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Notes on the Soils of the Hutt Valley

H. S. Gibbs

The soils of the Hutt Valley can be described in three groups according to their occurrence on either (1) river flats, swamps and sand dunes or (2) terrace lands or (3) moderately steep and steep hillsides. Moderately steep and steep hillsides occupy approximately 80% of the district whereas the other two divisions each total about 10% of the area.

On the river flats, swamps and sand dunes, the soils occur in strips generally parallel to the meandering courses of the streams or growth of the beaches. This pattern is due principally to the effects of water, firstly in sorting the materials according to size and secondly, in controlling the circulation of air through the pores of the soil. Thus gravel and sand soils occur along the stream channels and beaches and on these soils plant growth is limited by too much air and too little water. Along the river banks the soils are sandy loams and loams which are the most fertile soils of the district, partly because the water and air circulate freely yet maintain a satisfactory level for plant growth. In the river basins the soils are silt loams and clay loams in which the moisture content generally rises with distance from stream channels and becomes more and more the chief limiting factor to plant growth. As the effects of moisture increase, subsoils change in colour from yellow to grey and in the intermediate stages show many rusty-coloured mottlings. The extreme effects of moisture are seen in the southern end of the Mangaroa basin where tilting of the land produced a depression in which the surface is continuously wet, and decomposing organic matter has accumulated as peat. This peat is very fibrous and extremely acid (pH 3.6) and would require heavy and frequent applications of fertiliser for pastoral use. All other soils of this group are moderately acid (about pH 5.5) and slightly deficient in phosphate and lime. Under intensive use careful management is required to prevent deterioration of structure and depletion of organic matter.

The soils of the terrace lands are formed on the remnants of old floodplains now elevated from 20 to 800 feet above stream level through repeated uplifts of the land during the last 500,000 years. As a consequence of the uplifts all the deposits, excepting those on the lowest terraces, have been eroded and now comprise plateau, rolling and easy hill land. The sediments consist of lightly consolidated silt and gravel beds derived principally from the erosion of greywacke but including a little volcanic ash deposited over the district during ancient eruptions. Five series of soils are mapped—Heretaunga soils on the lowest set of terraces, Judgeford soils on the second lowest set, Matamau and Ngaio soils on the intermediate sets, and Kaitoke soils on the highest and oldest set.

The Heretaunga, Judgeford and Matamau soils are similar in having a profile of brown friable silt loam over yellowish brown friable silt loam. The differences of colour, organic matter and plant nutrients between top and subsoil distinguish the Heretaunga soils from the soils on the river flats. Judgeford soils differ from Heretaunga soils in having an increased development of small nutty structure and in being slightly more leached of calcium and magnesium. Matamau soils are similar in structure to Judgeford soils but differ in having darker colours to both top and subsoil and in being more leached of soluble cations. The differences between these three soils are due principally to greater age allowing more time for the development of soil structure and removal of soluble constituents in the drainage waters.

In contrast to the other soils of this division, the Ngaio and Kaitoke soils are greyish brown firm silt loams over yellow compact clay loams. Reddish and pale grey mottlings are common in the subsoils particularly in the Kaitoke soils which also have a more distinct topsoil, a more blocky structure and are more leached than the Ngaio soils. These differences are in accord with the greater age of the Kaitoke soils. The Ngaio and Matamau soils are derived from materials of approximately the same age, and the differences are explained by the location of these two soils. Matamau soils occur in regions of high rainfall (70 in.) and the soils are continually moist, the growth of plants and decomposition of organic material is continuous. Ngaio soils occur in regions of lower rainfall (50 in.) and are more exposed to drying winds with the result that the soils are alternately wet and dry. Alternate wetting and drying increases the rate of clay formation and the amount of shrinkage and compaction. The higher clay and greater compaction in the subsoil impede the movements of water in the soil and intensify the variations of climate. As a consequence of the widely fluctuating moisture conditions, the growth of plants and the rate of decomposition of organic material are uneven and the circulation of nutrients is less favourable than in the Matamau soils. On the other hand, the rate of leaching in the Ngaio soils is slower than in the Matamau soils and subsoils of the latter are much lower in calcium, magnesium and other mineral nutrients. However, from a grassland point of view, it is easier to add nutrients as fertiliser than to lessen the range of moisture contents and the Matamau soils are therefore preferred to the Ngaio soils. The physical disadvantages of the Ngaio and Kaitoke soils have hindered their development for farming, but by using grasses and clovers that tolerate wide fluctuations in moisture and applying suitable fertilisers, moderate quality pastures are now being maintained. Experiments by the Department of Agriculture have shown deficiencies of phosphate, lime, molybdenum, and cobalt on the soils of the terrace lands.

The five series of soils on the terrace lands represent stages in the development of the class of soils called yellow-brown earths. The Heretaunga, Judgeford and Matamau soils are early stages in which minerals are weathering rapidly and providing a plentiful supply of iron and aluminium oxides which tend to give excellent physical conditions in the soils. In this respect they resemble the soils derived from volcanic ash called yellow-brown loams. The Ngaio and Kaitoke soils are later stages in which most of the easily weathered minerals have decomposed and the soils are becoming well-developed yellow-brown earths. At this latter stage the importance of soil to vegetation and vegetation to soil must be recognised. Compared with soils of the early stages, the Ngaio and Kaitoke soils are suited to a smaller range of economic plants and have a slower rate of renewal of topsoil. Thus more care is required in selecting land use for the Ngaio and Kaitoke soils than for the other soils of this division.

