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1986/80. High groundwater levels along Shark Point Road, Penna.

B. D. Weldon

Abstract

A slope failure on the edge of a narrow coastal plain at Penna was initiated by high pore pressures. A body of sand extends from the surface to depths of over 3 m in places. The sand is underlain by a clay layer which presumably overlies bedrock. The lower level of the sand body is saturated. There is some indication that the groundwater may be contaminated by treated water supplies.

INTRODUCTION

The Department of Mines was requested by Dr R Connolly, in late July 1986, to investigate drainage problems at his property on Shark Point Road. Geologist B. D. Weldon inspected the property and reported verbally by telephone to Dr Connolly. Mr Weldon indicated that as several properties were affected by water seepage, an attempt would be made to investigate all properties as a community service. This was not undertaken until after land in front of Mr and Mrs Stokman's residence collapsed into the sea. Mr and Mrs Stokman are neighbours of Dr Connolly.

The Stokman's property was inspected following the collapse of the bank. It was apparent that considerable areas of the Stokman's land and their neighbours (the Missionary Sisters of Service) was saturated. The Stokmans were advised to effect surface drainage of these saturated areas as a means of decreasing the pore pressure in the bank. A backhoe was requested without prejudice from the Richmond Council to open test pits and to dig drains in the road reservation. This was ineffective on the downslope side of the road where the backhoe sank under its own mass to its chassis in an area which had previously been disturbed by trenching. The ground here was saturated just below surface level. Further access to this area was not attempted. Several test pits were dug on the upslope side of the road reservation. Additional investigations were made using a trailer-mounted drill rig.

GEOLOGICAL SETTING

Fine- to medium-grained sands, probably of Quaternary age occur at the surface. These appear to be well graded and of marine origin. Triassic, dominantly medium- to coarse-grained quartz sandstone locally form the bedrocks. An intrusion of Jurassic dolerite occurs to the east of the Missionary Sisters of Service establishment and the contact with the sandstone is exposed along the foreshore.

TOPOGRAPHIC SETTING

A very narrow coastal plain, about 8-10 m high occurs in the area under consideration. The houses are built on the outer edge of this plain, which rises inland to Mt Lord. A natural drainage line from the south-east slopes of Pontos Hills discharges to Pittwater north of the apricot orchard (in Sorell Municipality) with a secondary line draining the southern slopes of Pontos Hills entering Pittwater in the vicinity of Dr Connolly's residence.

SITE INVESTIGATION

Attempts were made to get a backhoe into an area where a break had previously been repaired in the water supply pipeline. This was unsuccessful. The trench opened to effect the repairs had been backfilled with the local sands. These are apparently in a loose state (i.e. high voids content) and are readily saturated and liquefied. Test pit 1 was dug adjacent to this area. It encountered sands which, below the surface, were saturated. Sand runs caused the hole to widen in area rather than increase in depth. The pit was abandoned but left as a sump from which water is periodically syphoned.

Two backhoe test pits were dug on the upslope side of the road reservation. These revealed sands from the surface to between 1-1.5 m depth where a sandy clay layer was observed. The clay layer was relatively dry but the sands immediately above it were saturated. The surface sands were dry to moist.

A series of boreholes was drilled using a trailer-mounted Triefus drilling rig. The boreholes were advanced by auger screwing. From time to time samples were taken from the drilling returns and by withdrawing the auger and collecting samples from the cutting bit and auger flights. The boreholes encountered a sequence similar to that in test pits 2 and 3 before reaching refusal, presumably on rock.

The sequence encountered by the test pits and the boreholes are summarised in Table 1. The various sites are shown schematically in Figure 1.

Table 1. RESULTS OF TEST PITTING AND BORINGS, SHARK POINT ROAD, PENNA

Hole	Depth *(m)*	Description
TP1	0.0 -0.35	Sand, medium-grained, dry to moist
	0.35-1.0	Sand, medium-grained, wet
TP2	0.0 -0.9	Sand, medium-grained, dry to moist
	0.0 -1.2	Sand, medium-grained, wet
	1.2 -1.4	Clay, sandy, orange-brown, moist
TP3	0.0 -1.1	Sand, medium-grained, dry to moist
	1.1 -1.4	Sand, medium-grained, wet
	1.4 -1.6	Clay, highly plastic, some sand, orange-brown, moist
BH1	0.0 -0.35	Sand, medium-grained, dry to moist
	0.35-2.0	Clay, highly plastic, moist to dry (doleritic)
	2.0	Refusal, probably on (? dolerite) rock
BH2	0.0 -0.9	Sand, medium-grained, dry to moist
	0.9 -2.0	Clay, highly plastic, moist to dry
	2.0	Refusal, probably on (? sandstone) rock

