1982/6. Groundwater investigations at Gardners Bay, Cygnet.

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Abstract

Fractured and weathered dolerite extending to a depth of 20 m is believed to contain a supply of average quality groundwater, suitable for stock and probably tolerable for irrigation and domestic purposes.

INTRODUCTION

At a request from a Mr White, investigations were conducted in order to determine the possibility of obtaining groundwater from his property at Gardners Bay, near Cygnet [EN095184]. Present domestic supplies rely on rainwater held in tanks. A small dam on the property receives little runoff due to its restricted catchment and the low to average rainfall of the area. Any potential groundwater supply must be suitable for domestic and/or market garden and orchard applications.

TOPOGRAPHY

The area under investigation is located on the northern side of a small (140 m high) ridge which trends approximately east-west. The small, alluvium-floored valley of Gardners and Holloways Creeks lies at the base of the hill-slope, immediately to the north of the homestead. Approximately 200 m from the house is a small seepage at the base of the hill-slope (fig. 1).

GEOLOGY

The geology of the region (fig. 2) has been mapped by Farmer (1981). Jurassic dolerite underlies White's property and the adjacent hill to the south. The dolerite margin to the south closely follows the surface contours and is therefore considered to be an intrusive, sub-horizontal sheet in this area. The Jurassic dolerite-Permian mudstone boundary immediately to the north of the property is relatively straight, cutting across surface contours. This margin may indicate a steep intrusive contact or a fault. Evidence from two dam excavations and a quarry shows that the dolerite adjacent to the northern margin is closely fractured. The quarry shows extensive close jointing, both vertically and sub-horizontally, with little evidence of joint infillings. The presence of joint infillings resulting from the deposition of minerals often indicates that the groundwater may be of poor quality.

GEOHYDROLOGY

Groundwater in Jurassic dolerite is held in rock fractures. The successful drilling of dolerite for underground water relies on intersecting suitable open fracture systems containing a reservoir of water. Two successful water bores have been drilled in dolerite approximately one kilometre to the east of the area under investigation. The results from these boreholes (Appendix 1) show that reasonable quantities of good to average quality water have been obtained at shallow depth (approximately 20 to 25 m). As the dolerite in the area under investigation is closely fractured and a small seepage is evident at the base of the hill-slope, the chances of obtaining groundwater may be good, with conditions similar to those at the bore sites to the east.

