COMMONWEALTH OF AUSTRALIA

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TECHNICAL SERVICES DIVISION

REPORT No. 2

TITLE:- THE SELECTION OF A TELEVISION SITE TO SERVE THE MELBOURNE AREA.

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TITLE: The Selection of a Television Site to serve the Melbourne Area.

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DATE: 21.4.1950.

R.B. Mair
Director of Technical Services.

Date of Issue.

C O N T E N T S

The Selection of a Television Site to Serve the Melbourne Area

ABSTRACT.

An examination has been made of a number of possible television transmitting sites in the vicinity of Melbourne. Comparisons are made of the predicted field strengths at a number of important receiving locations. It is concluded that the best all round site which can be selected is a 700 ft. tower on the high ground at Studley Park. Alternative sites having particular advantages and disadvantages could be provided either by a 500 ft. tower at Studley Park, or in the vicinity of the Exhibition Building, or a 500 ft. tower located in the vicinity of the water tower at Mont Albert.

1. Introduction.

A television transmitting site should be chosen primarily to give adequate field intensity at all the important centres of population which it is considered desirable to serve with a single transmission. A secondary consideration is that the "ghost" image interference at these centres should not be such as to require elaborate receiving aerials for its elimination. If these two conditions can be satisfied with a transmitting site situated near the main centre of population and the studios, the choice should be satisfactory If the site having the best "coverage" characteristics is not conveniently placed with respect to the studios, a coaxial cable or a V.H.F. radio can be used to link the studios and transmitter.

To serve a metropolis such as Melbourne the best site that could be found would be one situated in the centre of the city proper with the aerial raised to such a height that the field strength at outlying places like Lilydale, Frankston, Croydon, Ferntree Gully, Dandenong and Sunbury is adequate to ensure satisfactory reception and then it will be found that other centres of population within 25 miles of Melbourne are sufficiently well served. This would provide the highest field intensities in the city proper, the area in which man made noise and the shadowing effects of obstacles each have their greatest effect in reducing the received signal-noise ratio. Unfortunately, the required height for such an aerial would be 800-900 feet above sea level. Such an aerial would not comply with the requirements of the Department of Civil Aviation and in any case the procurement of a suitable site would be an extremely difficult problem.

The ground near the Exhibition Building in East Melbourne is 140 feet above sea level and a mast 530 feet above ground level could be erected within the limits imposed by the Department of Civil Aviation for the protection of aircraft using Essendon airport. Such a site is reasonably close to the centre of gravity of the population which occurs at a point 2½ miles East-South East of the centre of the city (Ref. 4). It would give an excellent signal in the city proper, and would be handy to the studios, its only disadvantage being the poor signal provided at Lilydale, Croydon and Dandenong.

The high ground at Studley Park is 150/200 ft. above sea level and is just over 3 miles from the centre of the city. A mast 700 ft. above ground

level could be erected within the Department of Civil Aviation restrictions. Such a site would give an inferior signal in the city to that given by the Exhibition site but it would be adequate and it would provide a satisfactory service to Croydon and Dandenong and improved service to Lilydale. A V.H.F. studio-transmitter link would probably be required.

If for any reason it were not practicable to erect masts at either of the above mentioned sites, then a mast up to 1000 ft. above the ground could be erected (on Department of Civil Aviation restrictions) on the high ground at Mont Albert near the water tower (400 ft. above sea level.) A 500 ft. mast erected at this site would give an inferior service in the city behind large buildings but it would give good service at most other important places, particularly in the Eastern and South Eastern suburbs. It would also give greater freedom from "ghost" images in the outer Eastern suburbs. The field strength in some Western suburbs would be lower than that provided by the above-mentioned sites but it would be adequate.

2. Calculated Field Intensities.

Field intensities have been calculated for the Exhibition, Mont Albert and Studley Park sites, assuming the use of a 500 ft. tower in each case and also assuming a 700 ft. tower at Studley Park, the highest available under Department of Civil Aviation restrictions. It is considered practicable to employ a 500 ft. tower in each case involving a base about 50 ft. square. A 700 ft. tower would involve a guyed structure and is not considered a very desirable proposition in view of the amount of land necessary.

