K	SO_4	Fe	Hardness	Ca CO_3	Alkalinity
Hutt River Kaitoke	7.1	5.6	Nil	Nil	0.006	0.058	77	0.7	6	15	0.9	2.8	Nil	19	13	9
Hutt River Moonshine	7.0	8.0	Nil	0.1	0.004	0.060	90	2.3	7	23	1.0	5.4	0.05	22	10	9
Hutt River Taita	7.0	7.9	Nil	0.15	0.006	0.016	106	1.5	9	25	1.0	3.9	0.05	14	11	9
Hutt River Rlwy. Bdge.	7.0	9.3	Nil	Nil	0.018	0.042	655	1.9	243	322	14.5	—	0.43	69	30	10
Hutt River Estuary	7.2	9.0	Nil	Nil	0.004	0.068	4542	4.0	1713	1580	36	285	—	—	100	16
Wakatikei	7.0	7.0	Nil	0.05	0.048	0.092	110	3.1	15	37	1.5	8.8	0.05	14	14	10
Mungaroa	6.5	7.5	Nil	0.3	0.016	0.108	75	2.7	11	27	1.3	7.0	0.19	58	10	9
Akatarawa	7.0	7.0	Nil	Nil	0.006	0.044	63	1.4	6	22	0.9	3.7	—	22	10	8
Pakuratahi	6.6	6.4	Nil	0.1	0.008	0.080	59	3.5	6	18	1.0	2.8	—	23	11	8
Dunlops Well	6.4	—	Nil	0.4	0.004	0.006	119	1.5	9	27	1.3	5.1	—	23	19	12
Gear Island	6.2	13.0	Nil	0.3	0.014	0.022	38	0.5	9	31	1.6	7.9	—	23	20	14

TABLE 2.—*Analyses of water taken from various points in the Hutt catchment on 28/7/58. Hardness (= Ca + Mg) and alkalinity are both expressed as p.p.m. $CaCO_3$. O_2 Cons. is the amount of oxygen in p.p.m. absorbed by potassium permanganate in one hour at 80° C.*

most. Green algae do develop in back waters and the chrysomonad *Synura* has been found for example. The catchments carry a considerable animal population, both wild and domesticated, and as a result the waters have a considerable bacterial content. *Escherichia coli* may be found up to several thousand per 100 ml. and *Streptococcus faecalis* to a similar extent.

This may be compared with the Manawatu River which is somewhat sluggish and may have 10^6 or 10^7 green algae per litre and the river shows a definite diurnal photosynthetic oxygenation effect.

The estuary of the river is tidal and green filamentous algae are to be found as well as the intestinal bacteria of the coliform and enterococci groups together with the sulphur bacteria of the sulphate reducing types.

Forest Variation in the Hutt Catchment

A. P. Druce and I. A. E. Atkinson

The Hutt catchment has an area of 245 square miles, most of which is hilly and mountainous country above 1,000 ft. The average rainfall in the lower part of the valley (south of Te Marua) and on the Eastern and Western Hutt hills is 50-60in.; elsewhere it is 80-100in. or more, probably exceeding 150in. at 4,000ft. Originally more than 95% of the catchment was in forest. Today approximately 42% (103 sq. miles) still carries primary forest, although nearly all of it is to a greater or less extent modified. The present vegetation of the catchment is as follows (figures approximate):—

Primary forest	42%
Secondary forest and scrub	33%
Shrub and tussock land (part natural, part induced)	1%
Unimproved pasture	8%
Improved pasture	5%
Plantations (exotic trees)	2%
Built-up, gardens, playing fields, etc.	8%
Riverbed	1%

For mapping purposes the primary forest has been divided into fifteen community types (Table 1). The distribution of these is shown on the vegetation map. The large area of secondary forest and scrub includes much hill-country farmland in various stages of reversion, as well as a great deal of burnt-off hilly and mountainous land that has never been utilised. The most important species are manuka, gorse, tauhinu, and bracken. Further details are recorded on the back of the map.

A more detailed account of this work will appear later as a D.S.I.R. Bulletin.

The catchment has been divided into four vegetation areas (see map), according to whether certain physiognomic species are present or absent, as follows:—

1. *Western Hutt Hills Area:* all four beech species absent, kamahi local, kohekohe present in south-western part.
2. *Wakatikei - Akatarawa Area:* silver and red beech absent.
3. *Tararua-Rimutaka Area:* all four beech species present (forest unstable at altitudes above 2,800 feet).
4. *Mangaroa-Eastern Hutt Hills Area* (N.W. of the Climie - High Misty ridge): red beech absent.

In this paper, variation in vegetation is related to the primary factors, biota, soil parent material, climate, topography, and time. Such variation is either continuous or discontinuous. If, at one extreme, there is a sudden change in canopy composition, it may be said that a sharp boundary exists between two different community types (variation discontinuous). If the variation takes place over a limited distance, the boundary between the two types is diffuse (variation continuous over a limited distance). At the other extreme no boundary between community types can be discerned (variation continuous). In this paper, vegetation exhibiting discontinuity is described as a mosaic, that showing continuity described as a sequence.

CLIMATIC VARIATION

Figure 1 shows the variation in canopy composition with altitude in the Wakatikei-