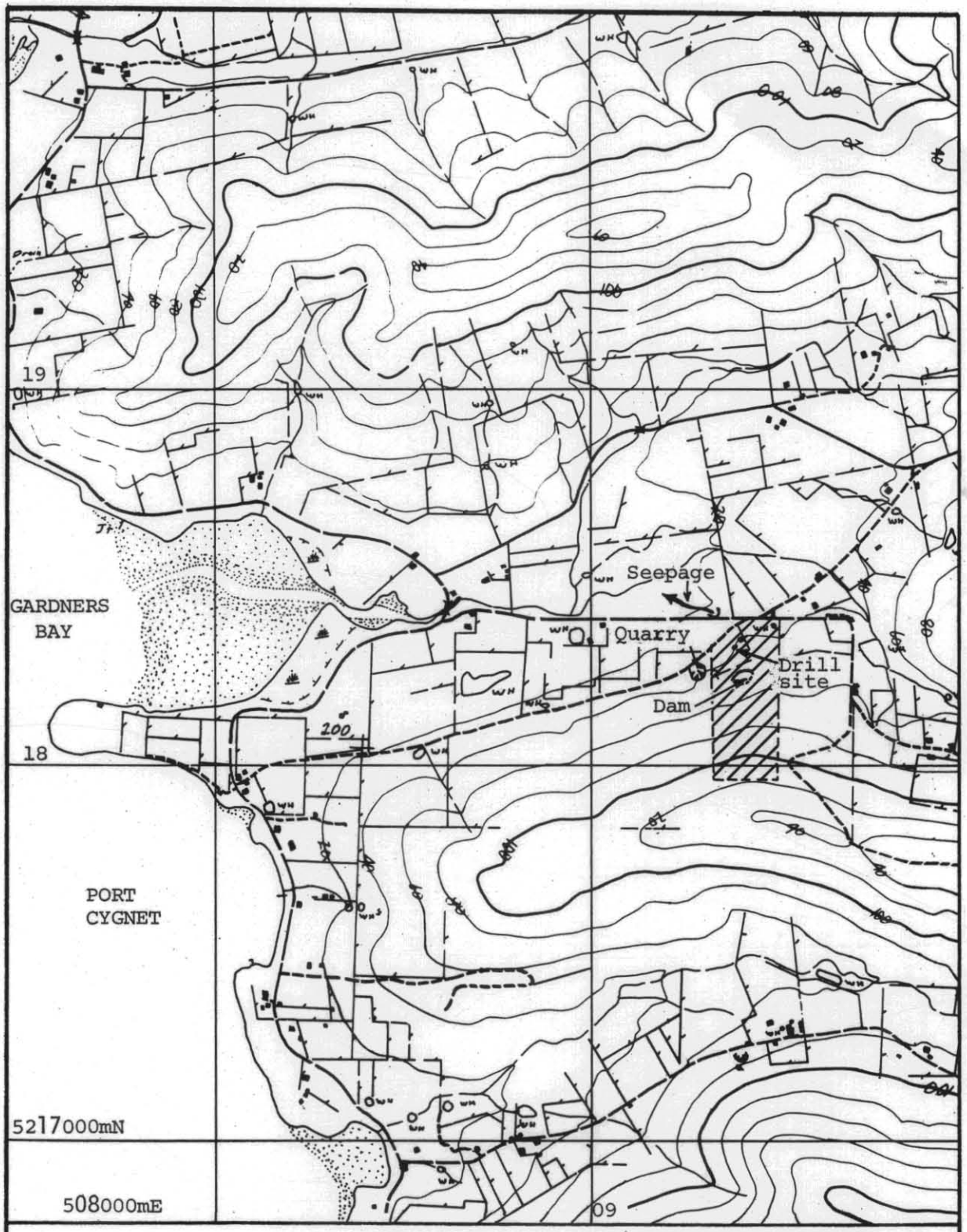


Figure 1. *Location of White's property, Gardners Bay*

Scale 1:15 840

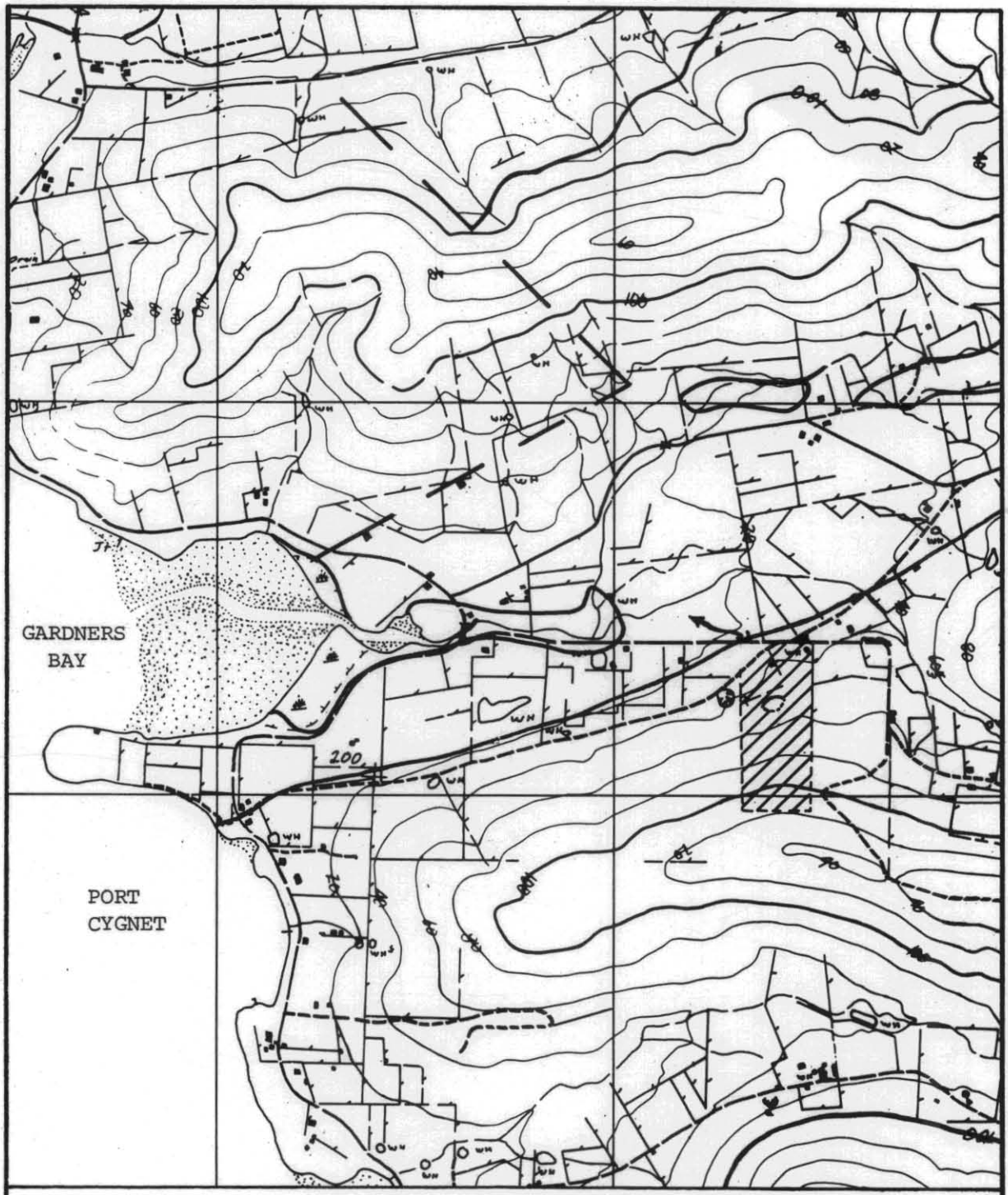


Figure 2. *Geological map of the Gardners Bay area (adapted from Farmer, 1981)*

An analysis of water obtained from the seepage area (Appendix 2) indicates that the water is of average quality (1100 mg/*l* TDS). The water is classified as Class 3 (Hart, 1974), suitable for stock and irrigation provided the soil is reasonably free draining (Appendix 3). No deleterious effect on pasture grasses can be observed in the vicinity of the seepage. For domestic purposes, the water is of very marginal quality, but could be tolerated for short periods (Appendix 4).

The analysis of the seepage water was taken as an indication of the quality of groundwater in this area. An acceptable result indicated that further investigation was warranted. Geophysical methods were required to determine the depth of the potential aquifer, which in this area is fractured and weathered dolerite.

GEOPHYSICS

One refraction seismic spread was fired in a north-south orientation, adjacent to the homestead. The results (Appendix 5) indicate that approximately 20 m of weathered and fractured dolerite is present below the ground surface. Below this depth Permian mudstone may be present, although the existence of reasonably fresh Jurassic dolerite is the favoured interpretation. The fractured and weathered dolerite zone extends to a depth which is approximately accordant to the depths at which water has been obtained from the nearby bores.

CONCLUSIONS

