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Witton Bluff Management Strategy

STUDY REPORT

1.9.83

½ revetment = $150,000
+ fill = $600,000 $15/m³

PAK-POY & KNEEBONE PTY LTD

THE CORPORATION OF
THE CITY OF NOARLUNGA

WITTON BLUFF
MANAGEMENT STRATEGY
Study Report

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October, 1982

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1.0 INTRODUCTION

1.1 HISTORY OF DEVELOPMENT

Witton Bluff is a prominent and scenic headland separating the beach-side suburbs and resorts of Port Noarlunga and Christies Beach south of Adelaide.

The Bluff itself is flanked by cliffs approximately 30 metres high which gradually reduce in height away from the Bluff. The cliffs extend northwards for about 500 metres to near Short Street in Christies Beach and southwards for a similar distance to the Port Noarlunga jetty at Saltfleet Street.

Early photographs of settlement of the area show that by 1924 very few houses occupied the heights behind the Bluff. In 1936, Witton Road was clearly evident on aerial photography, but still there was no continuous roadway around the top of the cliffs between Port Noarlunga and Christies Beach. Esplanade allotments between Saltfleet Street and Murray Road in Port Noarlunga had been largely built up, but almost no development existed between Murray Road and Beach Road, Christies Beach. Hence, the intensive development evident today virtually post-dates the 1939-1945 World War.

The existing Esplanade alignment was clearly not originally established as a main connecting roadway - Witton Road served this function - and right-of-way width is restricted to as narrow a width as 15 metres in places, one boundary being the eroding cliff top.

1.2 HISTORY OF EROSION AND PROTECTION

Table Rock, a large free-standing stack off the point of Witton Bluff was a notable landmark on the coast until about 1918. In a storm or series of storms the Rock eroded away rapidly, no remnant being visible in 1924.

This event is a graphic illustration both of the power of the sea and of the erodable nature of the materials making up the Witton Bluff cliffs.

It is quite evident from the shape of the existing headland and the bays on either side, that a sequential sea stack is in the process of being formed.

From available records it has not been possible to place a direct numerical value on the rate of recession of the cliffs. However, the presence of material at beach level fallen from the cliffs above is continuously evident and confirms the active state of erosion.

In 1972-73 cracks appeared in the road pavement of the Esplanade north of Fenton Avenue, which indicated the precarious state of stability of the cliffs at that location. The apparent danger of collapse initiated the construction of a stabilising earth bank against the cliffs with a rock-protected toe. The latter was continued northwards almost to Beach Road, and southwards to a point almost directly opposite Fenton Avenue.

No other major works of protection have been carried out. However, in recognising the importance of minimising erosion of the upper cliffs, the Noarlunga City Council has carried out roadworks so as to direct stormwater drainage away from the cliffs and to control vehicular access and personal access to the cliffs. A limited programme of establishing native plants at the cliff tops has been carried out.

Protective fencing between the road and cliffs has deteriorated, permitting widespread entry to the foreshore zone.

1.3 FUNCTIONS OF FORESHORE ZONE

Witton Bluff and the surrounding areas of cliff perform three main roles which are:

- geographical
- recreational
- scientific

The first relates to the physical characteristics of the cliffs as the primary interface in this part of the coast between the sea and the land. The cliffs are constantly changing shape through the combined effects of wave action and marine scouring from below, rain water and wind erosion from above and human and animal intrusion.

The recreational value of the cliffs derives from their appearance, height, steepness and location in an area of high amenity which is perennially popular with tourists and residents.

Their scientific value, as fully discussed in latter parts of the report, is thought to be considerable.

1.4 RECREATIONAL VALUE OF ZONE

The cliffs containing Witton Bluff have considerable appeal for tourists, day trippers to the beach and residents alike. The cliffs are elevated, offering dramatic views over the coast and town and are a favourite place for windy walks throughout the year.

The cliffs are fenced with posts and cyclone wire of about 0.8 metres height, except for the top section which has a vehicle safety barrier. Several pedestrian entries are constructed. One gives access to the Captain Barker memorial obelisk at the south end of the bluff and to a timber sheltered kiosk further seaward from the obelisk. A path is constructed from the esplanade walk in front of the jetty, up to the kiosk.

With the exception of this path, most of the remaining paths are unconstructed and access the flatter sections of the bluff only which are not vegetated.

The top of the bluff is precipitous and could be dangerous to children and those unfamiliar with the area. Only one or two seats are provided, one at the top of the bluff. Pedestrians walking between Christies Beach and Saltfleet Street (opposite the jetty) must use the esplanade footpaths on the seaward or the landward side of the road. There is no safe all-weather footpath around the cliffs themselves. Only rarely, at low tide, is it possible to walk on the beach around the bluff.

Much of the more accessible parts of the bluff, especially the flatter sections to the south, are badly eroded and denuded of vegetative cover through the unrestricted entry of children and animals over the years.

The more northern section which slopes downwards towards Christies Beach is also badly eroded and the strip visible from the road is in particularly poor condition.

Overall the recreational value of the bluff is summarized as follows:-

(a) a rare and interesting geological formation with educational value;
(b) a vantage point offering particularly fine coastal views;
(c) an area of interest for passive enjoyment and for walking;
(d) an area of identification and reference along the coast and within the town;
(e) a childrens' de facto play area;
(f) a natural marine reserve.

Some of the deficiencies and difficulties associated with the bluff and cliff area in their present condition arise from:-

(a) unsightly and ineffective fencing;

(b) uncontrolled access to animals and children who hasten erosion and cause damage of other kinds;

(c) danger to children and unwary visitors arising from precipitous sections near the top which are close to the road;

(d) insufficient access to meet apparent demand;

(e) unsightliness, particularly the top parts which suffer from disturbed vegetation, a profusion of unplanned and unmaintained footpaths and accumulated litter;

(f) danger to walkers below from falling rubble;

(g) lack of an obvious and attractive footpath linkage between the Saltfleet Road/jetty area and Christies Beach, other than the Esplanade Street footpaths;

(h) strip carparking along the Esplanade during periods of tourist interest, which mask views of the cliffs and the coast beyond and detract from the natural qualities which the cliffs possess.

1.5 NEED FOR MANAGEMENT PLAN

There are strong and often conflicting pressures on the authorities in whom the responsibility for the future of Witton Bluff is vested.

These include responsibilities for public safety, public efficiency, the interests of ratepayers, conservation, tourism, public mobility and access, recreation and other similar public and private needs.

We accept that these are valid needs and set out in the remainder of the Report an evaluation of the costs and advantages related to the fulfillment of those needs which are regarded as compatible.

2.0 WITTON BLUFF - GEOLOGY AND PHYSICAL PROCESSES AT WORK

2.1 GEOLOGY

Witton Bluff is situated on the northern side of Port Noarlunga 25 km south of Adelaide. The site is located within the Noarlunga Embayment, which is bounded to the north by the Eden Burnside Fault and to the south by the Clarendon Fault (Figure 1.). This embayment is of a Tertiary age and the rock deposits are marine and fossiliferous.

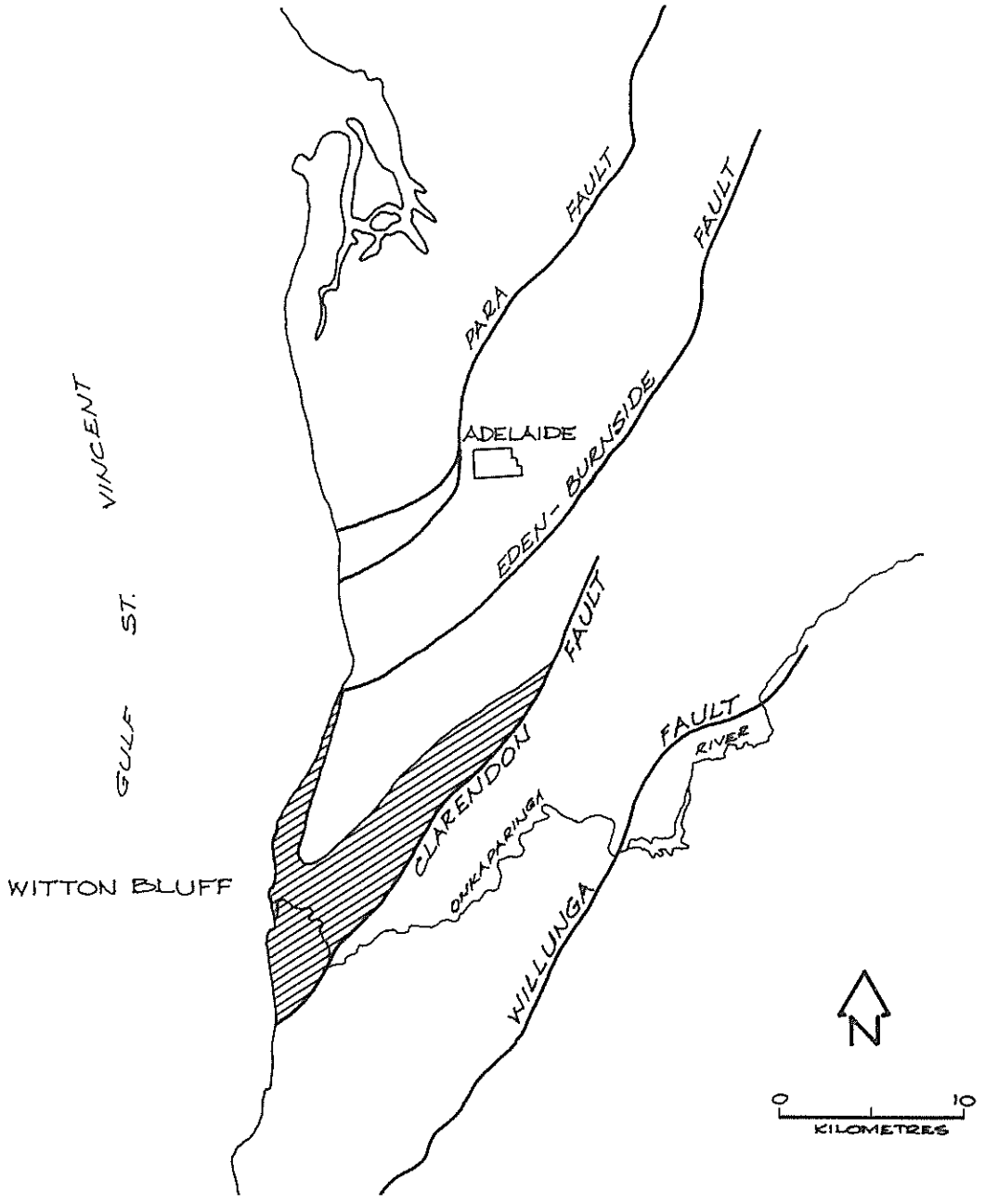
The geology of the cliff has been examined. Our field observations of the site and of other engineering structures nearby are supplemented by published data. A generalized profile of the cliffs in the study area is as follows:

A. RECENT TO PLEISTOCENE DEPOSITS (Present Day to 1 million years old)

1. Topsoil. 300 to 400mm sandy silt in thickness.
2. Calcrete (travertine). Variable thickness from being not present to 500mm in thickness.
3. Calcareous silt. Up to 3.0m in thickness.
4. Transitional calcareous silty clay. Approximately 1m thickness.
5. Mottled red-brown and grey green clay. Extend to a depth of up to 10m.

B. TERTIARY DEPOSITS (1 million to 70 million years)

1. Blanche Point Marls. Clayey siltstone and sandstones, extending over 30m in thickness.
2. South Maslin Sands. Brownish fine grained sands.



WITTON BLUFF ENVIRONS
EXTENT OF NOARLUNGA EMBAYMENT

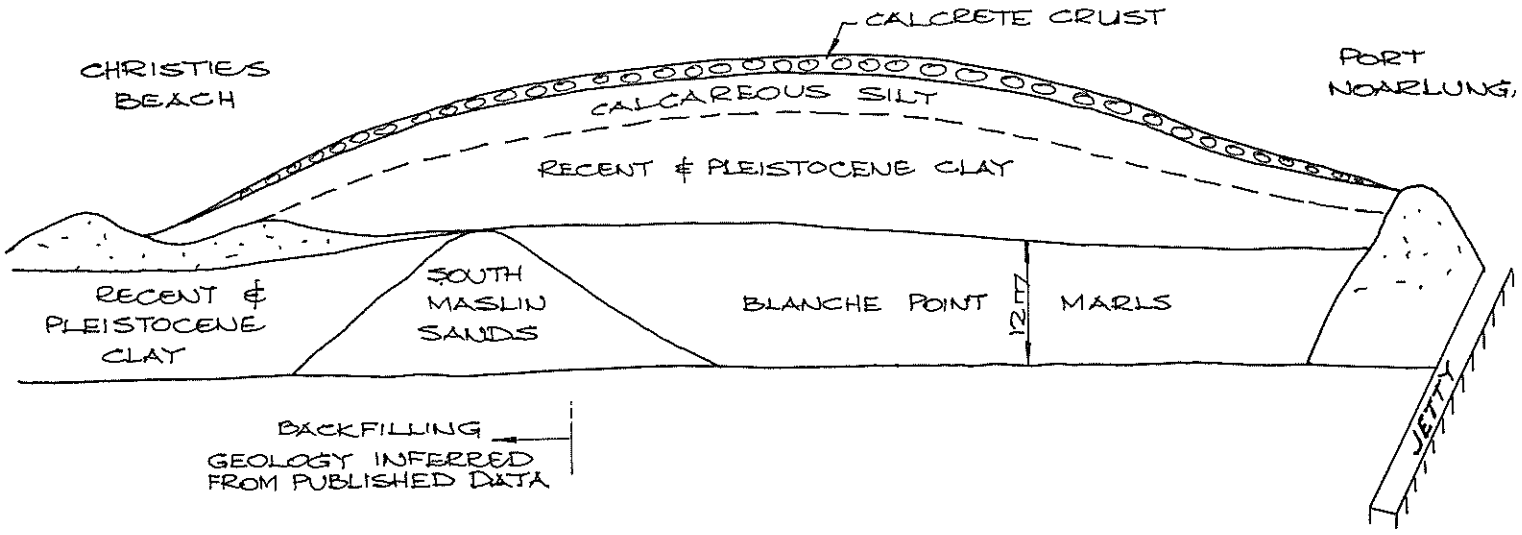
Pak-Poy & Kneebone Pty. Ltd.

