# *The Influence of the Geology of Durban on the Supply of Water from Wells to Early Settlers*

### *Introduction*

The provision of a secure supply of potable water is a primary requirement for the growth of a community. European settlement in Durban started with the arrival of the brig *Salisbury* in 1824,[1] with a subsequently increasing population causing a steady rise in water consumption. Supplies for owners of the original wattle and daub dwellings were drawn from surface streams, from shallow wells in backyards and collected from roofs in wooden casks.

By 1854 the first Town Council was established, with one of its earliest resolutions directing the Town Clerk to report on the state and requirements of the town pump, in order that it might be made available for the use of the public.[2] Situated in Smith Street, this was the Old Well, remaining in use until the 1890s.

The importance of the well water supply was such that from 1865 a report on the condition of wells throughout the town was included in the annual Mayor's Minutes published by the Council. The number of wells in use steadily increased, but the drought between 1878 and 1881 severely reduced yields from them. As stated in Henderson:

> the unsatisfactory quality and sparse quantity of water obtained from the public wells has been the source of serious and lengthy Council discussion since 1861.[3]

The drought precipitated matters and emergency measures were instituted to rail water from the Umgeni River. A search for a more permanent supply began, with local rivers being investigated for their suitability for dams. In the interim, boring operations by Councillor H.W. Currie at the foot of the Botanic Gardens succeeded, with Currie's Fountain continuing to be the principal source of water to Durban until the Umbilo waterworks were opened in 1886.

Some 100 years later in 1983, water supplies were again threatened by drought, with dams at critically low levels. Flow in the Umgeni River was low and in contrast to the situation in the previous century, groundwater supplies were investigated for drought alleviation. Exploration boreholes were drilled to determine water levels and potential well yields. These results, together with


Present-day Old Well Court leading to
Old Well House.

*(Photograph: Author's collection)*


A building constructed on the well site.

*(Photograph: Author's collection)*

other records, have been used to clarify the geology of the central City and suggest why the well water used by the early settlers of Durban was described as being of unsatisfactory quality and sparse quantity.

### *Positions of early wells*

Few original well positions are known with any accuracy. An exception is the Old Well in Smith Street, known by cadastral description and the presence of Old Well Arcade and Old Well Court, a building constructed over the well site. As implied by its name, the well appears to be the oldest which was in public use. It was first mentioned during a meeting on 23 June 1835, in which it was described as a natural fountain, named the Buffalo Spring, from which shipping obtained water.[4] Its use as a public well was reserved in the title deeds of the property in which it was sited, Erf 20 of Block D.

Wells are known to have been sunk in the sandy soil of Salisbury Island by refugees fleeing Dingane's threatened invasion of Port Natal in 1838, following Piet Retief's murder.[5] No records of the camp or well positions have been kept, but they would have been on high ground, drawing from the thin lens of freshwater which floats on denser saltwater in sandy sediments under islands.

A well was used for water supply to Fort Victoria at the Point,[6] whereas soldiers at the Old Fort drew water which was 'as black as ink'[7] from the adjacent reed-filled stream, which flowed southward under the present Municipal complex in Old Fort Place. Discolouration of the water would have been due to organic compounds leached from peat surrounding the now-buried stream channel, which currently causes many difficulties with the foundations of buildings in the area. The Old Fort well was dug together with protective embankments under the command of Captain Smith during a week of armistice between 26 May and 31 May 1842, during his battle with the Boers.[8]

A blockhouse built later near the old Fort Victoria on Alexandra Square behind Time Ball Station also used a well, which was still visible in 1899.[9] The present Timeball Road at the end of Point Road marks its approximate position.

With the passage of time and increase in number of wells in use, more details concerning them have been preserved.

### *Record of well construction and maintenance from 1854*

A chronological record is given below of wells sunk and their maintenance requirements, from the first Council meetings in 1854 to the opening of the Umbilo waterworks in 1886. This is mainly a summary of the Mayor's Minutes published annually by the Town Council, supplemented by details from *Fifty Years' Municipal History*, written by W.P.M. Henderson.