2.1 Calculated Field Intensities at Important Localities using the Methods of Bullington (Ref.1).

Profiles of the ground radiating from each of these sites in important directions were drawn using curvilinear co-ordinates drawn for an effective earth radius of 5280 miles to allow for the refraction caused by the earth's atmosphere in a normal state. Assuming an effective radiated power of 20 kw (5kw transmitter) and antenna heights of 500 feet for each of the three sites, the profiles were used to compute the field intensity at various important receiving points using a 30 foot receiving aerial. Calculations were also made for a 700 foot antenna at Studley Park. In general Bullington's methods of calculation were followed. The method most used was that of determining the tangent plans from the profile diagrams and then taking the effective transmitting and receiving heights above this plane. In determining the tangent plane, a receiving height of 15 ft. only was used in order to allow for the effects of houses, etc., in reducing the effective receiving aerial height. When the grazing angle is less than

0.17 degrees at the frequency under consideration (200 m.c.) it is considered that geometrical optics do not apply, and the field intensity is then obtained from other semi-empirical methods used by Bullington. These field strength figures are subject to variations of - 10db. to allow for the effect of trees and other obstructions not shown on the maps.

2.2 Calculated median field intensities at important localities

The methods of Norton, Schulkin and Kirby (Ref.2) were used. They found that "the fields measured around the station at a fixed distance could be satisfactorily represented by log-normal distributions with the same standard deviation (about 8db.) for all values of distance, frequency and receiving antenna height for which data were available." They also presented terrain correction factors (functions of frequency and distance), which could be applied to field intensity calculations based on smooth earth ground wave propagation theory to give the expected median field at a fixed distance. The median field at a fixed distance from the station is that field which is exceeded by 50% of a large number of field values taken around the station at a constant distance. With the type of field distribution mentioned above, the median field is the same as the logarithmic mean field, which is the average of fields expressed in db $>$ 1 mv/metre. In calculating the smooth earth field to arrive at the above conclusions, Norton, Schulkin and Kirby in all cases took the effective transmitting antenna height as the height of the antenna above the average height of the terrain at 2 - 10 miles distance. The receiving antenna height is taken as the actual height above ground.

2.3 Tabulation of expected fields and median fields.

Table 1 below gives the results of these calculations. It will be seen that there is a considerable difference between the values as calculated from Bullington, and the median values as calculated from Norton. The former are more accurate indications of the expected signal strengths at the receiving locations, allowing for the actual nature of the terrain, the existence of city buildings and so on. The latter are average values taking average terrain. Norton has expressed the probability of variation from these median values over the whole range of azimuths from the transmitter as + 8 db, being exceeded for 15% of the locations, and - 8 db. for 85% of the locations.

The figures calculated from Bullington are considered to be the most reliable in forming an estimate of the value of service provided at each location, and must be compared with some standard of adequate signal strength. For rural service and a good average receiver the F.C.C. indicate that 5$\frac{1}{2}$ microvolts per meter is necessary. For a city service in the presence of noise the earlier F.C.C. standards of good engineering practice indicate the necessity of a signal of 5 millivolts per meter.