Figure No. 1

A generalized geological sketch of the cliff face is shown in Figure 2. It is seen that the main Tertiary part of the cliff face consists of the Blanche Point Marls. These comprise a clayey siltstone grading to a clayey sandstone in its upper layers. The siltstone contains many fossils in the lower section of the Blanche Point Marl, this decreasing towards the upper layers. The Blanche Point Marl dips to the south-west so that to the north of Witton Bluff the base of the layer is exposed where the South Maslin Sands are present. Partly as a result of a higher strength of the Blanche Point Marl, erosion of the surface has left the Marl as scarps and terraces on the southern side of Witton Bluff.

To the north of Witton Bluff, the Tertiary South Maslin Sands are exposed, these comprising brown fine grained sand over clay. This material is easily erodable, and partly as a result the cliff headland has a deep recess cut by the sea on its northern side. Backfilling of the cliffs in 1974 has covered much of the South Maslin Sand exposures.

Overlying the Tertiary Deposits are the Recent and Pleistocene Clay, silt and calcrete crust. It is understood that prior to back-filling part of the northern side of the cliff face, a junction between the South Maslin Sands, and two layers of the Recent and Pleistocene Clays was exposed, which was a rare geological feature.



WITTON BLUFF ENVIRONS
GENERALIZED GEOLOGICAL CROSS SECTION OF WITTON BLUFF

Pak-Poy & Kneebone Pty. Ltd.

Figure No. 2

2.2 SCIENTIFIC VALUES AND THE CASE FOR AND AGAINST PRESERVATION

The strata exposed on the face of Witton Bluff, together with the strata exposed on the cliffs from the estuary near the mouth of the Onkaparinga River southwards is one of the few exposures of the rock sequence of the Noarlunga Sub-Basin. Because of this, it provides a link between the rock exposures of the Willunga Sub-Basin to the south and the Adelaide Plains Sub-Basin.

The Tertiary rocks are rich in a varied fauna of fossils, including rare bones of giant penguins (McBriar & Mooney 1977 p.50). Because of these reasons, the strata exposed on Witton Bluff have a considerable scientific and educational value.

However, because of the back-filling that has already been placed on the Northern face of Witton Bluff, much that was of a significant scientific value has been lost. As well, the same Tertiary sequence of Noarlunga Sub-Basin deposits is exposed on the south bank of the Onkaparinga River near its mouth, and a Tertiary sequence of strata (Willunga Basin) is better exposed in the cliffs of Maslin and Aldinga Bays and Blanche Point and Gull Rock. The fossils in the exposures on Witton Bluff are unfortunately not well preserved, as they are generally matted together and sometimes incomplete.

2.3 EROSIVE AGENCIES

2.3.1 The Sea

The extent of erosive damage to a shoreline is related to the severity and frequency of storms and the resistance of the shore to damage by wave action. The severity of a particular storm event will depend on such variables as wind velocity, direction and

duration which determine wave height, direction and power, the state of the tide and storm surge. The severest of storms will be less frequent e.g. the storm of 1948 which caused extensive damage to the Adelaide metropolitan foreshore was generated by winds of velocity and duration having a return period of about 60 years.

Because greatest damage is caused by least frequent storms, only very long period records of storm severity and frequency, together with detailed quantitative records of storm damage could result in a meaningful forecast of average rate of shore recession at a particular location.

At Witton Bluff, in the absence of further protective works, there are fortuitous circumstances which indicate that most rapid erosion in the future would occur right at the Bluff itself.
These circumstances are the presence of the off-shore reef at Port Noarlunga which affords protection to the cliffs further south than about 100 metres from the Bluff and the presence of more durable materials in the cliff base commencing at about the same point.

Based on a qualitative review of the available information in photographic form, we estimate that the average rate of cliff base recession in the bays described above would be about 5 metres per 100 years. Half of this recession might occur in the one extreme storm with some consequent cliff collapse which could commence to endanger the existing Esplanade roadway.

2.3.2 Wind and Rain

The Recent and Pleistocene Clay and Silts are very sensitive to moisture. In particular the clayey silt, and to a slightly lesser extent the underlying clay, lose strength when they come in contact with water. As a result, the cliff face with these exposures is readily erodible.

In this manner, rainfall has become a very significant mechanical force, creating "rain sculpture" on the softer Recent and Pleistocene deposits on Witton Bluff. Illustration of rain erosion on a considerable scale is occurring on the sea cliffs between Hallett Cove and the Onkaparinga River where because of the softer surface deposits overlying the harder Tertiary layers, rain erosion has caused a greater recession in the surface layers than the underlying layers. A platform exists on the southern side of Witton Bluff to mark the division between the lower seaworn cliff of Blanche Point Marl and the upper rain-eroded cliffs of the Recent and Pleistocene Deposits.

In several parts of Witton Bluff, the harder surface calcrete crust (or travertine) forms a ledge or platform over the underlying eroding calcareous silt.

2.4 SLOPE STABILITY

A conventional slope stability analysis was undertaken to predict the long term stability of the existing slope geometry for a range of soil parameters.

2.4.1 Method of Analysis

The calculation of the slope stability safety factors proceeded in two stages. A semi-manual method adopted with good results in a previous study was initially used to gain insight to the problem in hand. Finally a more complete analysis was performed using a bureau package.

The semi-manual method assumes that the failure surface is an arc of a circle.

The factor of safety against sliding for a particular failure surface is defined as the ratio of the moment of the available shearing forces on the trial failure surface to the net moment of the driving forces. The free body above the failure surface is divided into slices and the following three basic assumptions are made:-

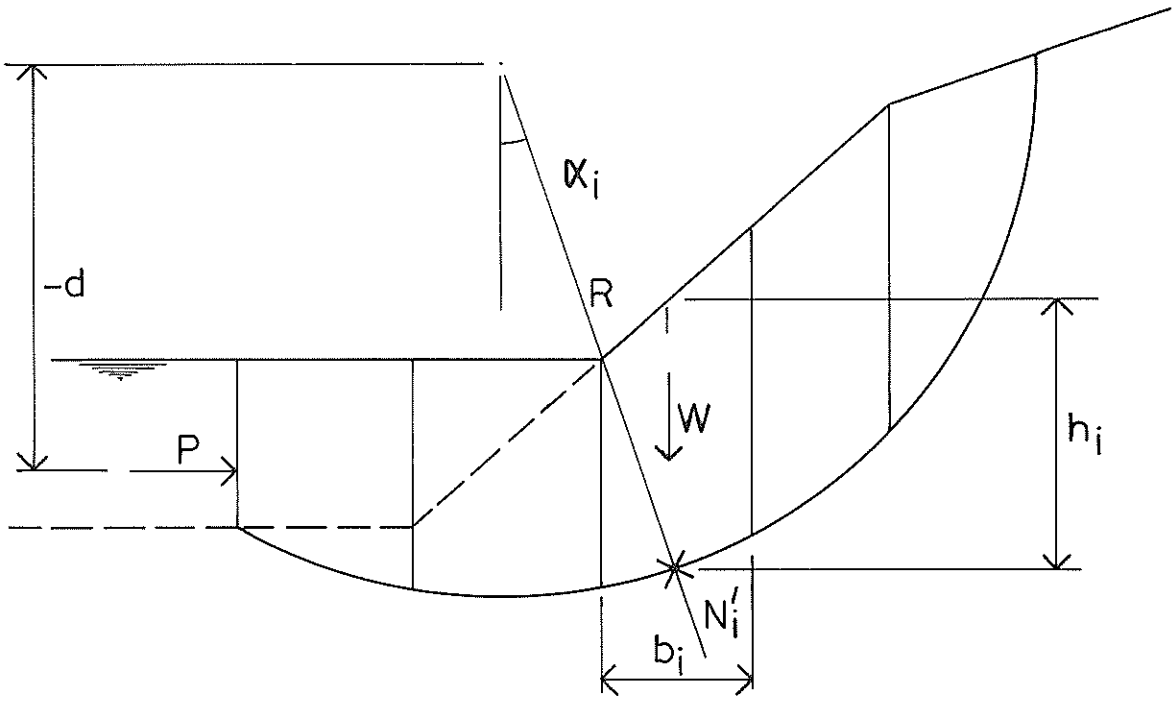
(a) The available shear strength of the soil can be adequately described by the Mohr-Coulomb equation: $S = c' + (\sigma - u) \tan \phi'$.

(b) The factor of safety is the same for all slices.

(c) The factors of safety with respect to cohesion (c') and friction ($\tan \phi'$) are equal.

A typical example of a slice (i) in a slope failure analysis is shown in Figure 3. The factor of safety against sliding is computed as follows:-

$$\text{Factor of Safety, } FS = \frac{\Sigma\ (c' \times b \times \sec \alpha + N' \times \tan \phi')}{\Sigma\ (W \times \text{siu } \alpha + Pd/R)}$$



WITTON BLUFF ENVIRONS
TYPICAL SLOPE
FORCES & GEOMETRY FOR TYPICAL SLICE

Pak-Poy & Kneebone Pty. Ltd.

Figure No. 3

where c', ϕ' = effective strength parameters,
N' = effective normal force,
P = external force.

For this project, the Normal Method of analysis was chosen, in which all forces, both shear and normal, on the side of the slice are ignored.

Pore pressure is neglected and effective strength parameters are taken as equal to total strength values.

In addition, no external forces are considered in the computation.

Thus, $N = W \times \cos \alpha$

and

$$FS = \frac{\Sigma \quad c \times b \times \sec \alpha + \quad W \times \cos \quad \times \tan \phi)}{\Sigma \ (W \times \sin \alpha)}$$

2.4.2 Computation

The slope was drawn to scale, a trial failure circle chosen and the slope above the failure surface divided into a number of slices. Usually five slices were taken, but this was varied according to the geometry of each case. The slice geometry was scaled off the drawing and input to a computer program for calculation of the factor of safety.

A number of trial circles were attempted for each centre point until a minimum factor of safety was approached for that point.

The large number of scale drawings required for each analysis forced the consideration of available computer programs on bureaus. SLOPE II controlled by the Control Data Corporation was the most readily available program offering features far in excess of the problem at hand. Data preparation was concise with a relatively low cost run time for the large number of slip circles analyzed. With six methods of analysis available as options the Simplified Bishop Method was chosen.

Input data required to define the geometry of the problem consists of the batter and height of the slope and the soil strata properties.

For analysis the soil was considered as homogeneous with design parameters of:

Soil Unit Weight	18 kN/m^3
Cohesion	5 kPa
Angle of Friction	35 degrees

This was considered the worst case corresponding to a saturated soil. The analysis was repeated for the case corresponding to a dry soil with the following parameters:

Soil Unit Weight	18 kN/m^3
Cohesion	100 kPa
Angle of Friction	35 degrees

Three slopes of varying height and batter were considered critical and requiring analysis. Each of these was run for the two different sets of design parameters.

The results of the computer runs are included in the Appendix.

2.4.3 Results of Analysis

The results indicate that for the dry soil properties, the slope is stable as shown by values of factor of safety being in excess of 1.0. However, for the saturated soil, the slope is shown to become unstable with a factor of safety as low as 0.53.

The case of a completely saturated soil is considered over-conservative as it will be unlikely the full slope will become saturated. However, the analysis does indicate that if the existing slope does become wet from any source, the potential for instability does exist.

3.0 POSSIBLE PROTECTIVE MEASURES

3.1 EROSION ZONES

The Bluff and adjacent cliffs are under active erosion both at their base by the sea and at higher levels by rain, wind and non-natural agencies.

The natural erosion regime is such that a rapid recession of the cliff face in the immediate vicinity of the Bluff could occur at any time in the event of a strong storm or particularly the succession of two or more such storms. This would occur both through the marine and wind-driven rain agencies.

Measures that may afford protection in the two basic zones of the cliff environment, base and upper zones, are discussed separately below. At the conclusion of the Chapter combined measures combating all erosive effects are assessed.