1854: On 14 November, the Town Clerk was directed to report on the state and requirements of the town pump, in order that it might be made available for the use of the public. (This, as already noted, was the Old Well in Smith Street).

1862: Mr. W. Hartley presented a drinking fountain to the Borough, sited in the corner of the Town Gardens facing West and Gardner Streets.

1863–1864: Twelve new pumps were erected.

1865: All wells were cleaned out and four more constructed.

1866: Three more wells were constructed.

1867: No new wells.

1868: Iron parts in wells were wearing away and replaced by copper.

1869: Well repair and maintenance in the town was contracted to Mr. Thomas Edwards. A tender from an Australian miner for the repair of the Berea Road well, damaged in the September 1868 flood, was accepted. He succeeded in sinking it to its original depth of 86' (26,2 m), with a water level of 6' (1.83 m).

1870: Berea Road well was now working while Umbilo well was to be sunk.

1871: Mr. Edwards was absent at the diamond fields, but Mr. Fysh was working for him. More iron was replaced by copper. A new well was dug in Mr. Brunton's premises in Smith Street, but required slight alterations due to a land slip.

1872: Repairs and maintenance was let to McNeil & Singleton, at £68 p.a.

1873: Drought had affected well supplies. The Council apologized for any inconvenience to burgesses.

1874: Repairs and maintenance were again let to McNeil & Singleton.

1875: All wells were cleaned and deepened, with soundings morning and evening showing an everage depth of water of 7' (2.2 m). The well in Smith Street on lot 20 of D (the 'Old Well') was rebuilt and deepened, providing a good supply for domestic but not drinking purposes. A substantial pump was placed on it. The large temporary well sited on Market Square for drought relief purposes might be sunk deeper for permanent use.

1876: The dangerous state of well covers in the town had been caused by Zulus and others removing them. The Town Clerk was to have all covers fastened down, with trap doors fitted and padlocked. The Market Square well was now 25' (7.6 m) deep and had the greatest holding capacity of any well in town. It would shortly be fitted with a rotary lift pump as an experiment. Soundings of all wells were taken and tabulated by the Superintendent of Police.

1877: An application from Mr. F. Hill to undertake borings for an artesian well was accepted, £50 being voted to pay for the experiment. Work proceeded to 54' (16.5 m), where the bore failed for various causes. A second boring reached 75' (22.9 m) before failure, the anticipations of the Council not being met. Mr. Winsor snr. of the Natal Government Railways indicated that the tools used were unsuitable and recommended discontinuance until material was imported from England. The Vote was supplemented by an additional £50. The rotary action lift pumps were found to be simple and effective and an order placed for

**Table 1: Summary of Well Sounding Results as Tabulated by the Superintendent of Police in 1876**[10]

| Well Position | Depth (m) | Hour of Sounding | | Interval Between Soundings (hours) | Depth of Water (m) | | Increase in Water in 9 Hours (m) |
|---|---|---|---|---|---|---|---|
| | | p.m. | a.m. | | p.m. | a.m. | |
| Market Place | not known | 9.10 | 6.10 | 9 | 0.58 | 1.58 | 1.0 |
| West St. near Natal Bank | 5.19 | 9.12 | 6.12 | 9 | 3.66 | 3.86 | 0.20 |
| Pine Terrace (Dacomb's corner) | 6.66 | 9.15 | 6.15 | 9 | 0.92 | 2.77 | 1.85 |
| Kennington House | 4.12 | 2.20 | 6.20 | 9 | 3.05 | 3.10 | 0.05 |
| Drew's corner | 6.41 | 9.30 | 6.30 | 9 | 0.61 | 2.97 | 2.36 |
| Queen St. | 3.36 | 9.25 | 6.25 | 9 | 2.81 | 3.38 | 0.57 |
| West St. (near Cathedral Chapel) | 5.80 | 9.35 | 6.35 | 9 | 0.28 | 0.36 | 0.08 |
| St. George's St. | 4.58 | 9.40 | 6.40 | 9 | 2.34 | 2.69 | 0.35 |
| St. Andrew's St. | 6.41 | 9.45 | 6.45 | 9 | 3.05 | 3.30 | 0.05 |
| Smith St. near Mr. Lumsden's | 2.90 | 9.50 | 6.50 | 9 | 1.40 | 1.58 | 0.18 |
| Smith St. below Mr. Lumsden's | 3.05 | 9.55 | 6.55 | 9 | 0.64 | 1.73 | 1.09 |
| Smith St. cnr. Post Office | 4.58 | 9.0 | 6.0 | 9 | 2.36 | 2.52 | 0.16 |
| West St. near Wilson's canteen | 3.97 | 9.05 | 6.05 | 9 | 2.03 | 2.16 | 0.13 |
| West St. cnr Prince Alfred Street | 3.97 | 9.10 | 6.10 | 9 | 1.02 | 1.12 | 0.10 |
| West St. at Cato's Creek | 2.75 | 9.25 | 6.25 | 9 | 0.92 | 0.97 | 0.05 |
| Pine Terrace near Gaol | 5.03 | 9.40 | 6.40 | 9 | 2.75 | 3.02 | 0.27 |

