

The country between Hell's Gates and Gum Creek Well, Reserve 9591, is all granite of the usual type. The granitic rocks also continue much further eastward, to the vicinity of Lawlers.

I did not, however, deem it necessary to extend my investigations as far as the town of Lawlers itself, that district and its mines having been fully dealt with by Messrs. Gibson and Montgomery, in the reports to which allusion has already been made.

Summarising the results of my investigations, it appears that from its geological constitution it is improbable that the stretch of granite country about 60 miles in width lying between Maninga Marley and Lawlers contains any auriferous or other mineral deposits of such a value as to warrant the construction of a railway for their exploitation.

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(3.) *The Prospects of obtaining a Water Supply for Geraldton, either Artesian, Sub-artesian, Wells, or Catchment Areas.*

Geraldton (114deg. 32min. E. long. and 28deg. 47min. S. lats.) is situated upon a low sandy promontory terminating in Point Moore, which forms the southern side of Champion Bay, and protects the shipping from all southerly and south-westerly weather.

The town itself has been built upon a long narrow belt of sandy flat or beach only a few feet above high-water mark, bounded by sea upon the north-west and sand dunes upon the south-east, behind which latter a low sandy plain extends to the base of the hills a distance of some six miles.

To the northward and north-eastward the country rises more rapidly towards the Moresby's Flat Topped Ranges, the rocks of which are sandstones and clays, and belong to the Jurassic Series. To the eastward the plain rises more gradually towards the Jurassic capped granite ridges of Newmaracarra, whilst to the southward upon the other hand the country is mostly flat, consisting of coastal and low alluvial plains, the more elevated portions being sandplains.

The area to the northward is drained by the Chapman River, which, although subject to floods in its upper courses rarely discharges any great volume of water into the sea, whilst when pools are met with in its bed the water is usually brackish or salt except immediately after rains.

The country to the south and east is drained by the Greenough River, which takes its rise upon the Murchison Goldfield, and this, like the Chapman, rarely flows except after heavy rains, when large tracts of alluvial plains near the coast called the "Flats" are flooded.

There are four possible supplies, all of which have been considered, viz., 1st from shallow wells within the municipal area, 2nd from artesian bores, 3rd from springs in the hills, and 4th by building dams and conserving water.

This question of a water supply for Geraldton has been under consideration for the last 15 years, during which time the Government has not only expended very considerable sums of money upon it, but have also employed their officers from time to time to report upon the various schemes brought forward.

Recently, however, the condition of things became so bad that the Railway Department installed a condensing plant, from which the locomotives and steamers are supplied.

*Shallow wells within the Municipal Area.*—The ground upon which the town is built is composed of recent marine and beach deposits piled up by the sea, consisting of sea-weed, shells, and sand, from which the present water supply is obtained at a depth of about eight feet.

The supply is derived directly from the rainfall (18 inches average) impounded by the sand of the dunes, this in its gradual passage towards the sea must pass beneath the town.

It is all very hard but varies very considerably in quality according to the nature of the deposits through which it passes, thus in the beds of decomposed sea-weed it is extremely bad and often salt, in the beds of shell it contains a larger proportion of lime, whilst in the sand it may be very fair quality even close to the edge of the sea.

Although the main supply is derived from the sand hills, this is augmented by the rain which falls upon the town itself, since the surface of the ground is also sand, and there are no impervious beds between it and the water level.

There is no sewerage system in Geraldton with an estimated population of 3,000, therefore, all the waste water after employment for domestic purposes is thrown upon the ground, and has been so disposed of ever since the town was built.

It naturally follows that the rain falling upon this surface becomes contaminated, and that after carrying on this practice for a number of years, that the eight feet of sand filter bed has become impregnated to such an extent that it no longer acts as a purifier, and therefore the usual consequences may be expected at any time attendant upon the consumption of sewerage.

*Grimshaw's Valley.*—This is situated within the Municipal Area in a depression amongst the sand dunes to the southward of the main portion of the town.