The area investigated is underlain by weathered and fractured Jurassic dolerite to a depth of approximately twenty metres. Two boreholes in an adjacent area have produced reasonable amounts of good to average quality water from weathered and fractured dolerite at depths down to twenty-one metres. Analysis of groundwater from a small seepage near the area under investigation shows that the water is largely suitable for irrigation and stock purposes.

It is therefore concluded that there is a good possibility of intersecting a moderate amount of average quality groundwater at shallow depth in the vicinity of the homestead.

RECOMMENDATIONS

It is recommended that a borehole be drilled to the west of the homestead, to a maximum depth of approximately thirty metres. If this is not successful, then another site could be tried, further to the west in a small drainage hollow below the dam. Some drilling contractors offer reduced rates for 'dry' boreholes. Such a rate may possibly be negotiated if a very low quantity and quality of water is struck. The contractor should be informed of the probability of striking fractured rock which sometimes proves difficult to drill.

Despite apparently favourable conditions, drilling for groundwater is often risky. There is always the possibility of striking little to no water or obtaining water of unsuitable quality.

REFERENCES

FARMER, N.F. 1981. Geological atlas 1:50 000 series. Zone 7 Sheet 88 (8311N). Kingborough. *Department of Mines, Tasmania.*

HART, B.T. 1974. A compilation of Australian water quality criteria. *Tech.pap.Aust.wat.Resour.Counc.* 7.