Remarks: Market Place well undergoing repairs, otherwise all wells in fair working order.

twelve more. Dry weather again affected well supplies, and with increasing population the necessity for providing another source of supply became imperative. Superintendent Alexander of the Police reported on his soundings taken in July 1877 of the 18 public wells, which yielded approximately 47 000 gallons (214 kilolitres) in 24 hours. The unsatisfactory quality and sparse quantity of this supply had been the source of serious and lengthy Council discussion since 1861.

1878: All wells were altered by fitting their pumps some distance away, to keep their water purer and prevent filth penetrating. The wells were nearly dry in the dry season and heavy pressure on the pumps by Zulus was causing damage. New large capacity wells were being constructed. Boring operations by Councillor H.W. Currie eventually succeeded, a well being sunk at the foot of Botanic Gardens which yielded 50 000 gallons (227 kilolitres) per day.

1879: Wells were now cleaner, iron troughs being used to lead water away. The drought made the possibility of the water shortfall so serious that the Mayor made arrangements with the Railway Department for a supply of water in tanks from the Umgeni River, to be sold at 1 penny per bucketfull.

1880: Hydrants were laid from some wells, and water sampling resulted in closure of others.

1881: Currie's Fountain was further developed to avert a serious water famine, as rainfall for the three years from 1878 had fallen far below average. Tanks on a tower were to be connected with the two wells and main by steam power, to increase the yield to 100 000 gallons (455 kilolitres) in 24 hours. Analysis showed the water quality to be favourable. Heavy outlay was required to maintain the town well pumps. Mr. Shire had sunk a well to over 50' (15 m) at Stamford Hill in Umgeni Road. First steps were taken to develop the Umbilo water supply.

1882: The supply from Currie's Fountain proved to be lower than hoped for, with 29 000 gallons (136 kilolitres) actually pumped.

1883: Currie's Fountain was inadequate for the growth of the Borough and the Umbilo water supply scheme was started.

1886: The Umbilo Waterworks was opened, celebrated by commissioning the Queen's Fountain in the Town Gardens.

1888: A lamp pillar and drinking fountain was erected at the corner of Point Road and West Street extensions as a memorial to Mr. Currie's exertions and skill in averting a water famine in the Borough.

### *Yields of water from the public wells*

Fortunately Superintendent Alexander's listing of well positions, depths and water levels for 1876 was reproduced in the Mayor's Minutes of that year.[10] Sixteen wells were sounded (Table 1), although their yields were not recorded until 1877, when dry weather was again causing supply problems and a further two wells had been dug. Total yield from eighteen wells was 47 000 gallons (214 kilolitres) in 24 hours, which in present-day terms would supply approximately 200 average households.

The method of measuring individual yields was not recorded, but would presumably have involved bailing the well dry for a certain period and recording the volume of water bailed. The subsequent restitution time of the standing water level is an important factor in well supply, being directly related to geological factors, namely the permeability of the surrounding soil and its storage capacity. This was obviously recognized in 1876, as shown by the column 'Increase in water in 9 hours' in Table 1, being the difference in water levels between the 9 p.m. and 6 a.m. soundings, recorded as 'depth of water'. Modern-day terminology is such that this would now be taken to be depth *to* water, but the overnight increase in values for each well shows that they are in fact differences between the bottom of well and water level.