3.2 CLIFF BASE PROTECTION

3.2.1 Marine Erosion

The disruptive effects of breaking waves are such that soft, weakly cemented rock-like materials, of which the lower cliff zone at Witton Bluff is composed, are readily eroded.

There is a wave-cut platform at about low water level facing the Bluff, extending some 80 metres seaward, which is the remnant of previous cliffs, and which now serves to cause larger waves to break some distance from the cliff face. However, energy in the broken waves running up to the cliff base at broken wave velocity is such as to cause the observed erosion.

To prevent recession at the base, this energy must be prevented from reaching the cliffs, or it must be absorbed or reflected at the cliff toe. Possible means of protection are described in the following sections.

3.2.2 Off-Shore Breakwater

The reef off Pt. Noarlunga acts as a natural breakwater which, although its top does not rise to mean sea level, does afford significant protection to the cliffs just north of the jetty. To give similar protection against the prevailing seas to all the Witton Bluff cliffs would require an additional 500 metres of breakwater extending northwards, either from the existing reef or further inshore, and having a similar top elevation.

This would cost at least of the order of $2.5 million and not afford complete protection. A higher breakwater would be much more costly and less acceptable in appearance.

3.2.3 On-Shore Protection

It is fortuitous that a resistant wave-cut platform exists at the base of the Witton Bluff cliffs. This would form a satisfactory foundation to the construction of one of several forms of toe protection to the cliffs as is evidenced by the existing revetment northwards of the Bluff.

or ordinary stone

These would include stone masonry or concrete seawalls or wave-dissipation by manufactured armour blocks such as "Tetrapods" or "Dolos".

The most economical and satisfactory of these on-shore protection methods is a form of construction similar to the existing revetment. This would comprise a revetment face of similar height to the existing, standing off from the base of the cliff with the space to the rearwards including any undercutting of the cliff, filled with suitable compacted material. The necessary filter zone would be present, to prevent washing out of finer material from behind the armoured face.

The distance that the new revetment would stand off from the base of the cliff would be such that a slope at 1½ horizontal to 1 vertical would be drawn to the 30 metre contour at the top of the cliff. This would allow the option at any time of filling against the cliff at this slope to prevent the upper zone erosion.

This construction would extend southwards from the southern end of the existing revetment and protect the two bays, one immediately north and the other immediately south of the Bluff, over a distance of about 220 metres.

Further south, the material in the lower cliffs is more resistant and the area of significant off-shore reef protection from marine attack is entered. No additional cliff-base protection is therefore required.

The top of a suitable revetment would be approximately at Elevation +6.0 metres to Australian Height Datum, similar to that of the existing construction and also similar to the height of the naturally resistant bench extending southwards, formed in The Blanche Point Marl, which would be continuous with the revetment.

Figure 4 illustrates this marine zone protection option which is estimated to cost approximately $350,000. It is noted that the possible filling against the cliff to give upper zone protection is costed separately in section 3.3.4.

3.2.4 Other Protective Measures

Other protective measures might be canvassed, such as groynes of various constructions, porous or non-porous. Major sand placement activity on the wave-cut platform might also be considered, with or without groyne construction.

None of these measures could realistically be proposed without off-shore breakwater protection since the zone is much too active in terms of concentrated wave energy and the configuration of the shore-line is most unsuited to these solutions.

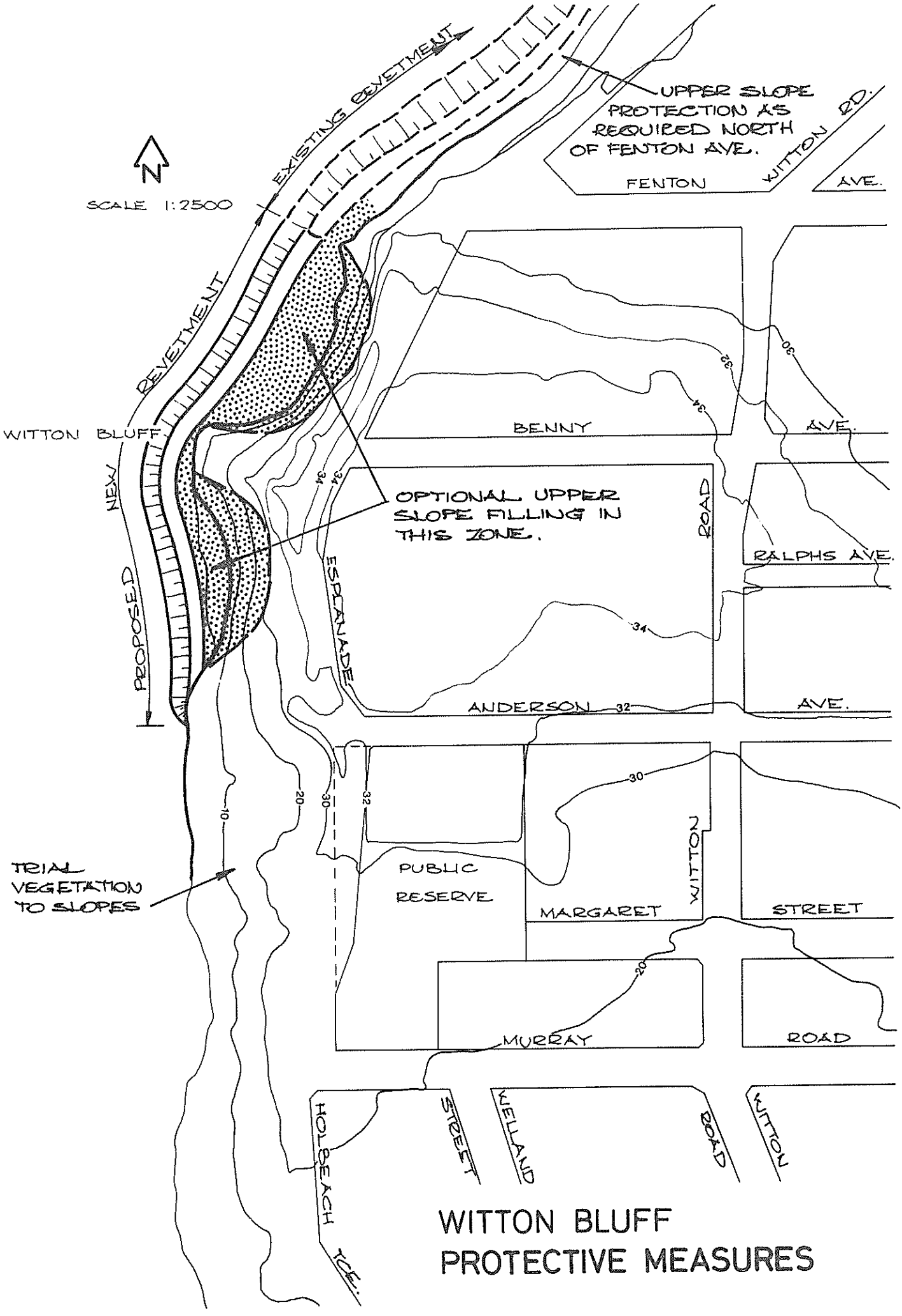
3.3 UPPER CLIFF ZONE PROTECTION

3.3.1 Propensity for Erosion

The upper zone pleistocene clays, calcareous silt and calcrete crust are vulnerable in the extreme to erosion by rain, the drying and shrinkage effects of wind and sun and further water erosion.

Without effectively blanketing the upper cliff face with some artificial protective cover, its erosion cannot be stopped. One such artificial cover is imported filling compacted against the cliff face as was carried out in the protective works in 1973. This possibility is discussed in Paragraph 3.3.4.

Other suitable measures such as planting and access control, although not able to totally prevent erosion, may slow it significantly.



WITTON BLUFF PROTECTIVE MEASURES

Pak-Poy & Kneebone Pty. Ltd.

Figure No. 4

3.3.2 Access Control

Control of random traffic by persons and animals is one positive means of slowing the erosion rate. The silty clays and calcareous silts of the slopes are so vulnerable to physical disruption that any continued access to those areas would noticeably accelerate recession of the face.

It is only the presence of the calcrete capping, and of course the paved footpath where it closely approaches the cliff top, that has prevented foot traffic from more quickly eroding the flatter cliff-top areas.

It is vital therefore that no access be allowed that would tend to abrade the more durable calcrete and hard soil capping materials forming much of the area at or just below road level. Not even boarded walkways or paved areas should be introduced as they break into the surface or concentrate stormwater run-off and thereby hasten erosion.

3.3.3 Vegetation

The existing slopes contain areas of South African Boxthorn (Lycium Ferocissium) which, from an examination of aerial photographs, have been established for some time. These have tended to have stabilized localized sections of the upper slope, but there is a general continuing erosion and scouring of the face of the slope.

Numerous native plants are suitable for this area of South Australia, however, not on an eroding soil which is also exposed to salt spray. Our information from the Woods and Forests Department, The Botanic Gardens, and the Botany Department of the University of Adelaide, indicates that it will be difficult for long term stabilization of eroding slopes of "collapsing" silt and clay using vegetation.

In any case, the establishment of vegetation could aggrevate the existing problem by altering the slope drainage with its root system, leading to moisture accumulation adjacent to the root zone and leading to soil softening. This is in contrast to the more familiar coastal conditions where the soil type is predominantly a sand dune.

However, it is recommended that a trial area become established using the following plants and the success of each species determined for propagation on a larger scale.

Trees	Shrubs	Ground Covers
Acacia sophorae	Leptospermum laevigatum	Myoporum parvifolium
Myoporum insulare	Nitraria schoberi	Kunzia pomifera
	Acacia ligulata	Goodenia amplexans
		Scaevola crassifolium

The area selected for the trial should be one of varied and difficult terrain.

3.3.4 Filling Against Cliff

When the earlier revetment work was carried out at the Bluff, the most vulnerable cliff section was blanketed by earth filling to stabilize it and prevent erosion. This work should now be completed where applicable over the sections of the existing revetment between Fenton and Short Streets at an estimated cost of $40,000.

A similar solution to the erosion of the steep cliffs both sides of Witton Bluff is feasible, with filling extending to the cliff top above the berm previously described in Section 3.2.3. The estimated cost of this option is $900,000.

3.4 COMBINED PROTECTIVE MEASURES

The possible means of protecting the base of the Witton Bluff cliffs were reduced in Section 3.2 to two, viz. off-shore breakwater and on-shore revetment. Of the two, the latter is directly applied at the site of the erosion and is of far lesser cost.

This cliff toe protection by itself will not prevent recession of the steep cliffs between Anderson and Fenton Avenues, since upper zone erosion will continue. Its function would be to remove the possibility of a serious cliff collapse endangering the Esplanade roadway in the event of a severe storm and therefore must be considered as a matter of public safety.

Other measures of less urgency but designed to slow or prevent where possible the upper cliff erosion should also proceed. These comprise the completion of filling above the existing revetment between Fenton Avenue and Short Street to stabilize the roadway edge, measures to control access and an area of trial vegetation in the slopes opposite the caravan park.

If no cliff recession is to be allowed in the immediate vicinity of the Bluff then filling against the upper cliff in the zone indicated on Figure 4 is the only course. This, together with the other measures described above, would avoid eventual disruption of the existing Esplanade roadway but would mask the existing natural formations and therefore be at considerable cost to the environment.

If filling is not carried out against the cliffs at the Bluff, but with all other measures carried out, consideration must be given to alteration to existing land use above the Bluff between Anderson and Fenton Avenues to provide for the future recession of the cliff.

It is noted that in the very long term, possibly 200 to 300 years, the recession of the upper Witton Bluff cliffs would result in the loss of the scenic attractions of the present near-vertical cliff face.

Another point of note is the continuing possibility, whatever the management strategy at the Bluff, of earth or rock falls at the beach. It would be advisable to post a warning to the public near the southern point of access to the area beneath the cliffs.

RT. try to do this now! please.

4.0 PLANNING MEASURES

4.1 PUBLIC ENTRY TO FORESHORE ZONE

It is recommended that the foreshore zone between Short Street and Saltfleet Street be separated from the Esplanade and street footpath by new secure fencing approximately 1 metre high.

The memorial obelisk and shelter kiosk at the southern end of the zone should be linked to the Esplanade footpath and to the foreshore area to the south by fenced footpaths.

It is recommended that no further entry be permitted to the area of the cliffs from the Esplanade.

The proposal by Rotary Club at present before the Council is in our opinion not appropriate and should be declined by the Council.

4.2 PLANNING MEASURES AT PRESENT BEFORE THE COUNCIL

The report prepared for the Council by Wallman Planning Consultants entitled "Guidelines to Planning Issues - Christies Beach / Port Noarlunga Area" (January 1982) provides the following ideas with regard to Witton Bluff and the immediate hinterland.

(i) Under the section dealing with Heritage Items, The Geological Society of Australia SA Division, is quoted as follows:

"The whole problem of coastal erosion could be considerably reduced if an adequate width from the cliff edge, say 100 metres, was protected at the top of the cliff. Building roads and facilities so near the cliff edge not only accelerates erosion, but also makes it necessary for the preventative measures described above, which are both scientifically and aesthetically destructive. This should therefore be avoided in the future."

