

12th MAY, 1887.

W. D. CRUICKSHANK, PRESIDENT, in the chair.

The following candidate was balloted for and duly elected as:—

**MEMBER.**

P. B. WALKER.

Mr. J. B. HENSON, then read the following paper:—

## THE SANITARY ASPECT OF THE SITE OF THE METROPOLIS AND ITS ENVIRONS.

*And hygienic precautions, which should be concurrent with the  
expansion of the area of population.*

BY J. B. HENSON.

THE growth of the metropolis during the last two decades has been very great, and instances are common where public works have been constructed of an extent estimated at the time to be ample for future requirements, but have scarcely been finished before their limited capacities have been perceived and additions demanded; the writer has, therefore, been impressed with the necessity of considering not only the site of the city and its surrounding suburbs, but also the whole area over which it is evident that in the immediate future a large population will be settled. The area under review will include the basins of the Lane Cove, Parramatta, and Cook's Rivers, the upland waters from which will, as population grows denser, become more and more contaminated, and bear an ever increasing amount of filth towards the city. A description of the physical characteristics of the whole area is a necessary preliminary, and will render future remarks more intelligible.

It is well known that the geological and physical features of a district which is a seat of population have an important influence upon the health of the inhabitants. There are many cities and towns which have obtained distinction, because they are situated on very healthy sites, whilst others, on the contrary, are characterized

by the extreme unhealthiness of their location. In these latter instances surprise may be expressed at the choice of the site, but it must be remembered that the requirements of commercial intercourse which promotes the concentration of population, often outweigh all other considerations. This is particularly noticeable in regard to coastal and river towns. The site of a town or city, no matter how unhealthy it may be naturally, may always be improved by the art and skill of man. The improvement may be slight; the expenditure to attain this improvement in the first instance, and maintain it subsequently, may be very heavy—so much so, that another and healthy site, offering less commercial facilities naturally, would for a similar, or, perhaps, even less expenditure on works to overcome this one drawback, be placed on an equal footing in regard to commerce with the former. The concentration of population forming cities and towns is an artificial order of things, and causes many marked changes in the natural condition of the locality and its surroundings. Many of these changes are directly detrimental to the health of the inhabitants, and steps have to be taken to counteract or mitigate their baneful influence. The character of the works necessary to attain this object is largely influenced by the physical conformation of the locality.

The metropolis of New South Wales is noted for its possession of a site which is naturally well adapted to the requirements of a commercial port, and, also taking the site as a whole, its healthiness is above the average. But the advent of population has degraded this latter characteristic, and one of the objects of the writer is to examine this matter and consider the remedies. The site of the metropolis presents many interesting features, scenical and geological, which have attracted a great deal of attention. No remarks are needed in regard to the former, as they are outside the scope of this paper, the latter will therefore now be more particularly described. The geological formation of the whole district is sedimentary, consisting mainly of massive sandstone resting upon the coal measures, and overlaid to a large extent with a comparatively thin capping of clay shales. There are also several drift sand beds and fluvial mud deposits of recent geological formation, which

must not be overlooked. The stratification as a rule is regular. The natural features of the whole district have been developed by erosive action, which has produced in the sandstone precipitous and rugged outlines and deep gorges, and in the easily weathered shales gentle and regular undulations of the surface. The waters of Port Jackson, including its numerous ramifications, and Botany Bay, lie in deeply excavated hollows in the sandstone rock. A main ridge, extending westerly from the coast at a point almost due east of the city, divides the drainage basin of Port Jackson and the Parramatta River from the drainage basin of Botany Bay and Cook's River.

Upon the northern and southern flanks of this ridge population has settled most densely. Inland, this ridge unites with other main ridges, the first joins on the southern side and extends around the basin of Cook's River in a southerly and easterly direction, terminating on the shore of Botany Bay, opposite the entrance. Much further inland, a main ridge joins on the north and extends northerly, easterly and south-easterly around the combined basins of the Parramatta and Lane Cove Rivers, and terminates opposite the entrance to Port Jackson. The area of the basin of Cook's River is fifty-five square miles, and the area of the Parramatta River basin, including Lane Cove River and other branches, is 167 square miles. The total area of the basins, the drainage water from which disembouges within the metropolitan area, is, therefore, 222 square miles. On the main central ridge the sandstone rocks reach their greatest altitude in the vicinity of the coast, the elevation approaching 300 feet above sea level. From this point going inland the elevation of the sandstone rocks decreases; in the neighbourhood of the city it has fallen to less than 100 feet above sea level, and at Concord, about fifteen miles inland from the coast, the rock disappears below the harbour waters. The clay shales are scarcely noticeable eastward of the city; within the city they are found a few feet in thickness, resting upon the sandstone summits. Going westward, however, they rapidly thicken, and extend over largely increasing areas, until the sandstone wholly disappears as a surface rock, and the shale takes its place.