### *Geology of central Durban*

Known and estimated positions of wells in use up to 1854 together with some of the sixteen wells recorded in 1876 are shown in Figure 1. This area, encompassing the main early Durban settlement, is underlain by estuarine sediments, deposited during the major sea level changes which affected the south-east African coast during the last 100 000 years. Cyclical periods of world-wide glaciation caused sea levels to drop, shore-lines to retreat and river valleys to become deeply scoured. During interglacial periods climates warmed, ice packs melted and sea levels once again rose.

A maximum sea level lowering of about 120 m occurred during the last (Wurm) glacial maximum 18 000 years ago, with the subsequent transgression peaking about 3 000 years ago, when sea level rose to 3 m to 4 m above present.[11] The Durban Bay was infilled with fine sands and silty sands, interlayered with sandy clays. Reworking and sorting under shallow, tidal waters occurred, gradually merging one sedimentary unit into another. When sea level dropped to its present state, aeolian processes became dominant, covering the exposed flats with a veneer of fine, wind-blown sands.

Geological cross-sections have been constructed across the central city from exploration boreholes, as shown in Figures 2 and 3. From these it will be seen that surface sands commonly cover a bed of sandy clay or clayey sands, although the reverse also occurs. The water table is shallow, with temporary perched phreatic surfaces developing on lower-permeability, clayey sediments.

### *Geological influences on well siting, depths and construction*

Geological information in relation to knowledge of well positions is inadequate to indicate whether or not variations in soil profiles and water tables influenced well siting in the central parts of the town. Sedimentary units vary across distances of hundreds of metres in this area, rather than over a single plot, and wells were probably sited for convenience to users rather than on geology. Variations in particle sizes of sands and water levels nevertheless can occur locally and an optimum site would probably have been selected after trial excavations or borings had been made.

The reported natural fountain on the site of the Old Well[4] is exceptional, as local geological conditions are not thought to be conductive to artesian water flow. However, examination of a contour plan indicates that the fountain was sited at the head of a concave depression draining to the Bay. Falling sea levels in geologically recent time (within the last 4 000 years) would have created