TABLE I

Transmitting Site & Height	Receiving Site	Distance (Miles)	Actual Field Intensity milli-volt per meter	Median field MV/m	Nature of Path
Exhibition (500)	Broadmeadows	9.8	4.0	10	grazing
Mont Albert (500)	"	16.2	13	6.5	optical
Studley Park (500)	"	11.3	20	8.0	"
Studley Park (700)	"	11.3	28.3	11	"
Exhibition (500)	Glenroy	7.4	80	16.5	"
Mont Albert (500)	"	13.8	24.0	8.5	"
Exhibition (500)	Sunbury	20.5		3.9	
Mont Albert (500)	"	27.3	0.42	2.5	monoptica
Studley Park (500)	"	22.2	1.2	2.0	"
Studley Park (700)	"	22.2	1.68	2.7	
Mont Albert (500)	Bulla	21.4	6.8	4	
Exhibition (500)	Melton	22.9	1.4	2.7	optical
Mont Albert (500)	"	30.8	1.0	2.0	"
Studley Park (500)	"	25.8	1.1	2.3	"
Studley Park (700)	"	25.8	1.4	2.8	"
Mont Albert (500)	St. Albans	18.2	14.6	5.5	"
Studley Park (500)	"	12.6	22.0	7.1	"
Studley Park (700)	"	12.6	29.7	10	"
Exhibition (500)	Deer Park	11.1	18.5	8.8	"
Mont Albert (500)	" "	19.1	12.8	5.1	"
Studley Park (500)	" "	13.5	14.5	6.1	"
Studley Park (700)	" "	13.5	20.1	8.6	"
Exhibition (500)	Sunshine	8.0	39.0	15	"
Mont Albert (500	"	15.2	16.1	6.6	"
Exhibition (500)	Footscray	4.5	144	45	"
Mont Albert (500)	"	12.5	40	10.2	"
Exhibition (500)	Heidelberg	13.2	6.1	3.9	"
Mont Albert (500)	"	23.2	4.1	3.1	"
Studley Park (500)	"	20.4	4.5	3.2	"
Studley Park (700)	"	20.4	6.7	4.5	"

Transmitting Site & Height	Receiving Site	Distance (Miles)	Actual Field Intensity milli-volt per meter	Median field MV/m	Nature of Path
Exhibition (300)	Laverton	11.9	17.1	6	optical
"	Spotswood	5	100	32	"
Mont Albert (500)	Altona	15.7	14.1	6.8	"
"	Williamstown	12.3	19.0	10.6	"
"	Blackburn	2.2	500	125	"
"	Nunawading	3.5	166	90	"
Mont Albert (500)	Mitcham	4.5	91	56	"
Exhibition (500)	Croydon	17.0	1.0	4.2	nonoptical
Mont Albert (500)	"	9.6	2.4	14.1	"
Studley Park (500)	"	14.6	1.4	5.4	"
Studley Park (700)	"	14.6	2.0	7.6	"
Exhibition (500)	Bayswater	16.5	3.1	4.5	
Mont Albert (500)	"	9.5	30.	18.8	optical
Studley Park (500)	"	14.1	3	5.5	
Studley Park (700)	"	14.1	4.3	7.8	"
Exhibition (500)	Lilydale	23.8	0.6	3.2	nonoptical
Mont Albert (500)	"	13.8	1.6	8.5	"
Studley Park (500)	"	18.5	0.6	3.7	"
Studley Park (700)	"	18.5	0.8	5.2	"
Exhibition (500)	Ferntree Gully	19.5	2.7-10	3.6	optical
Mont Albert (500)	" "	11.6	50	11.3	"
Studley Park (500)	" "	17.2	27	4.0	"
Studley Park (700)	" "	17.2	30	5.7	"
Exhibition (500)	Dandenong	18.4	1.1	3.9	grazing
Mont Albert (500)	"	12.3	4.7	10.6	optical
Studley Park (500)	"	16.6	1.6	4.3	
Studley Park (700)	"	16.6	2.2	6.0	nonoptical
Exhibition (500)	Frankston	24.9	2.3	2.3	optical
Mont Albert (500)	"	21.7	6.2	4.2	"
Studley Park (500)	"	24.1	5.2	2.4	
Studley Park (700)	"	24.1	7.25	3.3	"
Exhibition (500)	(Melbourne	1	16-30	225	nonoptical
Mont Albert (500)	(City St.	8.25	2-6	20	"
Studley Park (500)	(level)	3	5-16	103	
Studley Park (700)		3	5-16	103	"
Mont Albert	Belgrave	14.3	6.6	8	optical