MATTHEWS, W.L. (in prep.) The geology and groundwater resources of the Longford Tertiary Basin. *Bull.geol.Surv.Tasm.* 59.

[4 March 1982]

APPENDIX 1

Borehole information from a dolerite area one kilometre east of White's

Name	*Total depth (m)*	*Depth water struck (m)*	*Quantity (l/min)*	*Quality (µS)*	*Rock type*
Tonks	18	6-17	76	440	Dolerite
Beltz	23	15-21	182	720	Dolerite

APPENDIX 2

Analysis of seepage water, White's farm

Registered No.	814502
Owner	Bill White
Locality	Gardners Bay, Cygnet
pH	7.0
Conductivity (µS/cm)	1370
Item (mg/l)	
CO_3	Nil
HCO_3	465
Cl	330
SO_4	55
SiO_2	40
Ca	110
Mg	79
Fe	<0.1
Al	<0.2
K	2.1
Na	100
Total dissolved solids	1130
Alkalinity (as $CaCO_3$)	380
Permanent hardness	220
Temporary hardness	380
Sample date	17.11.1981

APPENDIX 3

Relative tolerances of crop plants to saline irrigation water (from Hart, 1974)

Water Class	EC (uS/cm at 25°C) (TSS in mg/l)	Suggested Plants				Precautions for Irrigation Use(b)
		Pastures and Fodders	Fruit	Vegetables	Ornamentals	
Class 1 Class 2	0-800 (0-500)	Ladino clover Red clover Alsike clover White Dutch clover Subterranean clover	Persimmon Loquat Passionfruit Strawberry Avocado Almond Apricot Peach Plum Lemon Grapefruit Orange Grape Walnut*	Parsnips Green beans Celery Radish Cucumber Squash Peas Onion Carrot Potatoes Sweet Corn Lettuce French beans*	Violet* African violet Primula Gardenia Begonia Azalea Camelia Magnolia Fuchsia Dahlia*	Avoid wetting leaves on hot dry days
Class 3	800-2300 (500-1500)	Cocksfoot Perennial ryegrass	Mulberry Apple Pear Rasberry* Quince*	Cauliflower Bell pepper Cabbage Broccoli Tomato Broad beans* Field beans* Sweet potato* Artichoke*	Geranium Gladiolus Bauhinia Zinnia Rose Aster Poinsettia Musa Podocarpus	Avoid wetting leaves during daytime Avoid light, frequent waterings Water quickly and use continuous-wetting sprinklers if wetting the leaves

Appendix 3 (continued)

Water Class	EC (uS/cm at 25°C) (TSS in mg/l)	Suggested Plants					Precautions for Irrigation Use[b]
		Pastures and Fodders	Fruit	Vegetables	Ornamentals		
Class 4	2300-5500 (1500-3500)	Oats (hay) Wheat (hay) Rye (hay) Lucerne Sudan grass Paspalum dilatatum Strawberry clover Sweet clovers Millet Wimmera ryegrass Rhodes grass Couch grass Barley Birdsfoot trefoil	Olive Fig Pomegranate Cantaloup*	Spinach Asparagus Kale Garden beets Gherkins*	Stock Chrysanthemum Carnation Hibiscus Oleander Bougainvillea Vinca Aus. Hop Bush *(Dodonea attenuata)* Coprosma (green and variegated) Japanese Pepper *(Schinus terbinthifolius)* *Ficus spp.* in general *Ficus hillii* False acacia *(Robinia pseudoacacia)* Queensland Pyramid Tree *(Lagunaria patersonii)* N.Z. Christmas bush *(Metrosideros tomentosa* False mahogany *(Eucalyptus botryoides)* Rottnest ti-tree *(Melaleuca pubescens)* *C. cuppressiformis* Rottnest cyprus *(Callitris robusta)* *Acacia longifolia* Buffalo grass Kikuyu grass Portulaca Mesembryanthemum Boobyalla *(Myoporum acuminatum)* Morrel *(E. oleosa)* Swamp yate *(E. occidentalis)* York gum *(E. loxophloeba)* Couch grass Bamboo Kondinin blackbutt *(E. kondininensis)* Native pine *(Actinostrobus pyramidalis)*	Avoid wetting leaves of most plants where possible Adequate leaching necessary
Class 5	Above 5500 (Above 3500)	Seashore paspalum *(Paspalum vaginatum)* *Puccinella ciliata* Salt water couch *(Sporobolus virginicus)*	Date palm		Canary Palm *(Phoenix canariensis)* *Paspalum vaginatum* (lawns) Salt sheoaks *(Casuarina cristata)* Salt sheoaks *(Casuarina glauca)* Salt river gum *(Eucaluptus sargentii)* Tamarisks (evergreen and deciduous) Saltbushes	Do not wet leaves where possible Excellent drainage and leaching essential