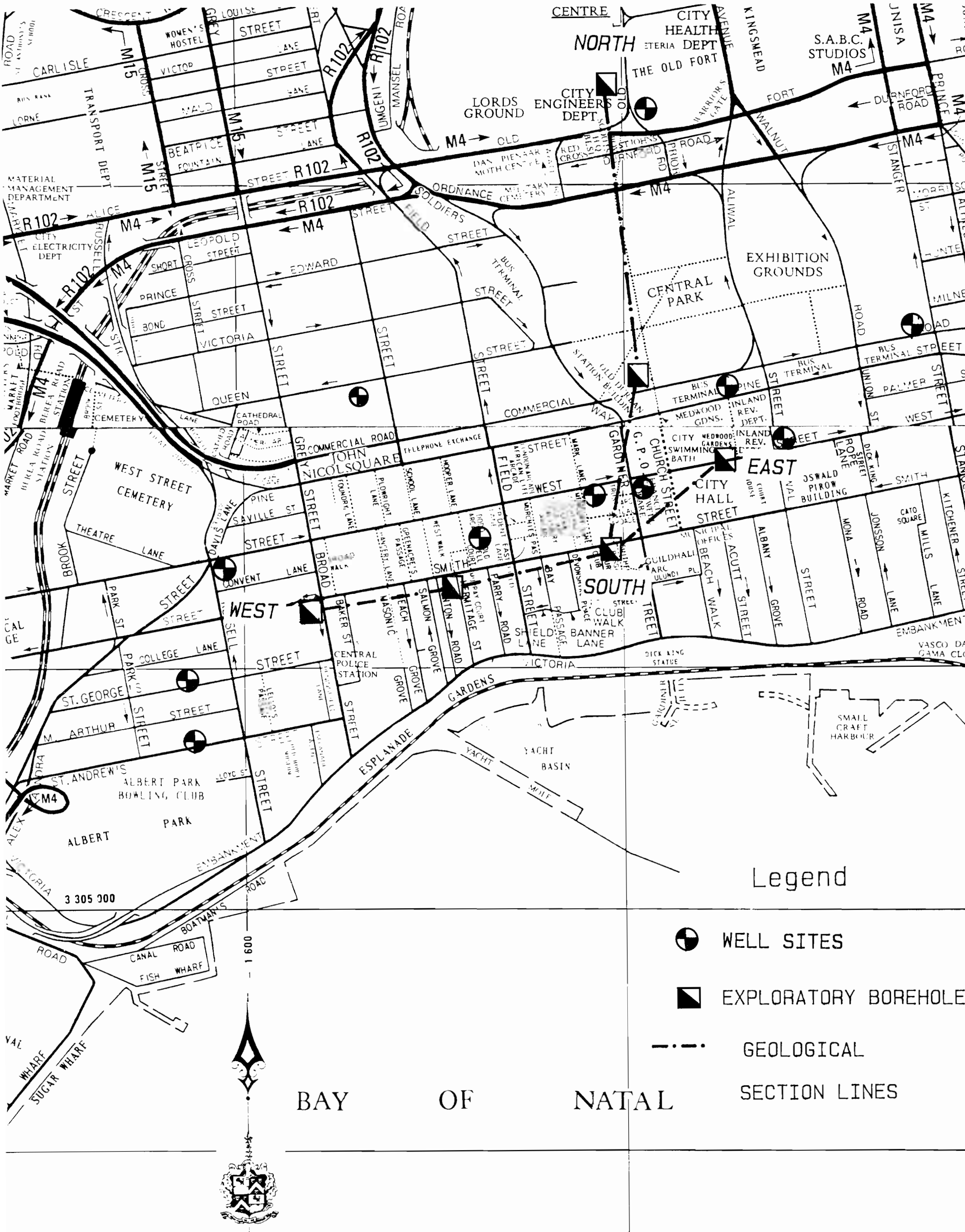


Figure 1: Plan of central Durban showing known well sites with positions of exploratory boreholes.

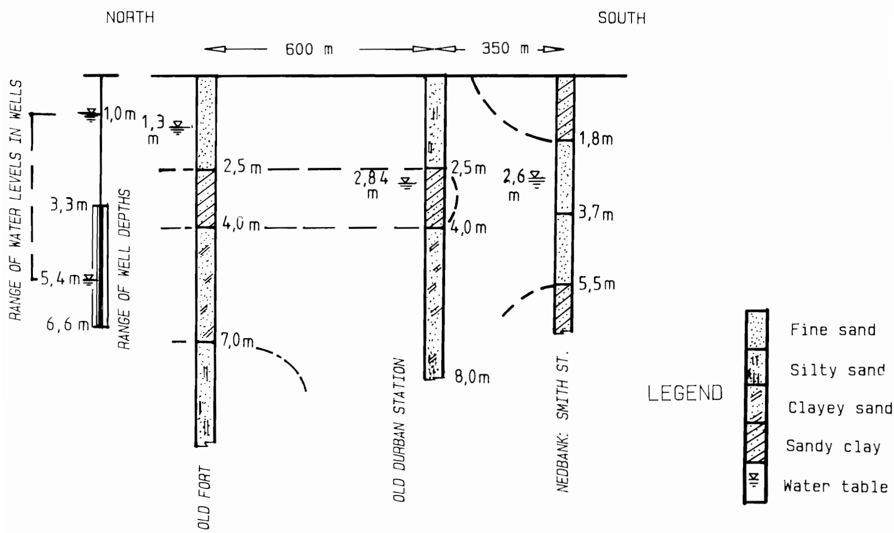


Figure 2: Geological section: North-South.