This flat is little over 12 feet above the sea level, whilst the bottom of the pumping trench to be mentioned later on was one foot six inches below it.

The supply here is derived directly from the impounded rain which falls upon the sand dunes, and owing to the fact that these contain large quantities of shell matter as do also the water-bearing beds, it is of a very hard quality.

The Government Analyst reports it to be very pure but extremely hard, this, however, he points out could be reduced to under 10 degrees by treating it by the Archbutt-Deeley process.

The first tests in this locality were made upon a well, which is stated to have yielded from 8,000 to 10,000 gallons per diem; later on, however, the Council, with Government assistance and under the supervision of the Public Works Department carried out the following work.

Extract of report presented to the Municipal Council, dated 15th December, 1907:—"In May last we excavated a trench well  $3\frac{3}{4}$  chains long, by four feet wide, connecting the original Grimshaw's Well with a well where 9 feet 3 inches of water was previously obtained. In order to sink the trench below water level, it was necessary to provide an engine and pump to keep the water bailed out, with the result that about 1,000,000 gallons were pumped out of the trench during sinking operations. A line of pipes 650 feet long was then laid over the rise of the sand-hills to the neighbouring valley, and during the first eight days 300,000 gallons were pumped over the sand-

hills, whilst from 1st June to 25th June (including the above quantity) 1,040,000 gallons were pumped away.

"One noticeable feature was that the water was making freely in several places at one end of the trench, and that when the water was reduced to two feet it necessitated the pump pumping from two to three hours to reduce the water, with a capacity of 6,500 gallons per hour. The water makes freely as will be seen from the fact that on the 1st June the water gauge read 5 feet 3 $\frac{3}{4}$  inches, and after 16 hours continuous pumping, accounting for 104,000 gallons of water, the water level was reduced at midnight to 1 foot 9 inches, but on the following morning at 10 a.m., it had risen to 4 feet 2 inches, the level each succeeding morning varying from 4 feet 6 inches to 5 feet."

Now it will be noticed, if the above figures are correct, that the average quantity of water pumped in June was 41,600 gallons per diem, and that the average depth of water in the trench after 16 hours pumping was 1 foot 9 inches or about 3 inches above sea level, therefore little more pumping could be carried on with safety.

Next, estimating the population at 3,000, requiring 30 gallons per head each day, their requirements would be 90,000 gallons or over double the supply.

I may next point out that the test was absolutely valueless, since it was carried on in May and June in 1907, during which months 9.81 inches of rain fell, or roughly speaking half the average rainfall of this district, consequently a very considerable portion of this water would be rapidly available.

In the next place, I understand that the volume pumped was estimated upon the capacity of the pump, this is supported by the statement that on 1st June 104,000 gallons were pumped in 16 hours, the capacity of the pump being 6,500 gallons per hour, but since pumps never come anywhere near their nominal capacity in practice, the very outside volume pumped would have been 5,000 gallons.

It is needless for me to go into this matter further, for without this source of supply is tested at the end of the dry season with pumps capable of supplying the requirements of the town and the quantity pumped registered by meter, and pumped to such a distance that there is no fear of a run back, it would be absolutely madness to consider it.

*Water supply from wells outside the Municipality.*—The general supply of the district is obtained from wells, in which the water level varies from 10 to 100 feet below the surface, the quality and volume are so uncertain that often several had to be sunk before a good potable supply was obtained, whilst there are extensive tracts over which it has proved either impossible to obtain a supply at all, or if obtained it was too salt to use, therefore the consideration of a supply from this source is also out of the question.

*Artesian Bores.*—The first attempts to obtain a water supply from this source were made in this district at the Racecourse in 1896, when a bore was put down by the Government from the bottom of an 83 feet well to a depth of 1,531 feet, when a supply of salt water was cut which rose to within 45 feet of the surface, and when the volume was gauged at a depth of 73 feet, it proved to be 11,700 gallons per diem.