Appendix 3 (continued)

(a) Data from Malcolm and Smith, 1971

(b) - The plant and water groupings are not meant to be rigid, but merely to provide a general guide.
- Plants are arranged in approximate order of salt tolerance in each column, with the least tolerant at the top.
- Soil texture and drainage may be extremely important.
- Plants listed as suitable for saline water will grow better with less saline water.

* Data from South Australian Department of Agriculture, 1968 (Horticultural Branch)
See also Appendix D; AWRC, 1969; Ham, 1970; Richards, 1954; *Salt Tolerant Plants*, A Review of CSIRO Research, Personal Communication, CSIRO, 1972

Guide to Permissible Number of Irrigations with Brackish Water Between Leaching Rains

Irrigation Water		Number of Irrigations for Crops Having:		
Total Soluble Salts (mg/l)	Electrical Conductivity (mS/cm)	Good Salt Tolerance	Medium Salt Tolerance	Low Salt Tolerance
640	1	No limit	15	7
1 280	2	11	7	4
1 920	3	7	5	2
2 560	4	5	3	2
3 200	5	4	2-3	1
3 840	6	3	2	1
4 480	7	2-3	1-2	0
5 120	8	2	1	0

Source: Lunin et al., 1960

APPENDIX 4

Recommended quality limits for drinking water+

Substance	*Maximum acceptable concentration*	*Maximum allowable concentration*
Total solids	500 mg/*l*	1500 mg/*l*
Colour	5 units*	50*
Turbidity	5 units†	25†
Taste	Unobjectionable	-
Odour	Unobjectionable	-
Iron (Fe)	0.3 mg/*l*	1.0 mg/*l*
Manganese (Mn)	0.1 mg/*l*	0.5 mg/*l*
Copper (Cu)	1 mg/*l*	1.5 mg/*l*
Zinc (Zn)	5 mg/*l*	15 mg/*l*
Calcium (Ca)	75 mg/*l*	200 mg/*l*
Magnesium (Mg)	50 mg/*l*	150 mg/*l*
Sulphate (SO_4)	200 mg/*l*	400 mg/*l*
Chloride (Cl)	200 mg/*l*	600 mg/*l*
pH range	7.0-8.5	6. 5-9.2
Magnesium + sodium sulphate	500 mg/*l*	1000 mg/*l*
Phenolic substances	0.001 mg/*l*	0.002 mg/*l*
Carbon chloroform extract (organic pollutants)	0.2 mg/*l*	0.5 mg/*l*
Alkyl benzyl sulphonates	0.5 mg/*l*	1.0 mg/*l*

* Platinum - cobalt scale † turbidity units

Other components which may be hazardous to health are fluoride and nitrate. Fluoride in large quantities may cause fluorosis in young children and a limit of 1.5 mg/*l* is applied. A high nitrate content can also affect infants and the limit set is 45 mg/*l*. The maximum recommended bacterial content of water is an average monthly coliform content of one MPN per 100 ml.

\+ World Health Organisation. Information from Matthews (in prep.)

APPENDIX 5

Summary of refraction seismic survey results

Spread No.	Shot point distance (m)	Velocity layers (m/sec)	Calculated depth to interface (m)	Symmetry of velocity pattern	Geological interpretation of velocity layers	Remarks
1	North = 10 South = 15	V_0 = 620-870 V_1 = 1540-1700 V_2 = 3600-4000	V_0/V_1 = 4 V_1/V_2 = 20	Asymmetric 3 layer south end 2 layer north end	V_0 = soil layer V_1 = weathered and fractured dolerite V_2 = slightly weathered dolerite ?Permian	V_1 Potential aquifer of weathered and/or fractured dolerite