The soils of the moderately steep and steep hillsides comprise 13 units all derived from greywacke. Five units on the moderately steep land and five on the steep land usually occur in pairs that can be described together. The soils of each pair are similar except that those on the moderately steep slopes are less stony and usually 6 to 18 in. deeper. The remaining three units comprise subdivisions of the Belmont and Renata soils for easy hilltops and a unit for the Tararua mountain soils.

Korokoro-Makara soils occur on Western Hutt hills south of Belmont at altitudes below 1,000 feet. They consist of 6 to 8 in. of brown friable silt loam over brownish yellow clay loam. Below 20 in. the subsoil passes into greywacke rock which is partially weathered to a depth of 3 to 6 feet. Both top and subsoil have a well developed fine nutty structure and a moderate content of plant nutrients. With fertiliser these soils make excellent pastoral lands and practically all of the original forest consisting of tawa, rata, hinau and other broad-leaved trees has been replaced by grassland.

Taita-Tawai soils occupy the hills on the eastern side of the Hutt Valley below an altitude of 1,000 feet and extending from Gracefield to Te Marua. They have developed under a hard beech forest now mainly destroyed and replaced by gorse-manuka scrub. The soils consist of 4 to 6 in. of greyish brown firm clay loam over yellowish brown compact clay loam to clay. Structural aggregates are not well developed and increase from moderate-sized nuts in the topsoil to coarse blocks in the subsoil. The subsoil has many grey and rusty yellow mottles and grades downward into greywacke which is weathered for 30 feet and more. In many places the weathered material is red as demonstrated in the railway cutting about one mile north of Upper Hutt. The soils have a moderate to low content of plant nutrients and although they have been a problem for pastoral farming, they have grown excellent pine forests.

Belmont - Wakatikei soils are mapped along the western hills from Normandale to the Akatarawa Valley and east of the Hutt Valley in a belt from the top of Stokes Valley to the Pakuratahi Valley. They occur adjacent to either Korokoro or Taita soils but in both cases further inland and at slightly higher altitudes. The profile is similar to the Korokoro soil except that the topsoil is dark brown and the subsoil yellowish brown, more silty and lower in plant nutrients. In the Wakatikei soils slightly weathered greywacke rock occurs at a depth of about 18 in., but on the Belmont soils the material below 18 in. consists of yellowish brown silt derived by freezing and thawing of greywacke during a past cold period. The junction between silty material and rock at 36 to 60 in. is usually very abrupt as a result of fine material sliding downslope after thawing (solifluction). The Belmont — Wakatikei soils developed under a rimu-rata/tawa forest now practically all cleared for farming. With fertilisers these soils can be converted to fair quality pastoral land on which there is little likelihood of serious erosion.

In the upper part of the Hutt Valley, the Belmont - Wakatikei soils grade into the Akatarawa-Ruahine pair. They occur over a similar range in altitude (600-1,400 ft.) but the Akatarawa-Ruahine soils supported a hard beech or rimu-rata/kamahi forest. The soils differ mainly in that the Akatarawa-Ruahine soils are darker in colour and grade into greywacke rock 18 in. or less from the surface. Also, the silt loam topsoil is only 4 in. thick and under forest is covered by 3 to 6 in. of reddish brown raw humus containing many plant nutrients. Whilst this organic store of fertility on the surface is safe under forest, it is vulnerable to rapid erosion if the forest cover is destroyed. Removal of the humus layer exposes a poor soil on which it is difficult to maintain pasture and cleared hillsides rapidly revert to fern and second growth forest. The soils are well suited to forestry and should be retained for that purpose.

Renata—Rimutaka soils occur on the ranges around the Hutt Valley at altitudes between 1,200 and 2,500 ft. They are developed under either miro-rimu/kamahi or red beech-kamahi forest. The soils have a raw humus layer 4 to 12 in. thick overlying 3 to 6 in. of brownish grey fine sandy loam. The subsoil is silt loam with a downward gradualtion in colour from brown to yellow. On broad ridges a thin iron pan occurs between top and subsoil and impedes drainage. Plant nutrients are low and the soils are less suitable for pastoral use than the Akatarawa-Ruahine soils. Soil renovation after clearing and erosion is slow and the areas should be retained as protection forest reserves.

Above 2,500 feet the Renata-Rimutaka soils grade into the Tararua mountain soils which are developed under silver beech forest or tussock grassland. Under the forest the soils are very shallow consisting of 4 to 6 in. of raw humus, 6 in. of grey stony sandy loam over greywacke which is stained grey and yellow. Under the tussock grassland slopes are usually not as steep and a subsoil of yellow stony silt loam is common. Generally they are strongly acid wet soils in which processes of development are very slow. Hence, replacement of soil lost through depletion of vegetation and subsequent erosion requires a long period, and for purposes of water conservation it is essential to maintain the entire soil. For this reason browsing of numerous deer, goats and opossum on the Tararua steepland soils is dangerous and has already caused the removal of soil from many areas in the upper catchment of the Hutt River.