BH3	0.0 -2.4	Sand, medium-grained, dry to moist
	2.4 -2.7	Sand, medium-grained, wet
	2.7 -3.9	Clay, highly plastic, moist, becoming gravelly
	3.9	Refusal, probably on rock
BH4	0.0 -2.4	Sand, fine- to medium-grained, dry to moist
	2.4 -3.0	Clayey sand, medium-grained, moist
	3.0 -3.9	Clay, highly plastic, moist
	3.9	Refusal, probably on rock
BH5	0.0 -2.7	Sand, medium-grained, wet, occasional hard layers
	2.7 -4.0	Sandy clay, medium plasticity, moist
	4.0	Refusal, probably on rock
BH6	0.0 -2.7	Sand, fine- to medium-grained, dry to moist
	2.7 -3.0	Sand, medium-grained, wet
	3.0 -4.7	Sandy clay, medium plasticity, moist
	4.7	Refusal, probably on rock
BH7	0.0 -0.9	Sand, fine- to medium-grained, wet
	0.9 -1.7	Clay, highly plastic, moist
	1.7	Refusal, probably on rock
BH8	0.0 -1.0	Sand, medium-grained, moist to wet
	1.0 -3.0	Clayey sands, moist to wet
	3.0 -3.4	Clay, highly plastic, moist
	3.4	Refusal, probably on rock
BH9	0.0 -2.8	Sand, fine- to medium-grained, dry to moist
	2.8 -3.0	Sand, medium-grained, wet
	3.0 -3.8	Sandy clay, medium plasticity, moist
	3.8	Refusal, probably on rock.
BH10	0.0 -3.0	(approx) Sand, fine to medium-grained, dry to moist
	3.0 -4.9	(approx) Clayey sand, medium-grained, moist
	4.9	Refusal, probably on rock
HA1	0.0 -1.5	(approx) Sand, medium-grained, dry to moist
	1.5 -1.8	(approx) Sand, medium-grained, wet

The subsurface sequence comprises a porous and permeable surface layer of sand, underlain at variable depths by a non-porous and impermeable clay layer which apparently, in turn, overlies the bedrock. The sand layer would appear to contain some clay (as evidenced by the turbid nature of water obtained from freshly drilled holes). This may have some bearing on the distribution of the saturated ground.

WATER ANALYSIS

The saturated ground is located downslope of a water supply pipeline which in the past, has had a leak. Samples of water were taken and tested for fluorine content. The results of these analyses are given in Table 2.

Table 2. WATER ANALYSES FROM SHARK POINT ROAD, PENNA

Sample	Laboratory	Fluorine *(mg/l)*
W1	Govt Analyst	0.14
W2	Govt Analyst	0.20
W3	Govt Analyst	0.13
W4	Mines Department	2.3
W5	Mines Department	2.1
W6	Mines Department	1.0
W7	Mines Department	1.1
W7	Govt Analyst	1.12
W8	Govt Analyst	‹0.08
W9	Govt Analyst	0.08
W4	Govt Analyst	0.17
W5	Govt Analyst	‹0.08

Notes: Government Analyst used specific ion determinations; equipment calibrated for each run.

Mines Department used colorimetric determination on discoloured samples; fluorine not distilled off.