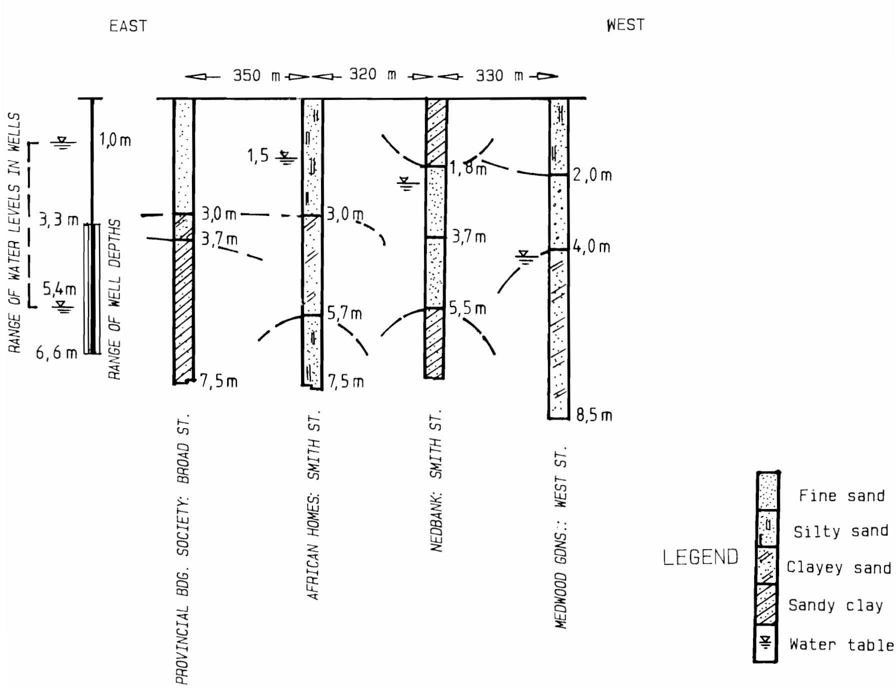


Figure 3: Geological section: East-West.

youthful channels draining higher ground above West Street. The heads of these would have been fed by artesian springs tapping the water table, which probably was the Old Well fountain origin.

Most wells would have been hand-dug to about 0.9 m diameter, but it is evident that by 1877 drilling machines were available to bore smaller diameter holes.[12] In that year a Mr. Hill persuaded the Town Council to vote money for exploration boring to find an artesian water source, or one from which water would flow without pumping. Unfortunately the place of work was not recorded, although the failure of it was, together with the additional expenditure required to import special equipment. Sympathy could be expressed for Mr. Hill, as the technical problems encountered during drilling through sands under even slight artesian pressure are formidable, even today. A similar comment could also be expressed concerning the problem of explaining a doubling of expenditure on a fruitless project to sceptical town councillors.

The geology of the City changes westward under the footslopes of the Berea ridge, where groundwater flows down the contract between red sands of the Berea Formation and lower-lying, clayey estuarine deposits. Particularly strong flows emanate from the area below the Botanic Gardens, known as Currie's Fountain. Councillor H.W. Currie presumably selected this site as suitable for supplying water to the town because of the wetland conditions which would have prevailed at the time.

Geological conditions giving rise to these flows are also exceptional, as the eye of the spring is a major fault zone in which the Pietermaritzburg Shale Formation is upthrust against tillite of the Dwyka Formation. A geological section between two exploration boreholes on either side of the fault is shown in Figure 4. Artesian water flows from the fault and sandy infill in the fault zone, confined by the overlying clayey layers. No present-day trace of