(ii) Roads in the area fall within four categories:

- major arterials
- sub-arterials
- major collectors
- minor roads

The Esplanade south of Beach Road is regarded as a major collector road linking with Beach Road at the northern end and Gawler Street at the southern end which are regarded as major arterials.

Witton Road is regarded as a sub-arterial road also linking with Beach Road to the north and Gawler Road to the south.

(iii) Witton Bluff is mentioned under ecologically sensitive areas. The report considers that plants are difficult to grow in the marine environment, depending on the depth of soil formed by the parent rock. The Council should act accordingly. Depauperate plants are normal to the area.

(iv) Under Policy Precinct 2 - the foreshore area, the report notes that the north of the precinct bounded by Beach Road is characterised by untidy shack development.

The report observes that:

"Witton Bluff itself is subject to massive undercutting erosion caused by the waves as well as surface erosion which results from the continued usage of the Explanade as a main thoroughfare offering large areas for carparking close to the cliff face where people can freely walk, thereby adding to the problem by destroying slowly what little stabilising vegetation that is left,"

and recommends:

- *"The Esplanade should be closed to through traffic between Fenton Avenue and Murray Road this being the sensitive area over Witton Bluff. However, a small 5 metre carriageway should be retained furthest away from the cliff face to enable frontage allotment residents access to their properties.*

- *Intensive cliff top vegetative covering is needed to help prevent further surface erosion. Access to this area should be strictly prohibited.*

- *Promote Witton Road as the new main thoroughfare between Beach Road and Port Noarlunga in preference to the Esplanade.*

- Relocate the existing bowling green and caravan park from Witton Bluff to the proposed town park. This vacant area then would be ideal for the development of tourist accommodation, as it is in close proximity to tourist related services as well as affording a panoramic view of the southern coastal area. Careful consideration must be given to any redevelopment proposal over this land in order that a full assessment can be made of the effect of the proposal on the stability of the cliff face, the likelihood of damage to the construction should the cliff recede, and the visual impact of the development. This should also apply to the adjacent residential areas.

- Promote pedestrian and where possible, cyclist priority along the whole foreshore area especially the jetty location but not the sensitive Witton Bluff revegetation area.

- Design and construct a pedestrian lookout area at the top of Witton Bluff restricting access to all other cliff top areas. In association with the lookout area, construct parking areas at the end of Anderson Avenue, Benny Avenue and Murray Road, the latter in association with any proposed tourist accommodation complex.

- Design plans should be prepared for all car parking areas along The Esplanade and reference should be made to the planting programme so that tree species which are salt tolerant and give effective shade and screening are selected. Parking areas should be line-marked and any access to the beach area restricted to selected boardwalks and pathways to protect the important foredune areas.

. *Programmes associated with the protection of Witton Bluff, the deviation of through traffic around the Bluff area and any proposals made by Council for a lookout area should be made in association with the consultation with the Coastal Protection Board and the Community".*

4.3 MEASURES RELATED TO FORESHORE ZONE

The strong implication of the engineering studies described in the foregoing sections of the report is that erosion of at least the upper parts of the foreshore cliffs in that area immediately around the Bluff will continue to occur. There is no single protective measure which can be applied to the control of erosion in this area which will be both effective and fully acceptable to the community.

Planning measures must be devised which recognize the dynamic characteristics of the foreshore zone, therefore.

The overall long term strategy for the foreshore zone is the threefold one of protecting the cliffs and bluff from the destructive effects of public usage, encouraging and providing for the orderly enjoyment of the whole foreshore zone by the public, and planning to meet the long term impact of cliff erosion on adjoining land use.

The first two of these parts of the strategy involve a mixture of immediate and longer term measures related to the foreshore zone itself, as described in Chapter 3.0 and in section 4.1, respectively.

The third aspect of the strategy involves land use planning and management measures with wide implications for the Council. Possible measures are described below.

4.4 MEASURES RELATED TO HINTERLAND OF FORESHORE ZONE

The southern part of the foreshore zone contains rapidly eroding cliffs very close to the Esplanade. It is thought to be possible to regrade this area to about 1 in 2 slope and to fill and plant the slope with soil stabilising species. If this measure proves effective over the next five years or so in halting erosion, the Esplanade Road and frontage properties between Short Street and Fenton Avenue can remain intact. If not, then a decision must be taken on the only other practicable measure available which is the closure of this section of the Esplanade and purchase of the frontage properties.

It is recommended that grading, filling and plant stabilisation measures be tried as they have a high chance of success and, at worst, will retard erosion considerably.

There would seem to be no prospect in the long term of halting erosion of the section of cliffs between Fenton Avenue and Anderson Avenue unless the drastic engineering measure discussed in section 3.3.4 is adopted.

If this measure proves unacceptable in principle, as is likely, then a decision must be taken to close a section of the Esplanade to through traffic, and eventually to all traffic, and for Esplanade frontage properties in this section to be purchased by the Council and/or the Coast Protection Branch of the Department of Environment and Planning as they come onto the market.

The Council is likely to take the decision, unrelated to problems of the foreshore zone, to relocate the bowling club, RSL Hall and caravan park elsewhere, making available the site for alternative public use. Traffic could thereby be diverted from a section of the Esplanade to Witton Road via Fenton Avenue and Murray Road. The whole frontage land in this section could be applied to a variety of uses in the community interest.

The Council may wish for a variety of reasons not related directly to foreshore erosion to close a larger area of the Esplanade over the long term. Properties between Short Street and Saltfleet Street have been included in the appraisal of properties set out below.

4.4.1 Esplanade Properties

From the viewpoint of possible property acquisition in the future those properties with frontage to the Esplanade between Short Street and Saltfleet Street are of most interest.

They are described as follows, from north (Corner of Short Street and Esplanade) to south (within three properties of Saltfleet Street):-

No. 58 Esplanade (Ref A3)

Single storey house. Brick, more than thirty years old, in poor condition. Garden poor. Capital Value - $27,800.

No. 59 Esplanade (Ref A4)

Single storey house. Timber frame, in reasonable condition but with well maintained site. 10-15 years old. Capital Value - $35,600.

No. 60 Explanade (Ref. A5)

Two storey house. 5 - 10 years old, well maintained house and garden. Capital value - $34,200.

No. 61 Esplanade (Ref. A6)

Single storey house. Timber frame, well maintained. In excess of 20 years old. Extensive lawn. Possibly 2 flats. Capital value - $25,600.

No. 62 Esplanade (Ref. A7)

Vacant block. Unimproved value $18,600.

No. 63 Esplanade (Ref. A8)

Single storey house. Timber frame, in excess of 10 years old, in reasonable condition. Probably 2 flats. Capital value - $25,800.

No. 64 Esplanade (Ref. A9)

Single storey house. Brick, in poor to average condition. Site average. Capital value - $31,400.

No. 65 Esplanade (Ref. A10)

Two storey house. Cement block construction with timber frame section. Used as two flats. Well maintained, in excess of 15 years old. Capital value (1) $25,974; (2) $18,426.

No. 66 Esplanade (Ref. A11)

Single storey house. Brick, about 5 years old. Good state of repair but garden poor. Capital value - $29,000.

No. 67 Esplanade (Ref. A12)

Single storey house. Stone and timber frame. 5 - 15 years old, well maintained. Garden average. Capital value - $29,600.

No. 68 Esplanade (Ref A13)

Two storey house. Brick at ground level, timber frame above. Well maintained, average garden, about 10 years old. Capital value - $57,000.

No. 69 Esplanade (Ref A14)

Two storey house. Stone below, timber frame above. Maintained well. Over 10 years old. Garden average. Capital value - $58,000.

No. 70 Esplanade (Ref A15)

Single storey house. Brick construction. Average condition, poor garden. 5 - 10 years old. Capital value - $33,400.

No. 71 Esplanade (Ref B8)

Single storey house. Rendered brick, in excess of 20 years old, in poor condition. Site fairly barren. Capital value - $24,000.

No. 72 Esplanade (Ref B9)

Single storey house. Rendered solid structure, in excess of 20 years old, in average condition, recently restored externally. Capital value - $24,800.

No. 73 Esplanade (Ref B10)

Single storey house. Rendered brick or block in average condition. In excess of 20 years old. For sale. Capital value - $30,000.

No. 74 Esplanade (Ref B11)

Two storey house. Timber frame with hardboard and solid end wall. 10-15 years old in average condition. Capital value - $30,000.

No. 75 Esplanade (Ref B12)

Vacant allotment. Unimproved value - $17,000.

No. 76 Esplanade (Ref B13)

Two storey house. Cream brick house in good condition. Perhaps 5-10 years old. Currently for sale. Well maintained site. Capital value - $57,000. ask for $77,000

No. 77 Esplanade (Ref B14)

Two storey house. Timber frame with asbestos in fair condition. About 20 years old. Some recent structural improvements at front. Assessed capital value - $48,000.

No. 78 Esplanade (Ref C9)

Single storey house. Timber frame in fair condition. In excess of 20 years old. Recently painted and reroofed. Assessed capital value - $21,000.

No. 79 Esplanade (Ref C10)

Single storey house. Rendered brick in poor condition. In excess of 20 years old. Assessed capital value - $32,000.

No. 80-81 Esplanade (Ref C11)

Single storey rendered solid house. In good condition, 5-10 years old. Well maintained garden. For sale. Assessed capital value - $65,000.

No. 82 Esplanade (Ref C12)

Single storey brick, part two storey. In good condition, perhaps 15 years old. Well maintained garden. For sale. Assessed capital value - $49,000.

No. 83 Esplanade (Ref C13)

Two storey rendered brick house. In fair to average condition, about 30 years old. Assessed capital value - $46,000.

No. 84 Esplanade (Ref C14)

Two storey brick house, in good condition. About 15 years old. Assessed capital value - $48,000.

No. 85 Esplanade (Ref C15)

Single storey flats. (Ocean court). Block structure in fair condition. In excess of 20 years old. Assessed capital value each of four flats $15,600, $8,400, $15,600, $15,800 = $55,400 total.

Bowling Club (Ref D6)

Brush fence. Red brick clubhouse (15-20 years old).

Caravan Park (Ref D7)

Average condition, fairly open site. Recent internal fencing but few further recent improvements.

RSL Club Hall (Ref D8)

Brick and block single storey structure about 15 years old. Site not well developed.

No. 88 Esplanade (Ref E1)

Single storey rendered brick house in poor condition. Assessed capital value $36,000.

No. 89 Esplanade (Ref E2)

Two storey cream brick house about 5 years old. Good garden, no fence. Assessed capital value - $70,000.

No. 90 Esplanade (Ref E3)

Two storey block house in poor condition, 15-20 years old. Assessed capital value - $43,000.

No. 91 Esplanade (Ref E4)

Single storey rendered stone or brick villa in excess of 40 years old. Assessed capital value - $31,000.

No. 92 Esplanade (Ref E5)

Single storey stone and brick villa in fair condition in excess of 40 years old. Assessed capital value $38,000.

No. 93 Esplanade (Ref E6)

Single storey rendered brick house in average to good condition. Well kept site. About 20 years old. Assessed capital value - $32,000.

No. 94 Esplanade (Ref E7)

New two storey house under construction. Brown brick. Assessed capital value - $63,000.

The combined assessed value of the properties of interest along the Esplanade (all properties between Short Street and within three properties of Saltfleet Street) is as follows:-

Short Street to Fenton Avenue	
Nos. 58 - 70	$450,400
Fenton Avenue to Benny Avenue	
Nos. 71 - 77	$230,800
Benny Avenue to Anderson Avenue	
Nos. 78 - 85	$316,400

Anderson Avenue to Murray Road

Bowling Club	$ 76,600
Caravan Park	$ 47,000
RSL Club Hall	$ 12,000
	$135,600

Murray Road to Saltfleet Road (part of section)

Nos. 88 - 94	$313,000

Without the caravan park, bowling club site and RSL Club Hall which are Council owned and therefore not rated, the remaining 34 residential properties had a combined assessed capital value of $1,310,600 in mid 1981.

The Council has made available comparable unimproved land value estimates of the three Council owned properties between Anderson Avenue and Murray Road, totalling $135,600. These are regarded by Council Officers and by the Consultants as particularly conservative, even for mid 1981. The Consultants have increased the estimates by 30 per cent to better reflect likely unimproved values. (The value of the RSL Hall building is low and has been ignored). The revised mid 1981 unimproved value is therefore $176,300, which is on a comparable basis to the assessed capital values of the residential properties.

The total Council-based valuation for all the Esplanade properties under consideration at mid 1981 values is:-

$1,486,900

If the ACV is struck at approximately 75 per cent of market value and the ACVs were last reviewed in mid 1981, then allowing an annual inflation rate of 10 per cent, the present day value of the properties considered is :-

$2,280,000

in December 1982.

4.4.2 Esplanade Services and Roadway

Utilities servicing properties on the Esplanade near Witton Bluff are indicated on Figures numbered 5 to 8 and are briefly described hereunder. Services generally do not comprise large diameter mains but only sizes typically serving local streets.