LOCATION GARDNERS BAY SUBURB

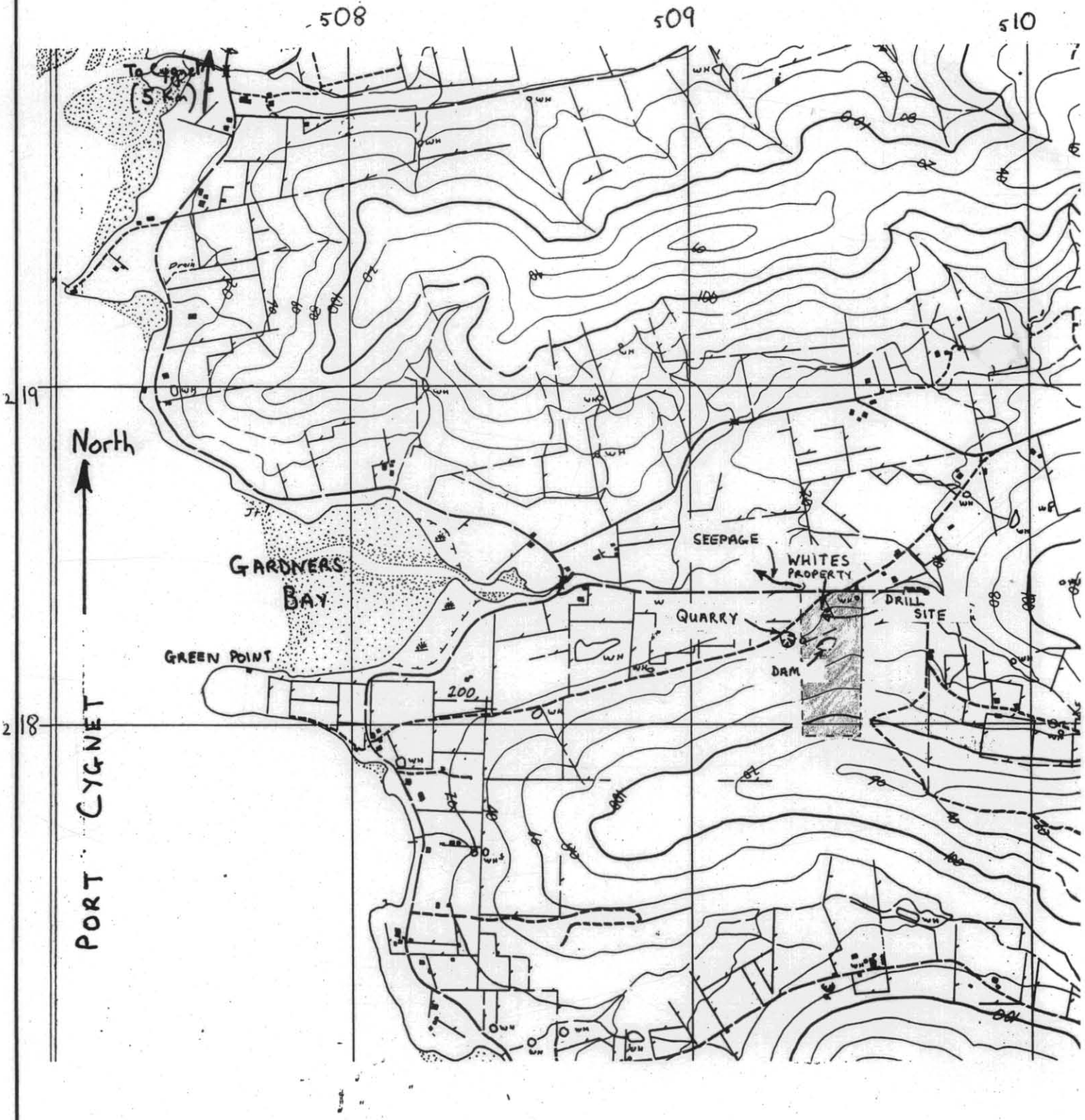
OWNER B. WHITE TOWN CYGNET

GEOLOGIST D. J. SLOANE

DATE 16/2/'82

12/13

FIGURE 1



SCALE 20 chs = 1 inch.