Patches of dark red soil over purplish red rocks are found on some areas of Wakatikei, Ruahine, Rimutaka, and Tararua soils. A good example may be seen halfway up the Rimutaka Hill road. These soils are derived from volcanic lavas intruded into the greywacke. They make excellent pastoral land but occupy areas too small to be shown on a district map.

The wide variety of soils derived from greywacke provide excellent illustrations of how soil differences are developed. For example, along the western hills Korokoro-Makara soils occur at the Petone end and grade northward into the Belmont-Wakatikei soils which in turn grade into the Akatarawa - Ruahine soils, Renata-Rimutaka soils and finally Tararua mountain soils. In this sequence the soils show:

(1) a lessening in fertility as a consequence of increased leaching,

(2) an increase in the general wetness of the soils,

(3) a decreasing thickness of topsoil and increasing accumulation of raw humus on the surface.

(4) decreasing proportions of clay particles in the subsoil, and
(5) merging boundaries rather than sharp divisions.

All these differences are consistent with the trends in climate up the Hutt Valley. Annual rainfalls at the Petone end average 45 to 50 in. and rise to more than 100 in. at the Tararua end. Soil temperatures decrease inland with the increase in altitude and distance from the coast. The increasing rainfall provides more water to percolate through the soil and produce changes (1) and (2); decreasing temperatures tend to lessen the rates of decomposition of organic matter (3) and of weathering of minerals into clay (4). The merging soil boundaries (5) resemble climatic trends which are gradual rather than abrupt changes.

The sequence of soils along the western hills is also correlated with differences of native forest (see descriptions) and this also supports the responsibility of climate for the broad pattern. However, vegetation (like soil) is not entirely dependant on climate and can modify its effects. Thus, on the Belmont soils the dead leaves, branches and bark of the forest (rimu-rata / tawa) are rapidly digested by soil organisms and mixed with mineral materials to produce the deep moderately fertile topsoil. On the Akatarawa-Ruahine soils the litter from the forest (hard beech) is digested more slowly with the consequence that there is an accumulation of raw humus on the surface. This accumulation delays the circulation of nutrients and causes a greater loss of substances in the drainage waters. Hence, although the climatic differences between the two soils is slight, there are distinct differences in leaching and in ability to hold pastures (see p. 37). Other factors such as slope or distribution of solifluction silts modify the influence of climate and extend or reduce the area of particular soils.

The Taita-Tawai soils were not included in the sequence because they appear to be much older soils. The high content of kaolinitic clay, deep weathering and low fertility can best be explained by their geological history. They occur on the remnants of an old land surface which has been tilted in towards the Hutt Valley and suffered very slow erosion. Otherwise the red products of weathering, considered to have formed more than 50,000 years ago, would have been stripped off as they generally have been on the western hills. In a few places on spurs of the eastern hills erosion from two sides has removed all the deeply weathered rocks and a Makara-like soil has developed. Hence, although the climate of the Taita-Tawa soils is fairly similar to that of the Korokoro-Makara soils, the differences are attributed to the longer period of soil formation on the eastern hills. This difference does not extend above an altitude of approximately 1,000 feet because on higher lands the old products of weathering have been removed either by solifluction or other processes of erosion.

All the soils of this group, except Tararua soils, are classed as yellow-brown earths of varying degrees of weathering, leaching and gleying. The Taita soils are moderately to strongly weathered and leached. Korokoro, Belmont, Akatarawa, and Renata soils are a sequence of moderate to weak weathering and moderate to strong leaching with weak podzolization in the Renata soils. Weak gleying occurs in the Renata soils and increases towards the Tararua soils where it is moderately expressed. The Tararua mountain soils show little development and are included in lithosols.

The high proportion of hillside land ranging from sea level to 4,500 feet means rapid runoff of rainfall and the need for a close cover of vegetation to control the rate of erosion. Serious soil erosion is occurring only on some areas of the Tararua mountain soils, but depletion of the present forest cover on the Tararua, Rimutaka or Ruahine soils would give rise to extensive slip and scree erosion as well as frequent flooding on the river flats. Under pastoral farming a small amount of sheet erosion occurs on the Taita-Tawai soils and a very small amount of slip erosion on the other soils of the hillsides.

From a farming point of view many soils are complementary and size is not a true measure of importance. Thus pastoral use of most of the moderately steep and steep hills is of a low standard and eventually fails unless the farms include at least 5 to 10 acres of river flat, Heretaunga, or Judgeford soils. These small areas of better soils owe their enhanced importance to their ability to grow high yielding pastures or crops to feed stock and spell the hill country. For this reason the withdrawal of such soils for housing settlements is usually accompanied by the reversion of a much larger area of adjacent hill country to manuka and gorse. This waste would be avoided if the hill country were developed for housing at the same time as the flat land.

These notes indicate the range of soils developed in the Hutt Valley. They show that rock composition is only one of the factors in 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