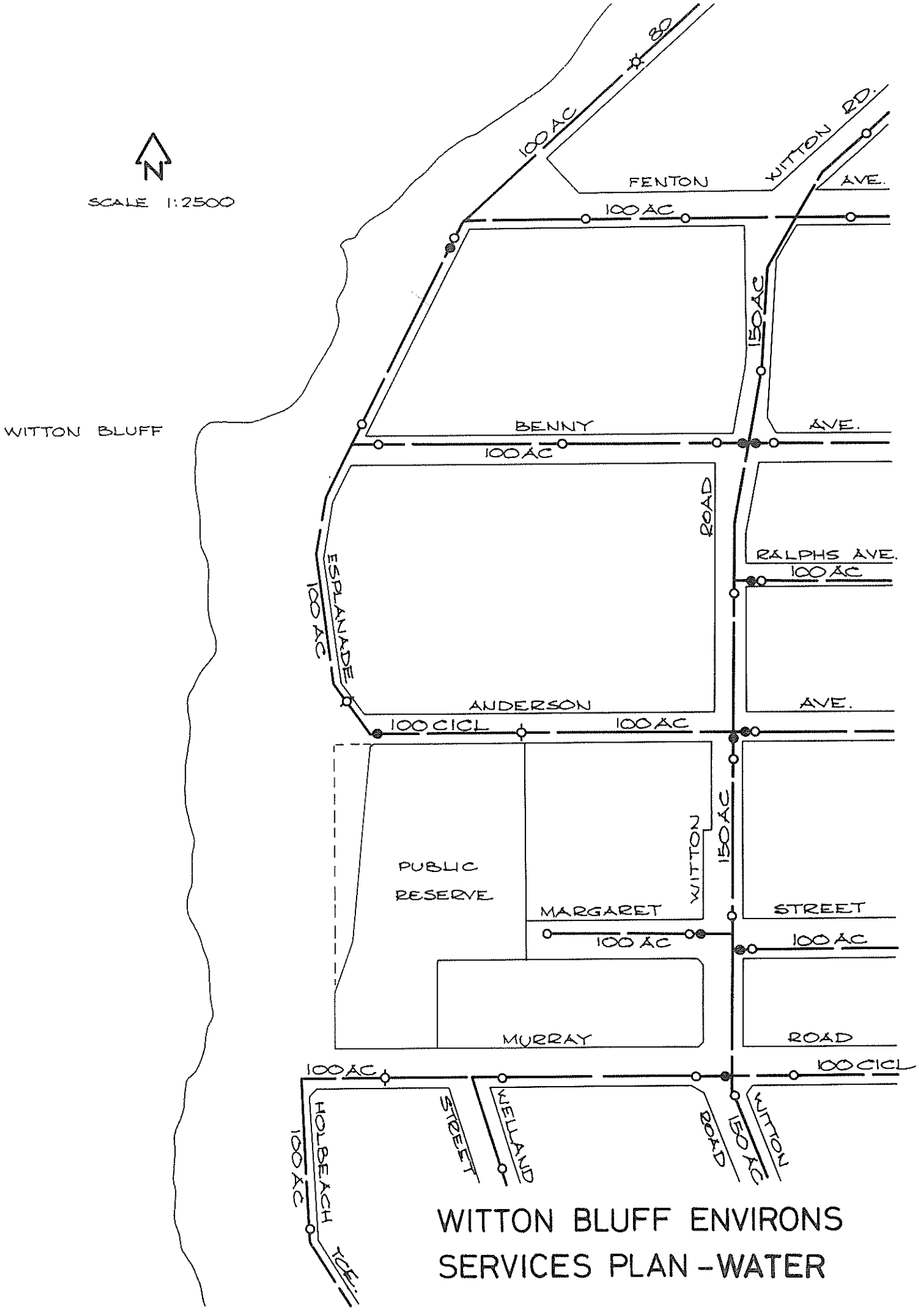
Water mains are a maximum of 100mm diameter and sewerage is 150mm diameter. Gas is generally supplied via the east-west street-system as is the Telecom service with laterals into the Esplanade. All electricity is overhead.

As an indication of the extent of public investment in services in the environs of the Bluff, the replacement cost of services on the Esplanade between Murray Road and Fenton Avenue is estimated as follows:-

		$
E. & W.S.	Water	30,000
	Sewerage	36,000
Telecom		25,000
E.T.S.A.		30,000
Gas		Nil
		$121,000

The public asset represented by the Esplanade roadway between Murray Avenue and Fenton Avenue is estimated to be approximately $250,000 for the 500 metres.

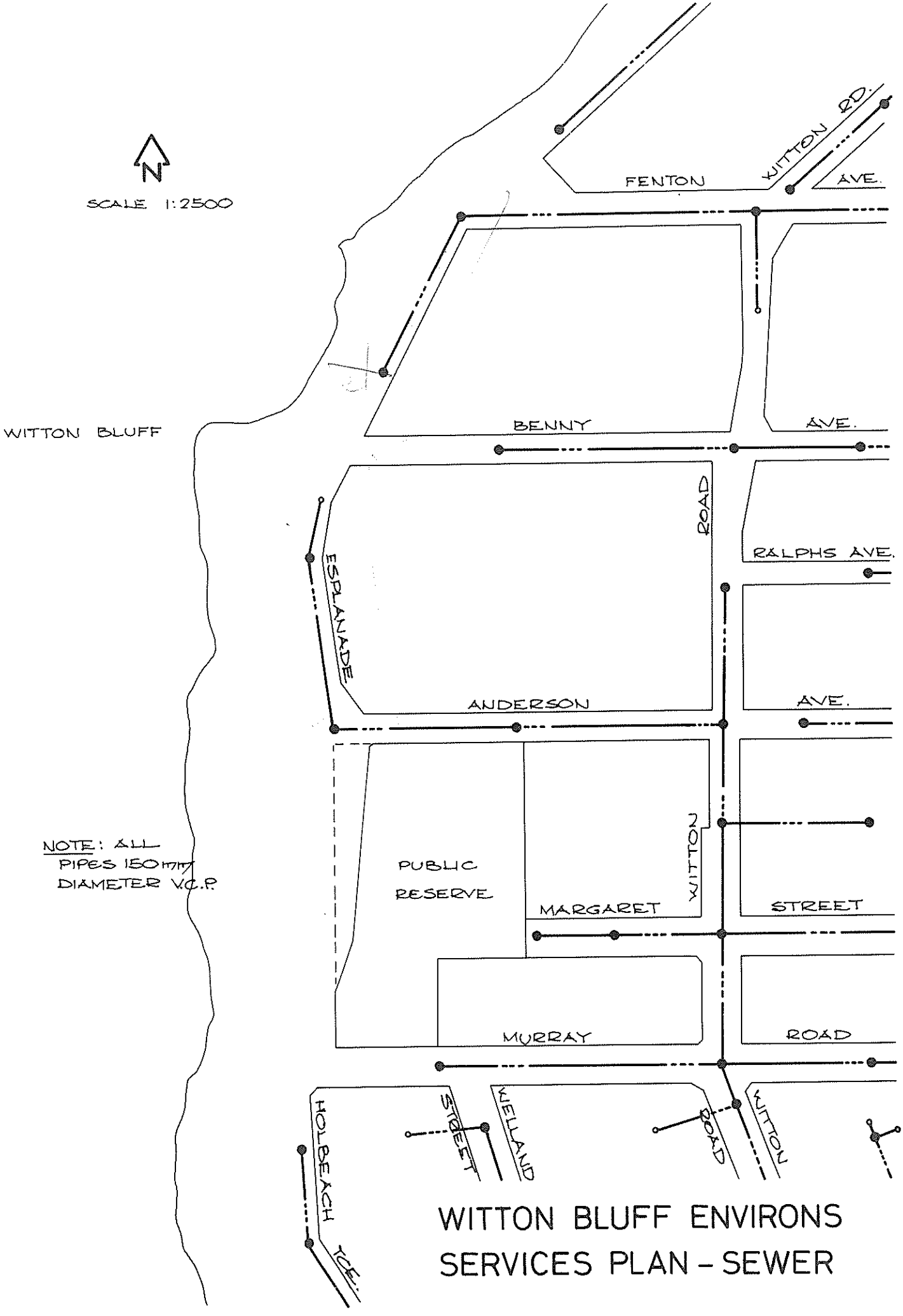
If part of the Esplanade were rendered unusable by erosion loss, then the proportionate direct loss of public asset would result. Similarly, any change in land use which resulted in obsolescence of these assets would result in loss of public asset. If this obsolescence occurred over an extended period of time, then it would be difficult to allocate a loss, since the facilities would in any case be requiring replacement or rehabilitation.



WITTON BLUFF ENVIRONS SERVICES PLAN - WATER

Pak-Poy & Kneebone Pty. Ltd.

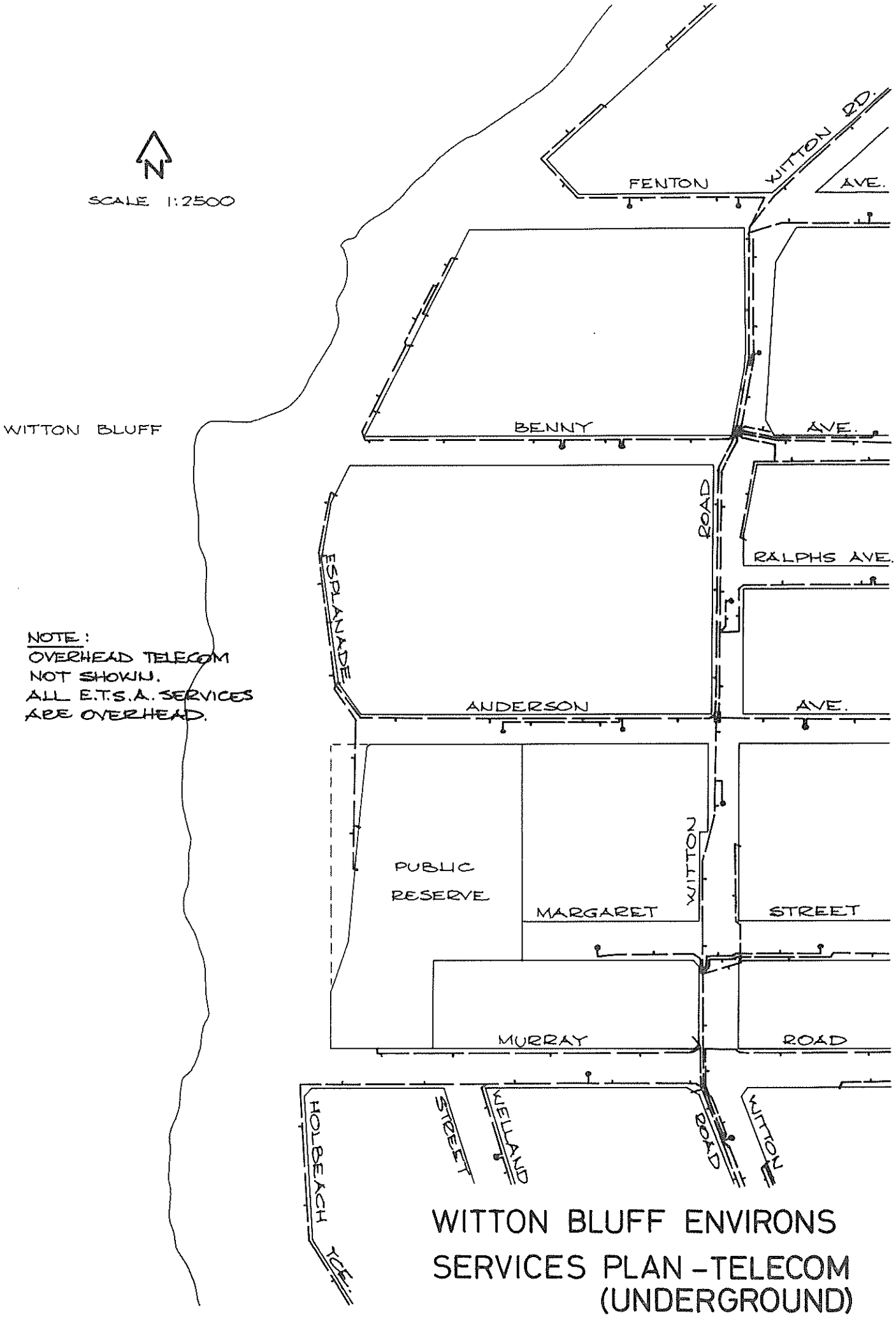
Figure No. 5



WITTON BLUFF ENVIRONS SERVICES PLAN - SEWER

Pak-Poy & Kneebone Pty. Ltd.