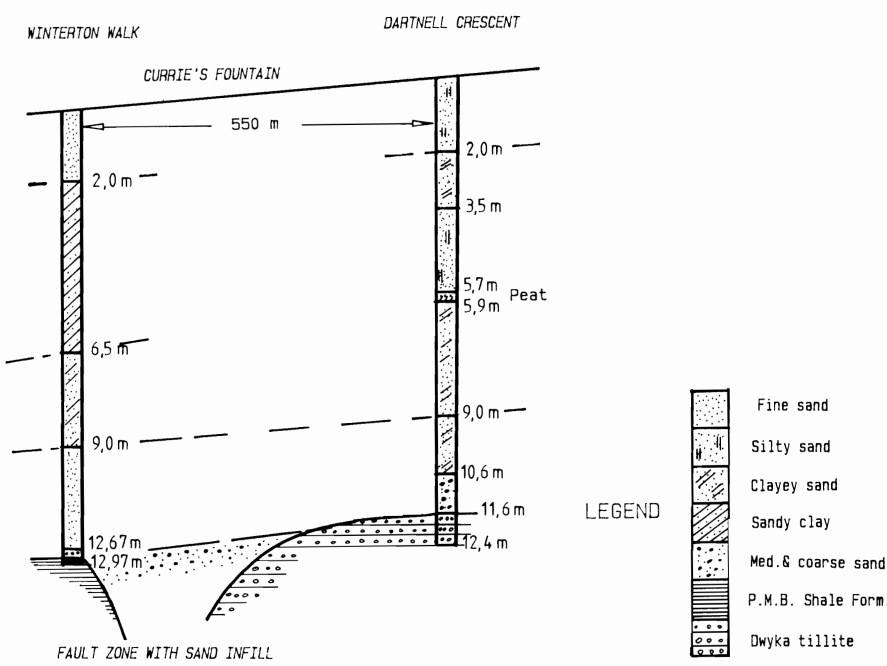


Figure 4: Geological section across Currie's Fountain.

Councillor Currie's wells or headworks remain, but it is probable that they would have been sited above the fault in the area reclaimed as the Currie's Fountain sportsfield. The artesian water now flows underground, discharging into a culvert draining along Warwick Avenue to the Bay.

The 1869 reference in the Mayor's Minutes to a Berea Road well[13] and an Umbilo well in the succeeding year[14] indicate that the individuals responsible for well siting were aware of the widespread presence of groundwater below the Berea footslopes. The Berea Road well is reported as being 26.2 m deep, with groundwater levels in exploration boreholes suggesting that it would have been sited some distance up from Umbilo Road, possibly in the Turner's Avenue area. Details of the Umbilo well are not recorded, but the buried zone of seepage extends far southward along Umbilo Road beyond the boundary of the City, and could have been intercepted at any point.

Depths of individual wells would have been such as to allow sufficient storage of free water in the well to supply abstraction by bucket or pumps. Superintendent Alexander's survey in 1876 (Table 1) recorded well depths from 2.75 m to 6.66 m, with between 0.28 m and 3.66 m of standing water in each. These depths are superimposed on the geological sections across the City (Figures 2 and 3), from which it will be seen that most wells terminated in silty or clayey strata of lower permeability than the overlying sands. Present-day groundwater levels are similar to those recorded in 1876, as shown on the geological sections.

The far greater depth of the Berea Road well would have been necessary to reach a layer of clean, water-bearing sand which is known to overlie bedrock (probably shale) in this vicinity. Reconstucting a shaft of perhaps one metre diameter through loose sand to penetrate saturated sand for 1.8 m at a depth of 26 m would now be defined as a major civil engineering project, costing more than R100 000. The un-named 'Australian miner' rightly earned considerable respect for doing this in 1869, for his successful efforts were recorded in the Mayor's Minutes of that year. Repairs to the original well were necessitated by damage resulting from floods in 1868,[15] which probably caused sidewall collapse. The assumed well position is far removed from any surface streams and it is unlikely that the damage was due to inundation by floodwaters.

Shaft wall instability is the major problem encountered during well sinking, particularly when the water table is reached. Walls become less stable with depth and require more restraint as earth pressures increase, but by the late nineteenth century empirical rules for the size, type and placement of timber or brick support were well established. Early householders used simple methods, however, sinking holes 1,8 m to 2,4 m deep in their backyards, into which casks without heads were successively inserted. Wells were bricked after the casks rotted and caved in.[16]

Support timbers or bricks have to be placed against an exposed soil face shortly after excavation, to allow sufficient earth movement to occur to develop arch strength but prevent complete collapse. The process was not always successfully undertaken, as is apparent from the Mayor's Minutes of 1871, where it is recorded that 'the new well dug in Mr. Brunton's premises in Smith Street required slight alteration due to a landslip.'