Since this water upon analysis proved to contain about an equal quantity of salt to sea water it was absolutely useless for supply purposes.

Another bore was put down in the Railway Station Yard at about the same time, but this is reported to have encountered granite at a depth of 420 feet, but no water.

The Racecourse bore proves that the Irwin River artesian basin extends in this direction, whilst the Station Yard bore proves that the underlying granite rises rapidly towards the surface, and although no outcrops are visible in a northerly direction for a distance of nine miles, it would probably be met with at no great depth in the bed of the Chapman River.

In an easterly direction the first outcrop of granite is seen at the northward bend of the Chapman River, six miles distant from Geraldton, therefore conclusively proving that the Racecourse bore was sunk near the northern limits of the artesian basin (see map attached).

In this basin three artesian supplies have been obtained, viz., Yardarino, Dongara, and Geraldton Racecourse, but of these potable water was only obtained in the first mentioned, whilst that from the Dongara bore was even worse than the Racecourse containing about one-fifth more salt to the gallon than sea water.

Upon the evidence thus afforded, further expenditure in the direction of obtaining an artesian supply cannot be recommended.

*Natural Springs.*—This district generally abounds with springs which, as a rule, break out in water courses upon the hill sides at the junction of the overlying Jurassic sandstones with the granite, whilst after ringbarking and destroying the timber, water of a saline nature usually oozes out from the sides of the gullies.

Higgety's Springs are situated about 18 miles as the crow flies in a northerly direction from Geraldton; they break out at the northern end or head of a valley at a point where the granite rocks are exposed, over laid by the Jurassic sandstones which cap the higher ground.

Along this point of contact the water oozing out over a considerable area for countless ages has encouraged a dense growth of vegetation, consisting of rushes, bracken, and paperbark, the rotting matter from which in the course of time has formed a deposit of peat covering an area of over 100 acres.

No stream of water flows from this bog, but at one or two points of depression small quantities of water may be observed welling up and trickling along a channel upon the surface for a short distance until it is soaked up again by the peat.

This spring has generally the reputation of being permanent, but Mr. Campbell, late of this Department, states that at the time of his visit in March, 1909, it was quite dry, and this statement I can fully credit, because I noticed unmistakable evidence that considerable areas of the peat itself, which was at the time of my inspection quite boggy, had been burned probably last summer.

There is no indication of this being a deep seated spring, but everything points to the conclusion that it is of shallow surface origin, derived directly from the rainfall upon the elevated sandstone, which drains out in the valleys upon encountering the practically impervious granite.

If this swamp were trenched and drained, there is no doubt but that a considerable quantity of water could be drained off, but this once accomplished there is no evidence to warrant one in assuming that the springs are sufficiently strong to replenish it. In my own opinion a considerable quantity of the water

held in the peat bog is directly impounded from the rain, which the springs are not sufficiently heavy to replenish, thus the peat dries towards the end of the summer, when it is easily ignited and burns out to a considerable depth.

This repeated burning in recent years has considerably diminished the quantity of peat, and therefore a lesser quantity of water can be retained than formerly, the consequence being that whilst in the past a stream was said to flow from it, at the present day there is no indication of such a thing.

I therefore come to the conclusion that there is absolutely no prospect of obtaining a large permanent supply of water at this locality.

*19-Mile Spring, Northern Railway.*—Upon Loc. 613, about two miles south of Newmarra carra and close to the railway line, a series of small springs break out in a gully at the junction of the Jurassic rock with the granite. The uppermost one of them is very good potable water, but following down the creek they get saltier and saltier until they become quite briny.

There would be insufficient supply from these, but the idea advanced in favour of this locality was that by erecting a dam lower down the creek where there is a good site, that the impounded rain would be augmented by the springs.

This site is absolutely out of the question as the reservoir area is saturated with salt.

Northern Gully springs issue from a railway cutting, and are utilised by the Railway Department for a locomotive supply on account of the pure quality of the water, but the supply is quite inadequate for their own requirements.