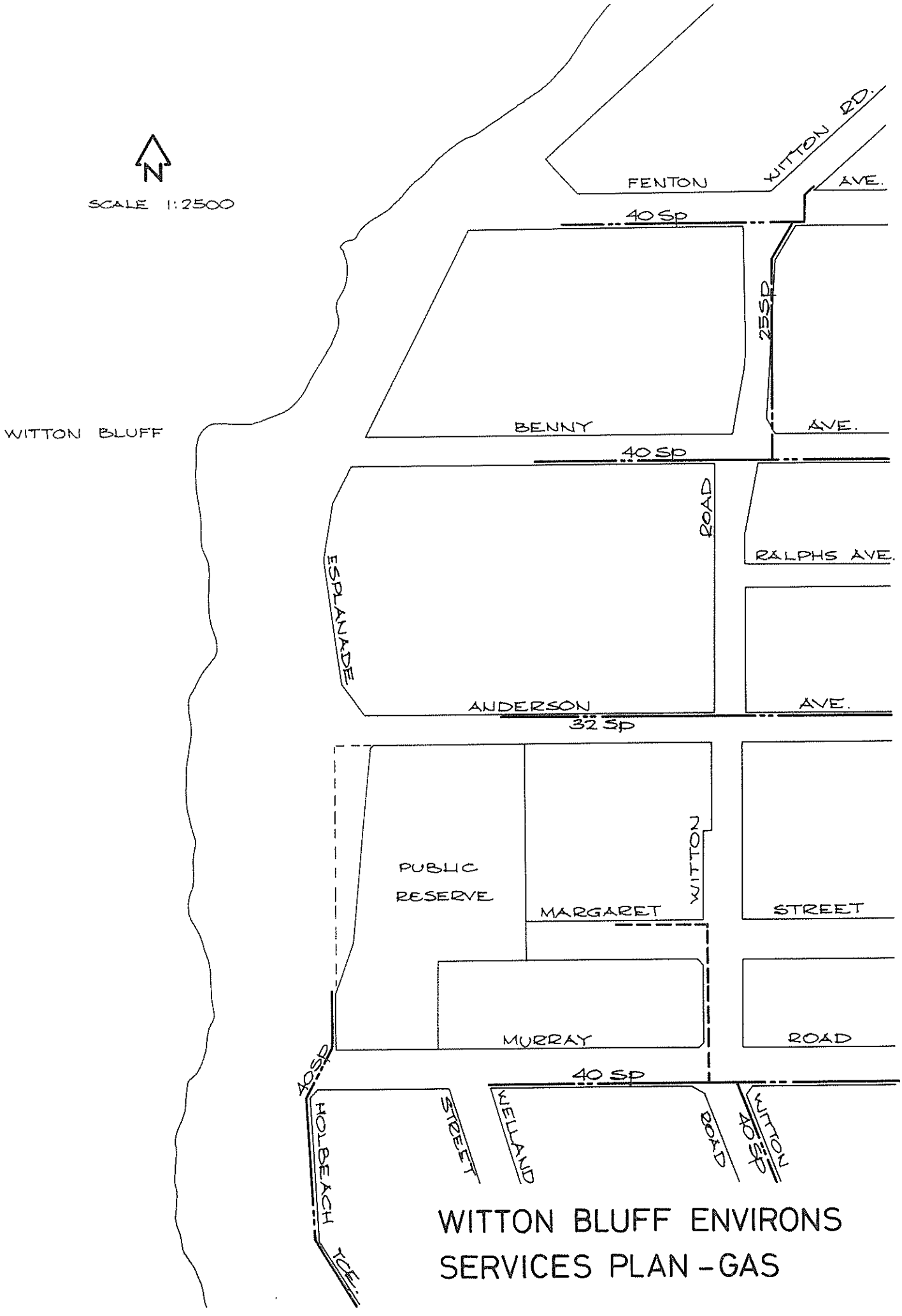
Figure No. 6



WITTON BLUFF ENVIRONS
SERVICES PLAN - TELECOM (UNDERGROUND)

Pak-Poy & Kneebone Pty. Ltd.

Figure No. 7



WITTON BLUFF ENVIRONS SERVICES PLAN - GAS

Pak-Poy & Kneebone Pty. Ltd.

Figure No. 8

4.4.3 Alternative Use of Esplanade Land

The whole of the frontage land which may eventually be acquired amounts to about six hectares. Access to the land would be from the landward side via existing east-west streets.

The site would be gradually reduced in area as the foreshore erosion proceeds inland, until a position of relative stability is reached after which further intrusions would be very slow.

Temporary uses of the land are therefore appropriate.

Clearly considerable study is needed to decide upon appropriate uses as each new property is acquired but some suggestions are as follows:

- the temporary lease or lease-back of individual residences under short term arrangements;
- dense plantations of trees selected for shelter shade and appearance;
- pedestrian footpaths;
- small barbecue areas;
- areas for concessionary uses such as kiosks, stalls, side shows and fairs;
- temporary camping area for mobile caravans and tents;
- holiday rental shacks which are owned by the Council and of demountable design;
- public carparks, toilets and change rooms;
- temporary exhibition and display areas for paintings, cottage crafts etc.

4.4.4 Traffic Management Measures

The planning report prepared by Wallman Consultants for the Council recommends the closure of the Esplanade to through traffic between Fenton Avenue and Murray Road.

The present Consultants believe it will be unnecessary to close the section between Short Street and Fenton Avenue for reasons of progressive erosion alone. Planning and traffic management factors may however favour such closure.

Whether or not the Esplanade should be closed between Murray Road and Saltfleet Street will again depend upon traffic engineering and planning factors. From an ecological viewpoint it will probably be unnecessary except in the very long term.

For purposes of illustrating logical phases in the planning process it is assumed that the Council will decide to close eventually the Esplanade between Fenton Street and Murray Road only.

4.4.5 Phasing of Planning Measures

There appear to be three logical groups of actions related to the hinterland which fall roughly into phases, although a degree of overlap between the phases is envisaged:-

PHASE A

1. Relocate bowling club and public caravan park as recommended by others;

2. Purchase frontage properties between Fenton Street and Anderson Avenue (or within a wider band) which come onto the market;

3. Lease-back or lease out residential properties under short term arrangements;
4. Begin property acquisition for upgrading of Witton Road;
5. Reconstruct fencing on the foreshore zone;
6. Introduce pilot planting project around Witton Bluff;
7. Fill and plant northern section of Foreshore zone above existing revetment;
8. Introduce "no development" form of zoning over frontage properties. down zoning!

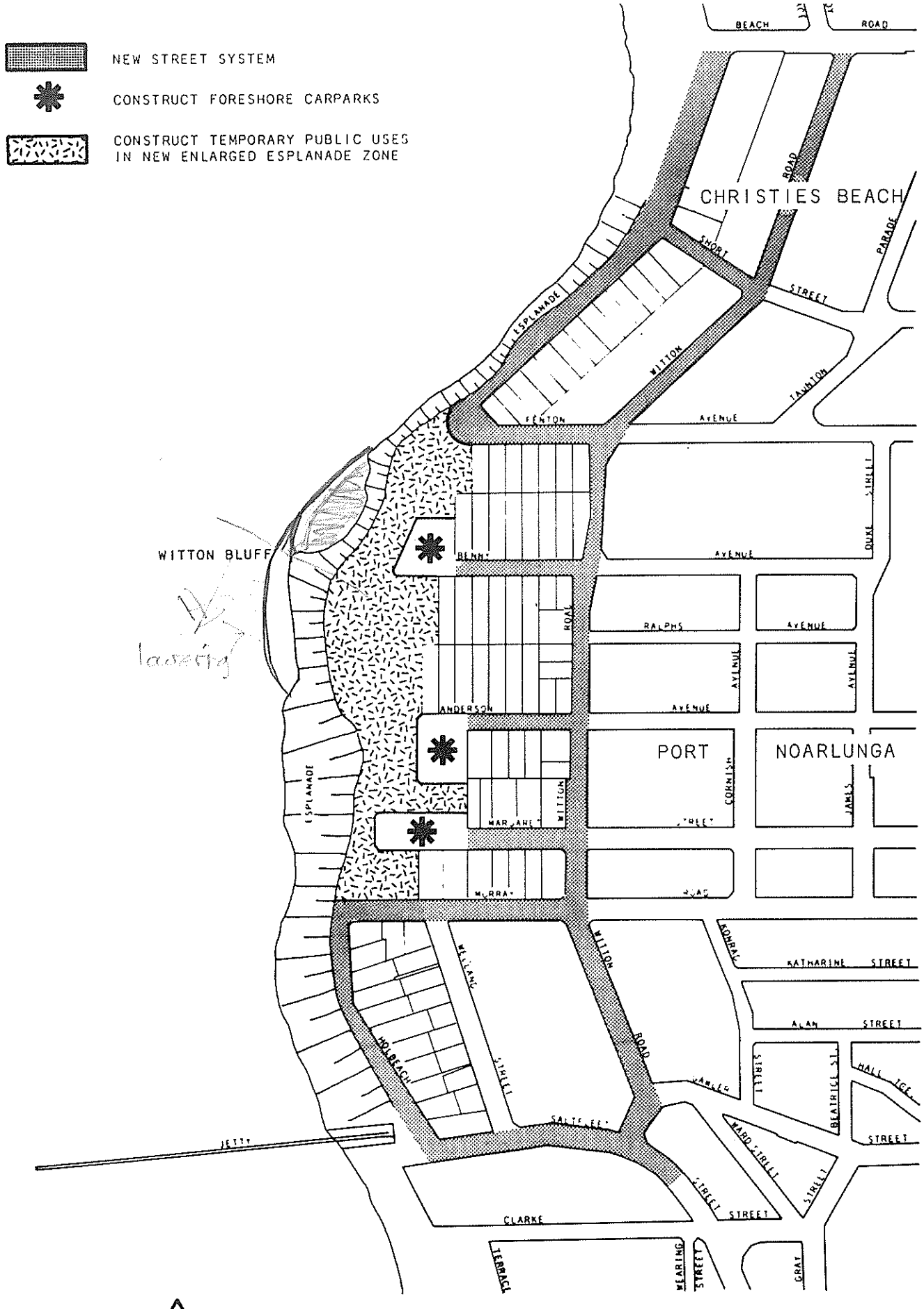
PHASE B

1. Continue foreshore stabilization planting programme if pilot project successful;
2. Widen and improve Witton Road to full sub-arterial status; - how much will that cost?
3. Continue Esplanade property purchase by agreement with owners; and selective leasing of properties;
4. Close Esplanade to through traffic. Reconstruct as a narrow temporary private access road to serve remaining residential frontage properties;
5. Reconstruct the western end of Benny Avenue, Anderson Avenue and Margaret Street as culs-de-sac to continue to provide access to frontage properties and to foreshore carparks on the Esplanade land reclaimed from residential use.

PHASE C

1. Improve Fenton Avenue and Murray Road for increased traffic volumes;
2. Construct foreshore carparks and other temporary uses where amalgamated sites are available;
3. Close Esplanade as a temporary private access road.
4. Complete foreshore improvements.

Phases A to C are illustrated on Figures 9 to 11 which follow.



WITTON BLUFF ENVIRONS PHASE C

Pak-Poy & Kneebone Pty. Ltd.

Figure No. 11

Casual access to the upper slopes should be further restricted and it is recommended that no new lookout or other access works at the cliff tops be approved.

Notwithstanding all the above measures, the near vertical cliffs on either side of Witton Bluff still remain vulnerable to erosion, which will inevitably progress, although not in the large and possibly catastrophic steps as with the marine erosion. The only course available to prevent this would be to blanket these cliffs with filling, supported and protected at the toe by the revetment around the Bluff previously described. This would have the effect of concealing the attractive headland, with consequent loss of natural amenity. The measure may be unacceptable to the community.

The works at the Bluff itself are estimated to cost $350,000 for the revetment only, and an additional $900,000 for the blanketing fill against the cliffs.

As an alternative strategy to the latter filling, it is suggested that the gradual transfer of land on the Esplanade frontage between Anderson and Fenton Avenues, from private to public ownership be considered. The transfer of further land to the north and south of the above streets may be desired as well, for reasons other than foreshore erosion control.

Essential requisition might proceed at the rate of purchase of one property per annum over a period of 15 years. At an annual average value of, say, $40,000, this represents a present day capital value of much less than $900,000 for the cliff filling. For example, at a discount rate of 8 per cent per annum the present day value would be of the order of $350,000.