In a northerly and southerly direction across the centre of the basins, which is a line transverse to the trend of the lines of main drainage, the sandstone is found reaching its greatest altitude at the northern extremity of the northern ridge. At this point, it is capped with clay shale beds, the surface level of which is 600 feet above sea level. From this point, the strata inclines towards the Parramatta River, continues on horizontally towards Cook's River, then rises slightly towards the south. The two recent formations before referred to, viz., the sand beds and mud deposits, have a very important relation to the subject of this paper. The largest of the sand beds is on the northern shore of Botany Bay, and it extends from the Bay northerly to the crest of the main central ridge, and caps it in several places. The next in importance is the sand bed lying between Bondi Bay and Rose Bay; besides these, there are other sand beds of small extent and minor importance. The sand beds are composed of drift sand. The Botany sands extend over an area of about twenty square miles, and they rest partly upon clay shales and partly upon sandstone rock. These underlying strata have been deeply eroded before the deposit of sand took place, and the sand is therefore found to vary in depth from a few feet to over 100 feet, the deepest places being along the course of the former gullies and creeks. Portions of these vast sand-beds have been of immense benefit to the city, and deserve more than a passing notice. The Botany sands may be divided into three areas, corresponding to the three streams which flow across them—the Eastern, or Bunnerong Basin, the Central, or Lachlan Basin, and the Western, or Shea's Creek Basin. The Lachlan and Bunnerong basins have been the source from which, until within a few months, the water supply for the city of Sydney and many of its suburbs has been wholly derived. The amount of water drawn from the Bunnerong Basin has been but small, the bulk has been drawn from the Lachlan Basin. The Shea's Creek Basin extends into a populous district, and the water derivable from it has for a long time been unfit for domestic use; it has never been utilised for the supply of the city.

The Botany sands are not barren, but are covered with a thick, low growth of vegetation commonly called scrub, and have therefore long been unaffected by the action of winds. The water storage capacity of clean drift sand has been illustrated by the Lachlan basin in a very conspicuous manner. From an area of 3740 acres sufficient water has been obtained for a constant service to about 200,000 persons. The average annual rainfall is about fifty inches, and for several years past very little water has been known to have wasted into the Bay. Population has closed in around the Lachlan basin, and the danger of pollution to the water is increasing. In a few months time the new water supply works will be so far advanced that the sand beds may be altogether abandoned.

The remaining feature to be noticed is the mud deposits. The most conspicuous of the mud deposits are found at the embouchure of Cook's River, and at the mouths of the various rivers and streams which discharge into Sydney Harbour, and its numerous ramifications. The head of each of the numerous shallow bays is generally found to be a shelving mud and sand deposits. A large area of these mud flats is exposed at low tide, and as the mud consists mainly of the debris washed from adjoining slopes, much unpleasantness is caused especially in the summer time. The total area of the mud deposits is about 2000 acres.

The clay shale beds which occupy so large an extent of the surface are known geologically as the Wianamatta Beds. They consist mainly of laminated clay shales more or less impregnated with iron in various combinations. The upper portion of the beds has been disintegrated chiefly by the action of the roots of plants and has been converted into clay varying in depth from two to six feet or more. This layer is more porous than the original compact shale, yet it is, in common with all clays, very retentive of moisture. The area occupied by the Wianamatta Beds is characterized by the undulating aspect presented along the flanks of the ridges—the undulations becoming flatter towards the main lines of drainage until they are almost lost in a general level. The slopes

on the hill sides are very regular and range about 1 in 20. This shows a uniformity in the texture of the shale which is not unexpected when its origin is considered. The clay and shale are easily and quickly eroded when exposed to the action of flowing water. Dense forests of large timber trees originally covered the whole shale formation.

The surface of the sandstone area is of a varied character, ranging from a compact level table to the extreme of ruggedness. Generally the surface is covered with a layer of angular boulders and sand, which has resulted from the weathering of the softer layers of rock and the disintegrating action of roots of trees. The sandstone rocks are traversed with vertical fissures which trend in two directions nearly at right angles with each other, and thus divide the rocks into large cubical masses. Rain water penetrating these fissures causes springs to appear at the base.