In my opinion a supply derived from springs for the town is not worthy of further consideration as I do not consider there is the slightest possibility of obtaining a sufficiently large volume to meet the requirements of Geraldton.

*Water Conservation.*—Having carefully considered all the sources of water supply which came within the province of a geologist, and arrived at the conclusion that there is no hope of obtaining a sufficient supply of good potable water from any of them, brings us to the consideration of impounding surface water.

Strictly speaking, this is out of my province, as it is purely an engineering question, but still in travelling over the country I have been on the look out for any, to my mind, suitable situation; therefore the following remarks must be taken as suggestions only, whilst any further consideration must be left to the engineers.

The Bullen River crosses the Geraldton-Northampton road at a distance of about 9 miles north of the former town.

It takes its rise some four miles to the northward of this point, flowing down a wide valley, which is followed by the railway line to White Peak Station, when it turns abruptly to the westward, cutting a gorge-like channel through the ironstone and limestone capped granite hill to the sea.

In the upper portion of its course there are no sites suitable for dams, whilst from the tests made by the Resident Engineer, the water is not of a very good quality and of limited quantity, the greatest run off apparently taking place upon the hard ground below the railway line.

There are two good sites for dams here at points where the valley is contracted by granite bars, one being at the road crossing and the other a little lower down at the bottom of the Government Reserve. At

either of these a large body of water could be impounded, having a considerable depth at the dam head.

Owing to the fact that there are no indications of salt in the dried up rock pools in the bed, the conclusion arrived at is that the fresh water run off in this lower section far exceeds the saline water from its upper courses.

The only difficulty that I see in the matter is its elevation, which I should estimate roughly, taking White Peak Station as a starting point as the bottom of the lower site, only about 30 feet above Geraldton and the upper about 70 feet.

It would also be impossible to convey the water direct without pumping owing to intervening hills, but the mains might be laid down the valley and so round by the coast.

Before this scheme is seriously considered, it would be necessary to gauge the flow and sample the water, besides ascertaining accurately the levels.

Ego Creek is situated upon the eastern side of the Moresby and Flat Topped Range, about 6 miles from Geraldton. It takes its rise between the ranges and the Brothers, where there is apparently a very fine catchment area, the only question being if there is a suitable site for a dam further down its course, and from what I could see from a distance, I should judge that there would be one near Loc. 1380.

This would be an ideal site if practicable, since there is sufficient elevation to obtain a good head, the distance is short and the catchment area good and clean, therefore there would be every possibility of obtaining a large and good water supply.

There are doubtless many other suitable catchment areas in the Range and the neighbouring hills known to the local residents, which would be worthy of examination by an engineer. Such a piece of work would occupy three months at least, after which the selected and alternative sites would have to be tested.

*Conclusion.*—Having gone into this matter pretty fully, I think it will be apparent that the only feasible scheme is surface catchment, and if to this can be added natural gravitation it will be a great advantage. Although, perhaps, the initial cost may be greater, it will in the end prove to be more economical, whilst the quality of the water will be far superior if sufficient care is exercised in the selection of a site, and systematic sampling carried on throughout one rainy season before any scheme is adopted.

#### (4.) *The Mount Egerton Diggings, Peak Hill Gold-field.*

*Situation.*—These diggings are situated upon the north side of the Gascoyne River from which they are distant about eight miles, and about 10 miles south of Mt. Egerton trig. station.

The nearest postal town is Peak Hill which lies about 80 miles in a direct line to the south-eastward, the road of course being considerably longer and rather heavy for wheel traffic, whilst so soon as the claypans on this route dry up there will be a long stage without water.

*Means of communication.*—At the present time there are no facilities for communication with Peak Hill where there is a telegraph station and a weekly mail, or with Mt. Clare Station, a distance of 40 miles, which is the terminus of the Gascoyne River mail *via* Carnarvon. This latter is only a bi-monthly service.

Persons desirous of visiting the field must provide their own means of conveyance and stores, but fresh meat can be obtained at a reasonable rate from either