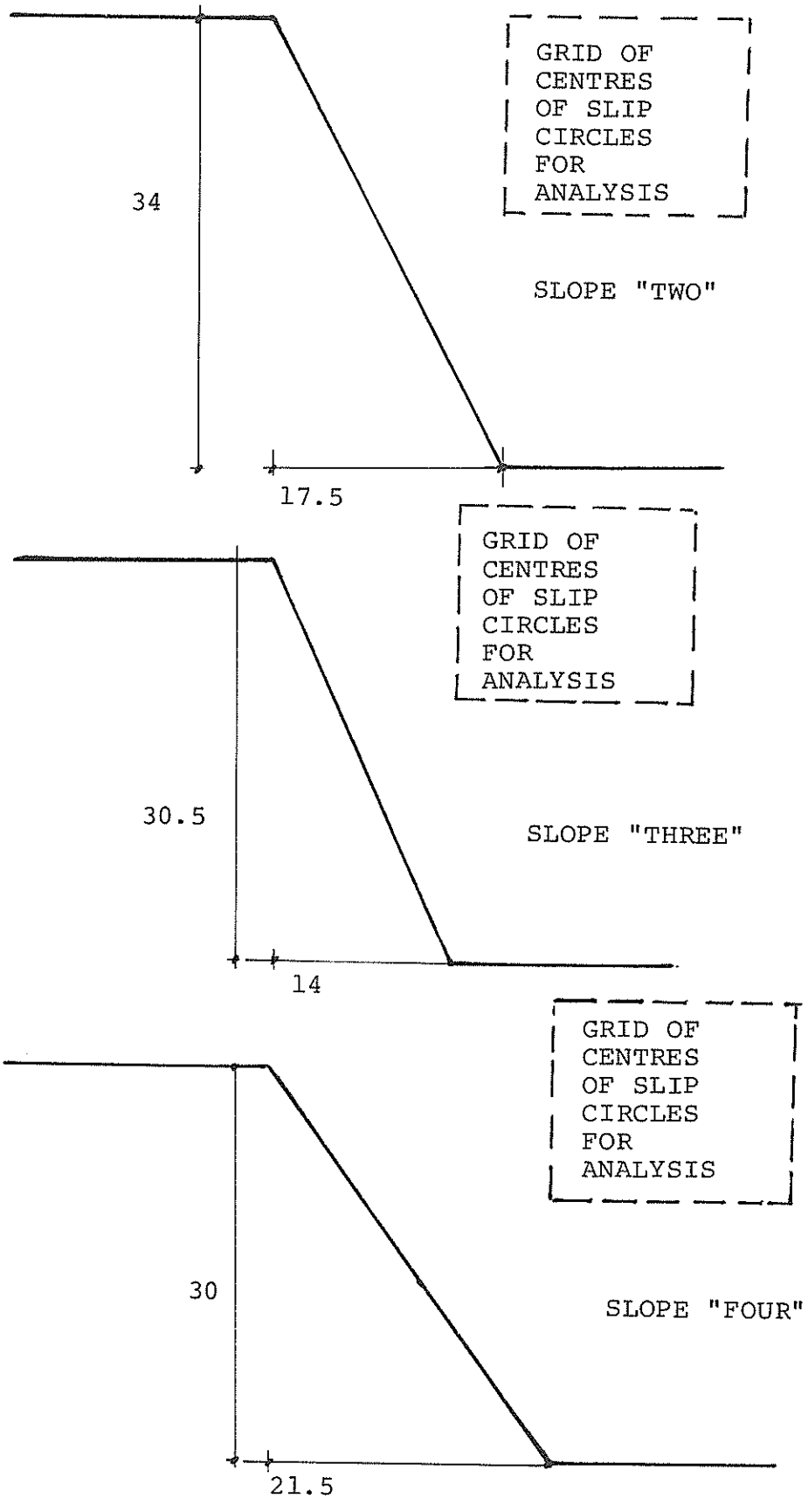
The present day value of all costs is not expected to exceed $600,000. This estimate includes an allowance for the eventual loss of utility services and a section of the Esplanade roadway, and a further allowance for future expenditure of funds on alternative traffic arrangements and public amenities on the Bluff.

If no action whatever is taken to protect the Witton Bluff cliffs, then the Esplanade and fronting properties will eventually be lost to erosion. Only by the expenditure of some $1,250,000 in the next few years on revetment and cliff filling, would assurance against eventual loss of the property be provided. However, this would be accompanied also by loss of natural cliff forms which is likely to be an unacceptable situation.

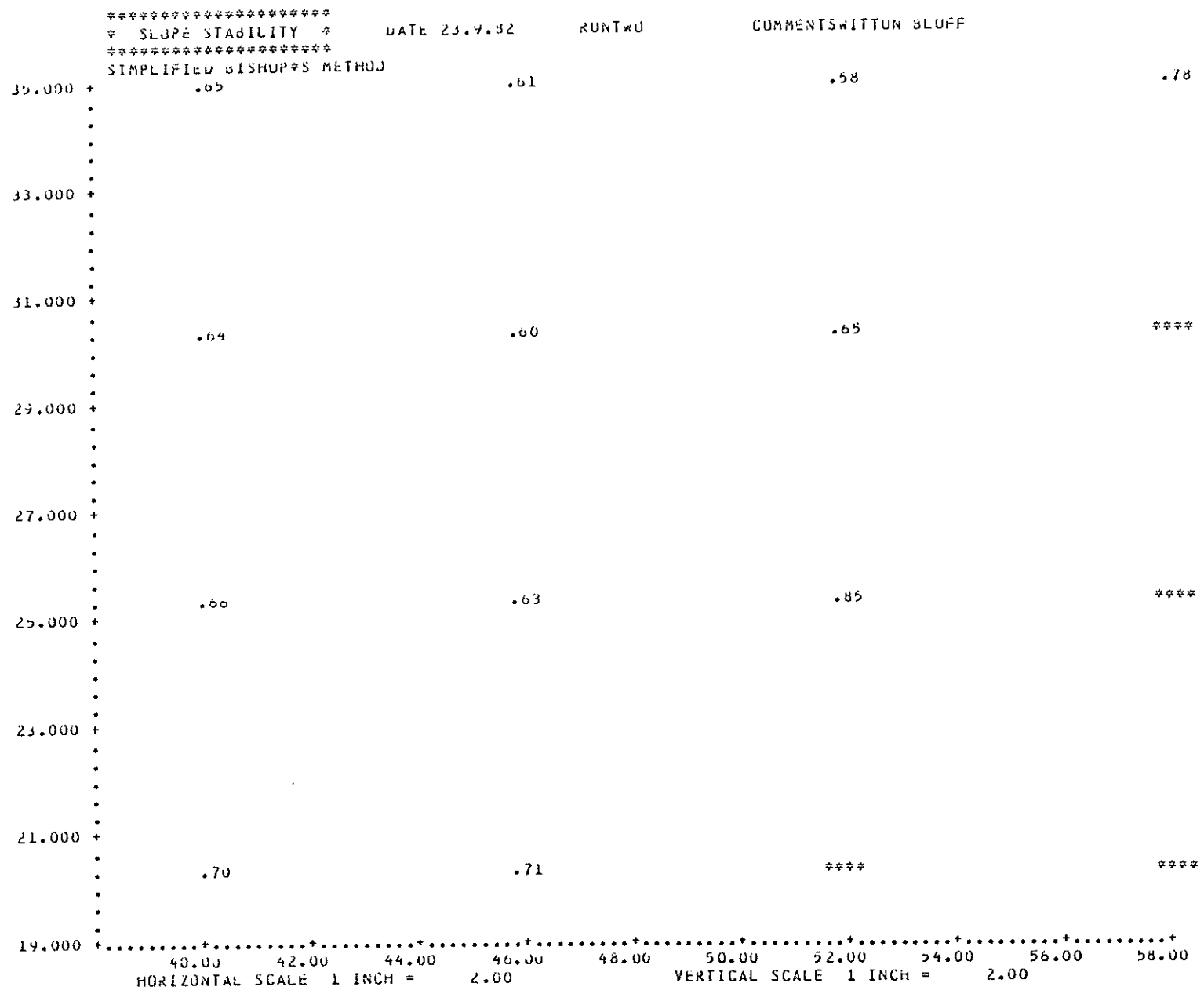
If the Corporation of the City of Noarlunga and the State Government choose the option of gradual transfer of land in the immediate hinterland of the Bluff to the public domain in the expectation that some erosion will continue to occur, then a sequence of actions as set out in the Report would be set in train. The result would be a planned cliff top environment available for public access and enjoyment, with due provision for traffic and other municipal requirements.

A P P E N D I X

SLOPE STABILITY ANALYSIS



GEOMETRY OF SLOPES ADOPTED IN COMPUTER ANALYSIS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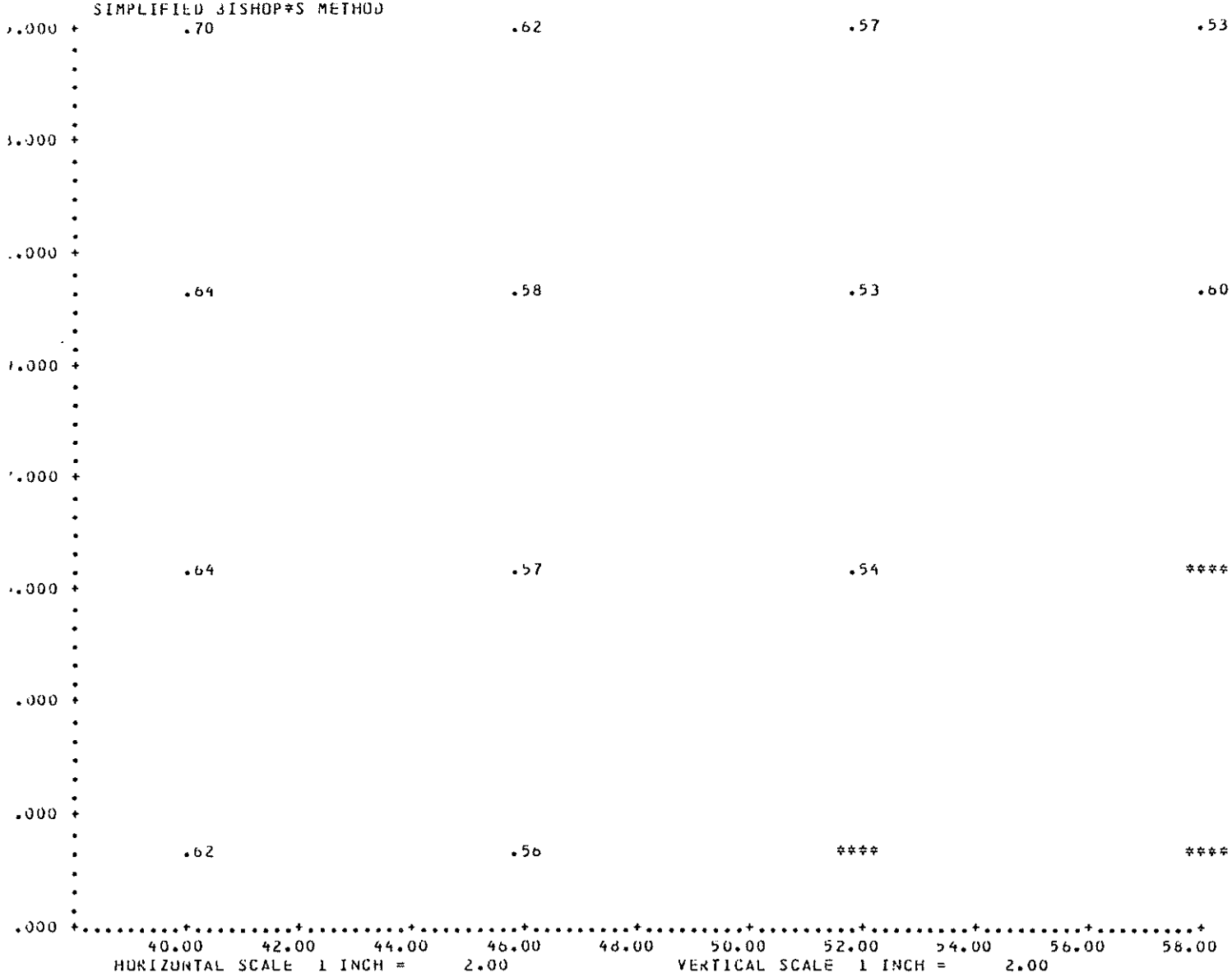