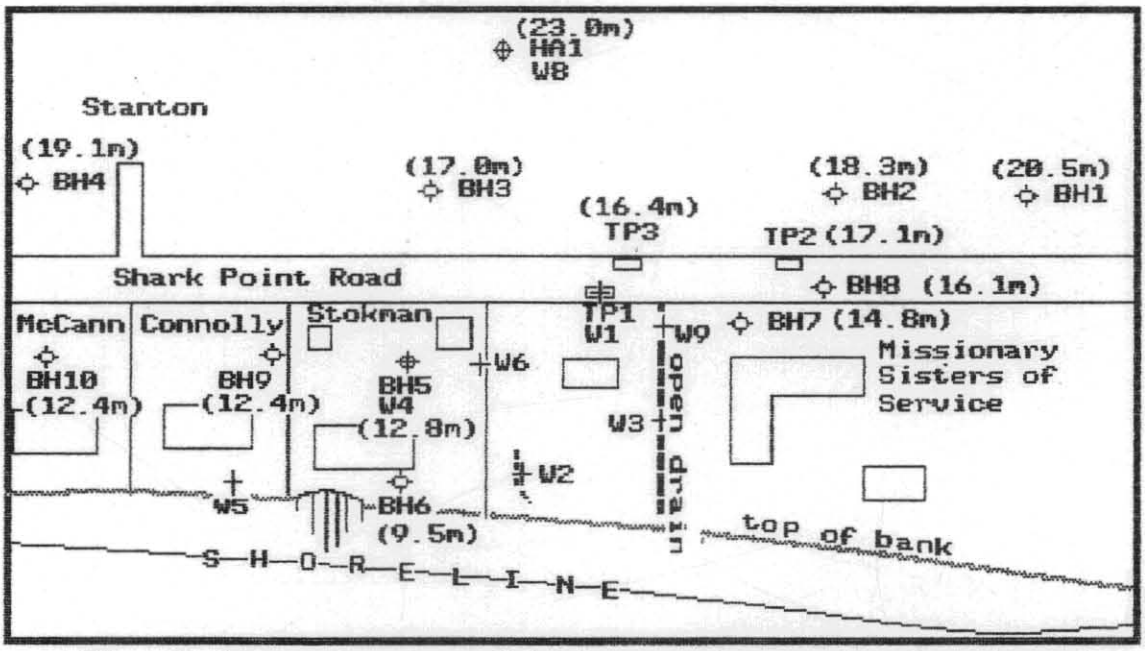

Fig. 1. Investigation of high groundwater levels, Penna

Not to Scale (Schematic only)

Indicated levels are approximate levels above State Datum

▭ TP test pit

⊹ BH borehole

◇ HA hand auger

\+ W water sample

N.B. water sample W7 from reticulated water supply

The Department of Mines results, because of turbidity in the samples and the relatively narrow sensitivity band for the colorimetric test, should be regarded with caution. The locations of the various samples are given schematically on Figure 1.

The Government Analysts results do, however, suggest some mixing of naturally occurring groundwater (as typified by sample W8) and treated domestic water supplies (as typified by sample W7). Samples W1-W4 contain roughly 75-100% more fluorine than that in the natural groundwater control sample (W8). Again, caution must be exercised. Samples W2 and W3 were obtained downslope from the outfall of septic tanks and may be contaminated from these sources. In the past there has been a leak in the supply line. Fluorine in the water at this time may have been absorbed by clay particles within the sand. The fluorine detected by the analyses could be from this source. Alternatively, the line might have a fresh leak.

SLOPE FAILURE

The bank in front of Mr and Mrs Stokman's residence has failed as a consequennce of excessive pore pressures in the granular materials comprising the upper 4-5 m of the bank. These pore pressures would appear to be due largely to natural groundwaters which have infiltrated the surface sands and percolated through these until reaching an impermeable barrier of clay. There is some indication that fluoridated water may be present in the groundwater. The lower portion of the sands becomes saturated, and in places, this saturation occurs up to the ground surface. The saturated sands are exposed in the face of the bank, appearing as seepages (such as are seen on Dr Connolly's property).

REMEDIAL MEASURES

The most effective remedial measure is to provide efficient drainage of the area. There is a relatively large catchment area which extends upslope well beyond the sand mine. A natural gully leads from this catchment roughly parallel to the access road to the sand mine, to the foreshore in the vicinity of Dr Connolly's residence. The sand body within this gully contributes groundwater to the properties, and it is this body of sand which must be drained.

Any drains must be keyed into the impermeable clay layer and not simply bedded on or near the surface of the clay layer. This task will not be easily achieved as, when saturated, the sands flow and trenches will be unstable. In the vicinity of the houses, the depth to the clay layer (in excess of 3 m) would require the use of expensive shoring techniques during trenching operations.

Shallow surface drains dug by Mr Stokman and hand dug holes (i.e. shallow well points) which are periodically syphoned, have succeeded in diminishing the extent of the saturated ground. However, when the groundwater level reaches the invert level of these drains and holes, their effectiveness will cease (unless the drains and holes are deepened). This suggests that progressive deepening of drains may be a means of effecting drainage.

Alternative techniques may involve the installation of a series of well points through the saturated sands. These would be manifolded together and periodically pumped. This would need to be done by all property owners affected by the high groundwater levels, to be effective. Yet another remedy may be to install horizontal drains from the bank in under the

houses. These would probably need to be installed by jacking rather than the usual technique of drilling (as the saturated sands would readily flow into the holes).

To minimise the quantity of water that could enter the sand body in future, a perimeter drainage system might be considered. This would need to be located on the property of Mr Stanton roughly where the bracken fern density decreases.

The failed section of the bank in front of Mr and Mrs Stokman's residence is too steep for long-term stability. Some form of retaining structure is required. This structure must not impede drainage of the sand body. The structure will need to be designed by a civil or structural engineer.

RECOMMENDATIONS

(1) The water supply pipeline from Sorell Municipality should be pressure-tested for leakages.

(2) The body of sand in the gully between the sand mine and the houses requires draining.

(3) An intercept drain be installed to minimise the quantity of water entering the body of sand.

(4) The bank in front of Mr and Mrs Stockman's residence should be retained by a free-draining structure.

[5 January 1987]