### *Groundwater quality*

The groundwater quality obtained from the old Durban wells was described by Russell as 'not nice, but preferred to rain water off tarred roofs or dusty thatch, combined with the flavour of wine or spirit hogsheads used as water butts'.[16]

General public concern regarding well water quality had been expressed from 1861[3] and in 1875 water from the Old Well was described as 'only suitable for domestic but not drinking purposes'[17] for unexplained reasons. Much controversy surrounded the supply from Currie's Fountain, which was initially feared to be unsuitable for dietetic purposes. A chemical analyst was employed by the Town Council, who tested the water and declared it to be suitable for drinking.[18] However, in 1880 certain wells had to be closed as a result of impurities found after analysis.[19] Test results were unfortunately not recorded in the Minutes, but it is probable that both chemical and microbiological analyses were undertaken.

Analytical chemistry was reasonably advanced by the 1870s, but the role of contaminated water in disease transmission had only been established in 1854 in London by physician John Snow. After more than 500 people died of cholera in a week in the area around the intersection of Cambridge and Broad Streets, Snow plotted cases on a street map to find the epidemic source. This proved to be the Broad Street water pump and removal of its handle halted spread of the disease.[20] Cholera epidemics continued, however, as shown by the drawing of Pinwell (reproduced below) documenting the 1866 London epidemic.

King Cholera dispenses contagion with drinking water:
George Pinwell's sketch, London, 1866.

*(Reproduced from National Geographic, January 1991)*

These epidemics no doubt caused the public concern in Durban over local well water quality and led to its regular sampling. Most bacteriological pollution enters wells through unsanitary conditions around their wellheads. This appeared to be realized by 1878, when all wells were altered by fitting their pumps some distance from them, and further improved in 1879 by using iron troughs to lead water away.[21, 22]

Apart from its bacteriological quality, which is dependant on conditions at the time of sampling, groundwater abstracted by the early wells would have been potable. Present-day testing from the shallow central city aquifer indicates that it is brack, with a high dissolved solids content, but otherwise suitable for drinking. Groundwater sampled at 3 m and 30 m depths below the Central Park (outside the present-day Workshop) and at Currie's Fountain is compared chemically with current Durban tap water, together with S.A.B.S limits, in Table 2. Brackishness is indicated by hardness values, together with total dissolved solids, which comprise various salts. It will be seen that the Central Park water is more brack than that from Currie's Fountain, due to leaching of salts from the estuarine sediments through which it is drawn. The latter supply, in contrast, flows through salt-free aeolian sands of the Berea Formation.

Some lower-yielding wells excavated into silty or clayey soil could have produced turbid water at times of heavy use, due to the infiltration of fine sediment. Turbidity caused by suspended solids, although innocuous, creates great concern in consumers and may well have contributed to the doubts which were continually expressed about water quality.

### *Conclusions*

Adequate quantities of groundwater from wells were available to meet the needs of the early settlers in Durban. Demands from an increasing population soon outgrew supplies, as the geology of the original town centre is not

**Table 2: Groundwater Chemistry**

| | Durban Tab | S.A.B.S | Central Park 3 m | Central Park 30 m | Currie's Fountain |
|---|---|---|---|---|---|
| ph | 7.9 | 6–9 | 7.7 | 8.1 | 7.1 |
| Conductivity mg/l | 13 | – | 91 | 55 | 56 |
| Sulphate mg/l | 3 | <250 | 197 | 9 | 52 |
| Chloride mg/l | 16 | <250 | 16 | 94 | 68 |
| Alkalinity mg/l | 30 | – | 182 | 147 | 82 |
| Total Hardness mg/l | 39 | <200 | 326 | 116 | 48 |
| Calcium Hardness mg/l | 23 | – | 236 | 72 | 24 |
| Total Dissolved Solids mg/l | 80 | <500 | 306 | 365 | 420 |

favourable for large-scale groundwater abstraction. Droughts during cyclical variations in the climate of South Africa created critical water shortages, which led to searches for more permanent sources. Currie's Fountain provided relief for a few years, until the town's first waterworks were opened in 1886.

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