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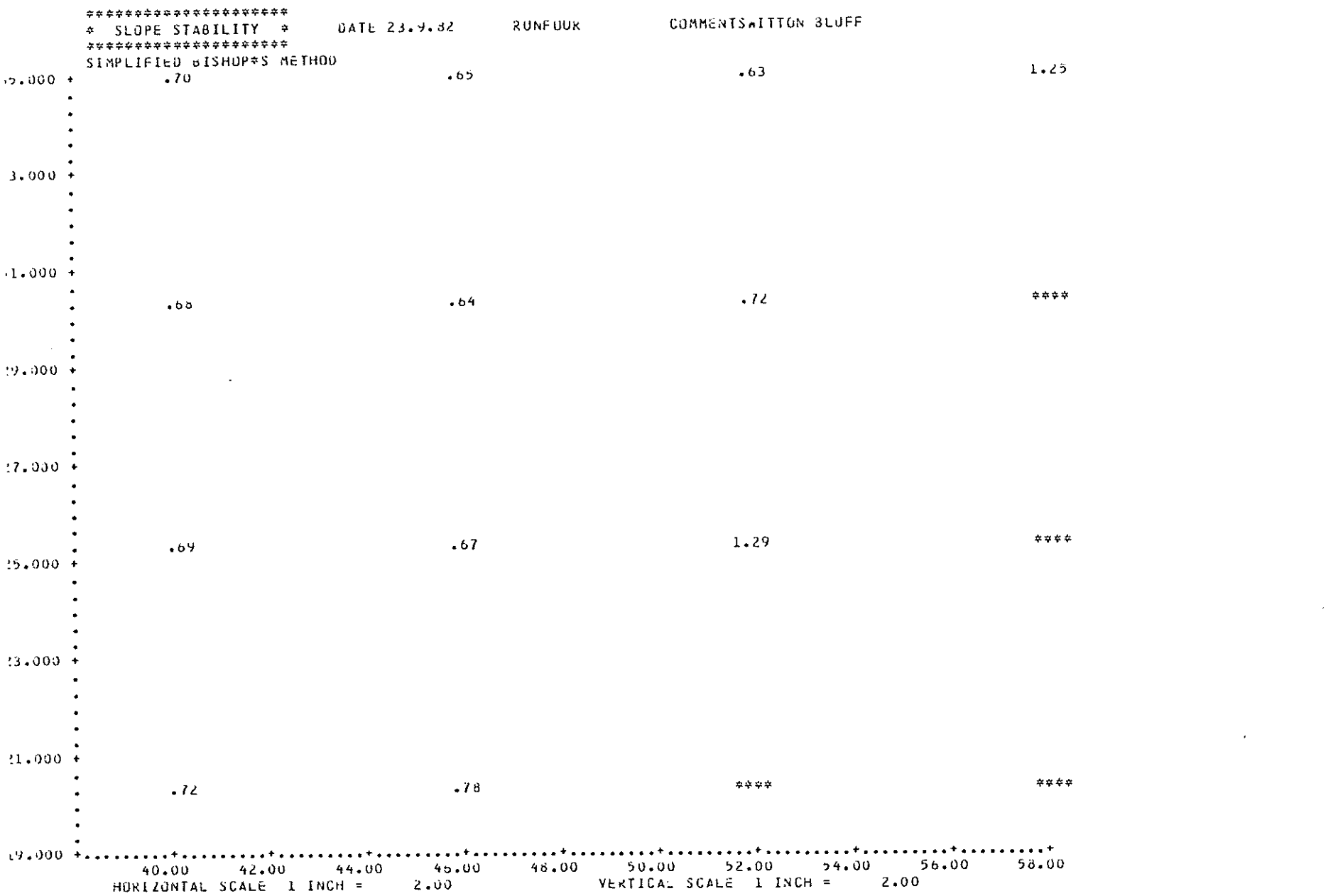
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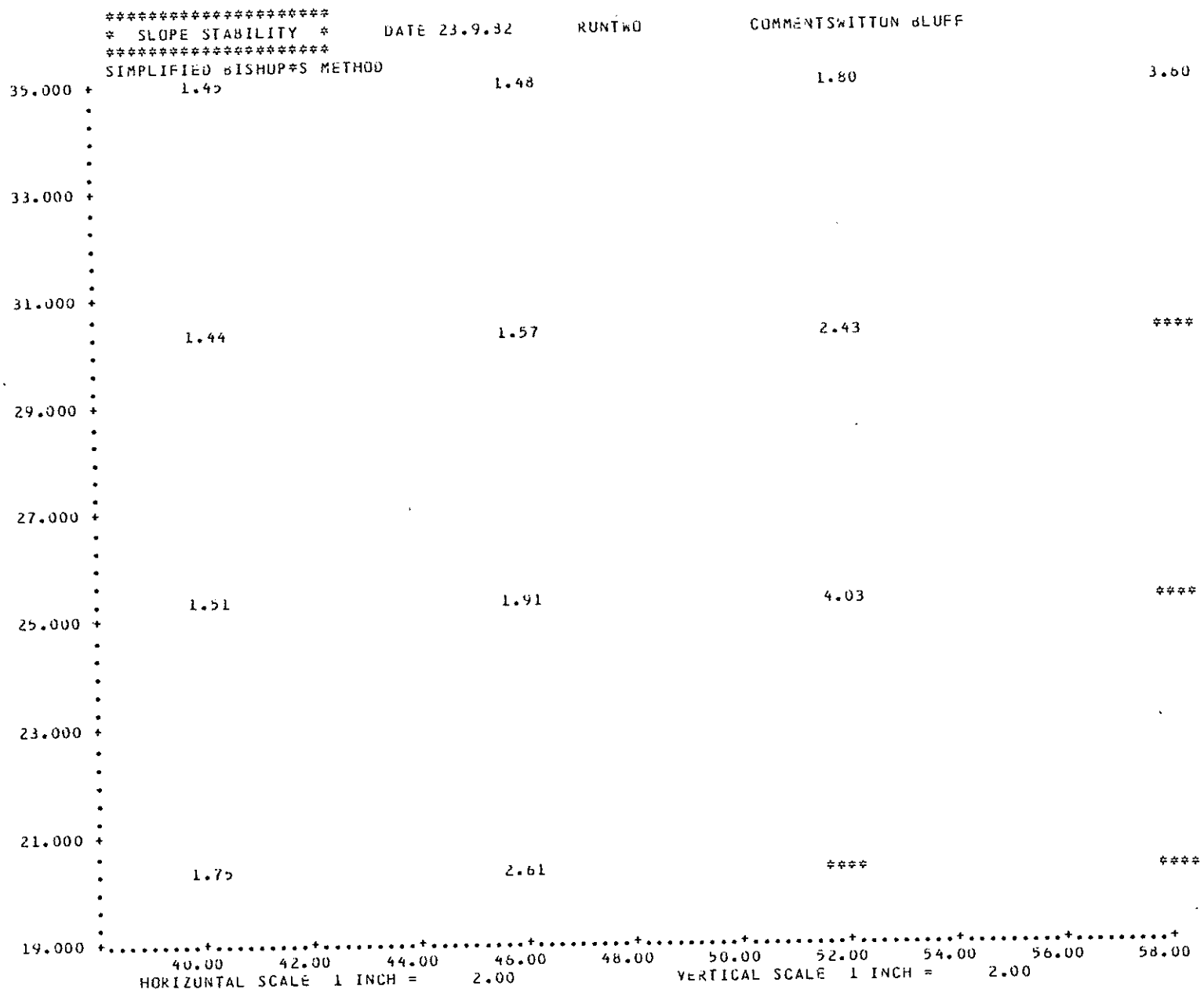
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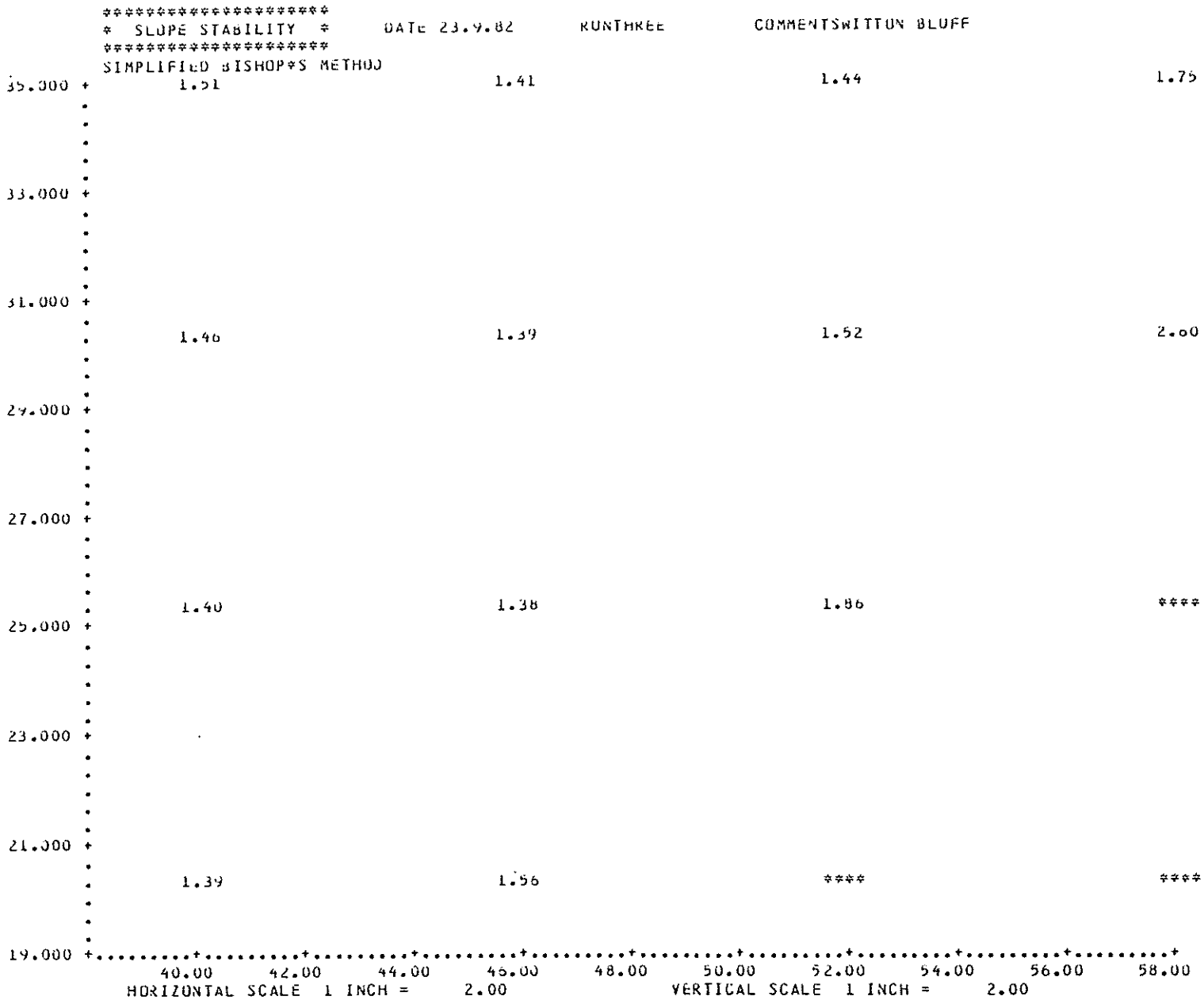
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SIMPLIFIED BISHOP'S METHOD
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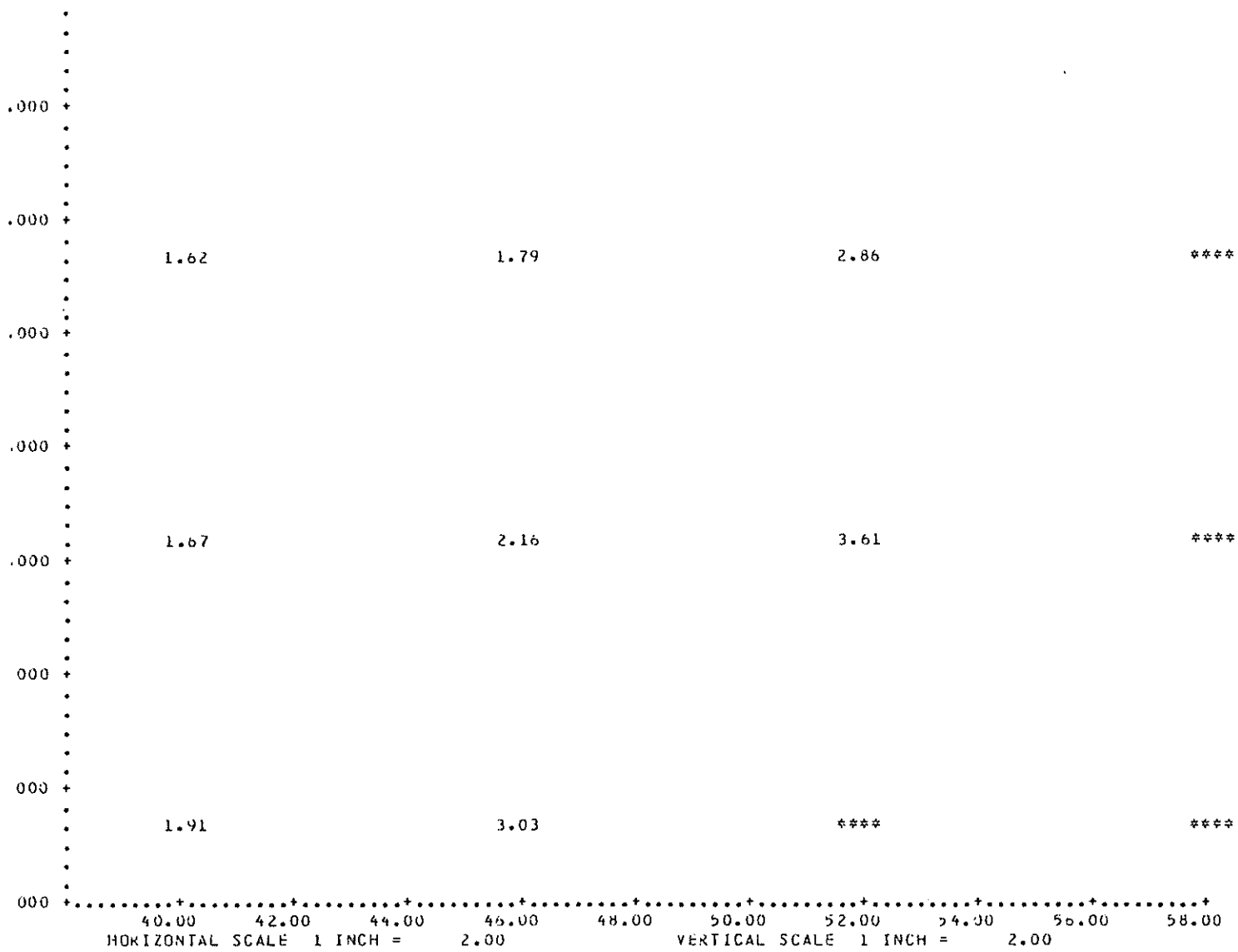

HORIZONTAL SCALE 1 INCH = 2.00 VERTICAL SCALE 1 INCH = 2.00