LEGEND

20° Slope angle and direction

Change of slope - downslope side indicated

Change of slope - upslope side indicated

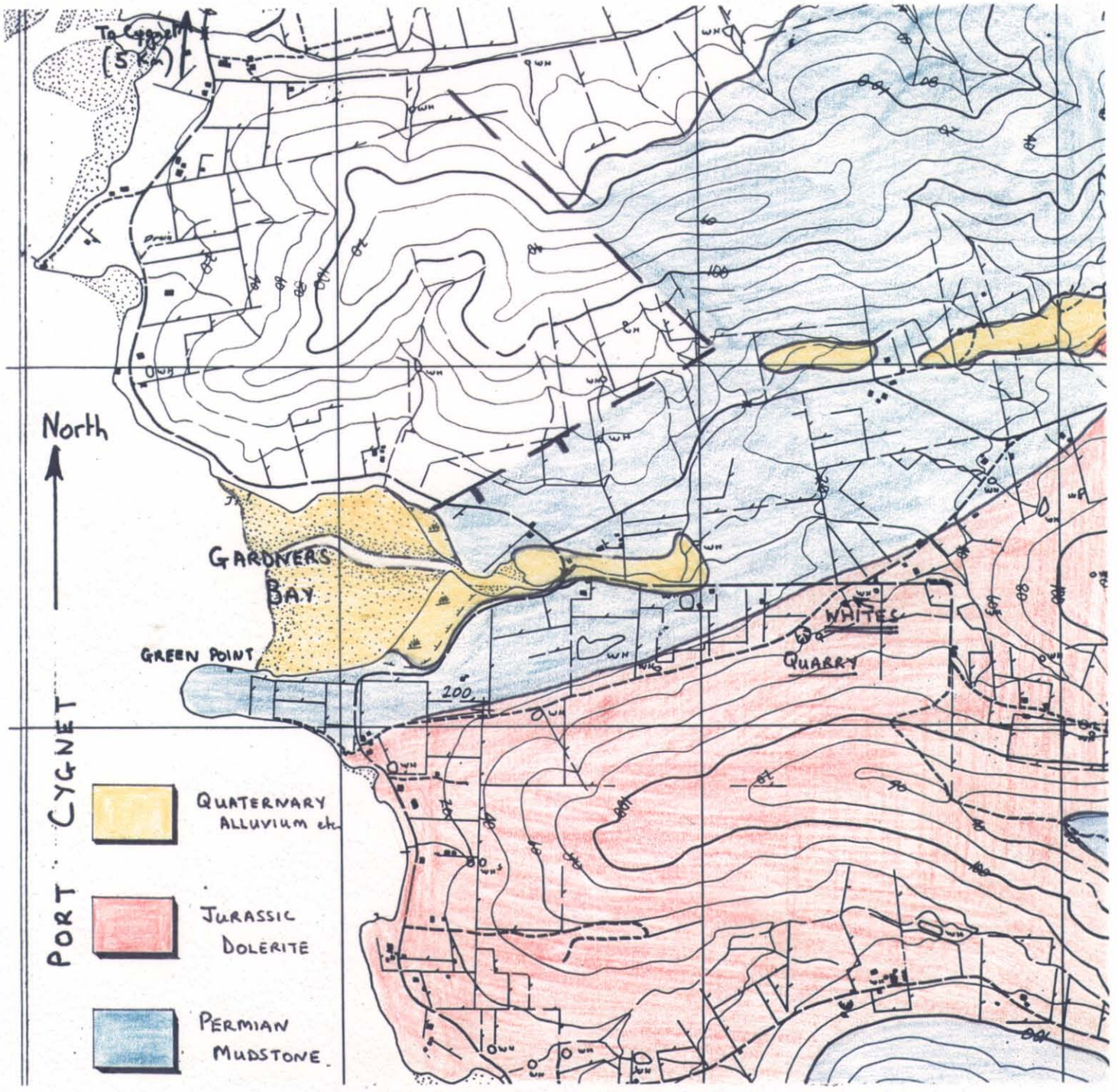
Area in which building advised

" " " septic tank "

5 cm

LOCATION GARDNERS BAY SUBURB	GEOLOGIST D. J. SLOANE
OWNER BILL WHITE TOWN CYGNET	DATE 16/2/'82

FIGURE 2



Adapted from FARMER (1981) - KINGBOROUGH GEOLOGICAL MAP SHEET.

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SCALE 20chn = 1 inch

LEGEND

- 20° Slope angle and direction
- Change of slope - downslope side indicated
- Change of slope - upslope side indicated
- Area in which building advised
- " " " septic tank "

5 cm