The natural healthiness of the site, taken as a whole, has been referred to as being a characteristic feature of the metropolitan district. A consideration of the nature of the various strata which form the surface will show their relative healthiness, it being generally understood that porous, open, well-drained soils are healthy, and that dense, undrained, or undrainable soils are the reverse. The sand stone areas and the upper portions of the sand beds, which rise into conspicuous hills, being well elevated, and naturally well drained, are the most favourably placed. The low-lying, saturated sands which receive the drainage water from higher levels take an inferior position. The area occupied by the clayey formation contains an insidious element of unhealthiness. The clayey soil and subsoil is very retentive of moisture, and its texture is such as to oppose that free drainage and æration of the ground which is so essential to the maintenance of an area in a habitable condition for man and other animals. This drawback is moderated or intensified in its action by the conformation of the surface. The summits of the hills and the upper portions of their sloping sides have the advantage of elevation to promote and facilitate drainage and the removal of subsoil water. The lower portions of the

slopes and the low-lying flat ground in the hollows or valleys are more or less charged, according to the season, with stagnant water. In winter these localities are very cold, and most certainly are very unhealthy; the fogs which form on the surface immediately after sunset are an indication of this. The natural condition of the mud flats is sufficiently indicated by their name, and needs no further comment. It will now be necessary to consider some of the effects produced by the advent of population on the areas just described.

The settlement of population in and around the metropolis has brought about many changes in the natural condition of the area, and the most important of these which directly affect its sanitary condition are as follows:—The removal of forest trees and shrubs, the pollution of the soils and streams, the deposit of silt and organic refuse around the outlets of the streams and watercourses, and upon the bed of the harbour, the accumulation of house refuse on the surface of the land, and the obstruction to the natural flow of surface and subsoil waters by the construction of road and railway embankments, infillings and reclamations.

Before proceeding further, it may be well to remark that nearly all of the most important works of modern sanitary engineering are provided on the general principle that pure water and pure air are the main elements essential to health. The degree to which the purity of the water supply has been affected by the changes just enumerated need not be investigated, for the necessity of providing an ample supply of water from a source outside the basins of the Parramatta and Cook's Rivers, long ago forced itself upon the attention of the authorities, with the result that a scheme was inaugurated, and is drawing nigh completion, which will accomplish the desired purpose. The town of Parramatta obtains its supply of water from the upper portion of the basin of the Parramatta River. This water is not of the best quality, and will rapidly deteriorate as population increases, so that resort to the new supply from the Nepean River must soon take place. It is, therefore, chiefly through the medium of the air that the evil effects of the aforementioned changes will be transmitted

to the residents, the principal exceptions being those which may be classed as dynamical.

The destruction of a large portion of the forests which once existed was necessary to afford room for the various purposes of civilization. This destruction still continues, and its effect is twofold—first, the purifying effect of the foliage upon the air is lost, and second, the shelter afforded to the soil by the foliage being removed, the soil when clayey becomes baked hard under the influence of the hot sun, and when rain falls it is not retarded, but flows quickly over the surface, and concentrating, rapidly erodes channels. The eroded material is carried by the flowing water and is deposited as silt at lower levels. Many water courses which are now deeply cut into the ground had no such defined position until the timber was removed from the surrounding hills. The removal of the forests has also had the effect of rendering the changes of temperature in the air more marked and sudden.

About one hundred years ago the first settlement of Europeans was effected upon the southern shore of Port Jackson, beside a small stream of fresh water which flowed into Sydney Cove. The water from this stream, which became known as the Tank Stream, was used for domestic purposes by the early inhabitants, but it was not long before the settlement, enlarging its borders, spread over the drainage basin of the stream and caused the pollution of its waters. A fresh source of supply had to be obtained. The stream soon became a receptacle for all descriptions of refuse, and as population grew denser it became a positive nuisance. Gradually it was hemmed in with buildings, and portions of its channel were covered over in various ways for various purposes—to increase yard space or to screen its offensiveness from view, and without regard to system. Whilst the stream was being transformed into a sewer the sandy mud flat at its outlet was gradually being raised with filling above sea level. A large area was thus reclaimed and appropriated to various purposes. The work of reclamation done at the outlet was not at once continued by the owners of low-lying land abutting on the stream higher up doing likewise; and these low-lying areas became liable to inundation during rainstorms,