3. Ghost Images.

Measurements made with the Jolimont transmission have indicated (Ref.3) that using an effective radiated power of 4KW at a frequency of 91.1 M.C the field intensity of the signal reflected back from the Dandenong ranges is of the order of 50 micro-volts per meter at such places as Croydon, Bayswater Lilydale etc. With a radiated power of 20KW from a 500 ft. mast at the Exhibition Building at a frequency of 200 M.C., this reflected signal could be expected to increase by at least 12 db., giving a field strength of approximatel 200 micro-volts per meter. Comparing this field intensity with the direct wave as given in Table I, it is seen that the signal-ghost ratio is 14 db. at Croydon, 10 db. at Lilydale, and about 24 db. at Bayswater and Ferntree Gully. As a signal ghost ratio of 30 db. is desired for an interference free picture it is apparent that a special receiving aerial will be required at these places to ensure satisfactory reception.

When transmitting from another site such as Mont Albert the reflected signal at the above mentioned places would vary inversely as the total distance (direct plus reflected) and consequently the field intensity of the reflected wave would be of the order of 300 microvolts per meter. Then from Table I it follows that the signal ghost ratio is 18 db. at Croydon, 14 db. at Lilydale and 40 db. at Bayswater and Ferntree Gully. It is apparent that the Mont Albert site will be appreciably better than the Exhibition site at some receivin localities when considered from this point of view.

4. Other sites considered.

A number of other likely sites in the precincts of Melbourne were considered. The sites and the reason for discarding them are listed below -

(a) Princes Park

This is located on high-ground (150 ft. above sea level) but because of its proximity to Essendon a mast of not more than 400 ft. could be erected. This is considered to be too low. It is also 3½ miles from the centre of population.

(b) Mount Dandenong

This is approximately 2000 ft. above sea level and would serve much of the Melbourne area well. However the field intensity in Melbourne and the whole of the Western suburbs would be too low, and the field intensity behind large buildings in the city would be quite inadequate. The general accessibility of this site would also be poor.

(c) Jolimont Railway Station

This is about 75 ft. above sea level, and a 700 ft. tower could be built without infringing Department of Civil Aviation regulations. It would provide a good service to the city, but generally the service would be slightly inferior to that provided from a Studley Park site. It is also very doubtful if a suitable site could be procured as a base for a high tower.

(d) Armadale

Some high ground (200 ft. above sea level) exists near the corner of Glenferrie and Malvern Roads. It is extremely doubtful whether land would be available in this area. It is also 4½ miles from the city.

(e) South Yarra

High ground (100 ft. above sea level) exists near the corner of Domain and Punt Roads. Once again it is extremely doubtful whether land would be available. Studley Park and the Exhibition are both superior sites to this one.

5. Conclusion.

(a) The most desirable site would be a high tower located in the centre of the City of Melbourne but this is not very practicable.

(b) A second choice would be a tower 450-550 ft. in height erected in the vicinity of the Exhibition Building. This would give adequate service to most important centres of population, notable exceptions being Lilydale, Croydon and Dandenong, which would be provided only with services as indicated in Table I.

(c) A third choice would be a tower 450-700 ft. in height erected on high ground at Studley Park. This would provide a service inferior to that from the Exhibition site in regard to receiving sites in the City of Melbourne behind large buildings. The service to such points would, however, be adequate. If a 700 foot mast were used, the service to Lilydale, Croydon and Dandenong would be appreciably improved over that provided by the Exhibition site with a 500 foot mast.

(d) Still another choice would be a 500 foot tower located on the high ground in the vicinity of Mont Albert water tower. The chief disadvantage of this site would be the poor signal provided in the City of Melbourne, behind large buildings.

Taking into account the limitation imposed by the Department of Civil Aviation in regard to mast heights, the best practicable site that could be chosen to serve the whole of the Melbourne area would be a 700 foot mast erected on the high ground at Studley Park. With a 500 foot aerial there is little to choose between the Exhibition site and Studley Park site. The Mont Albert site should only be chosen if it is decided that the field intensity behind large buildings in the city of Melbourne is not an important consideration.

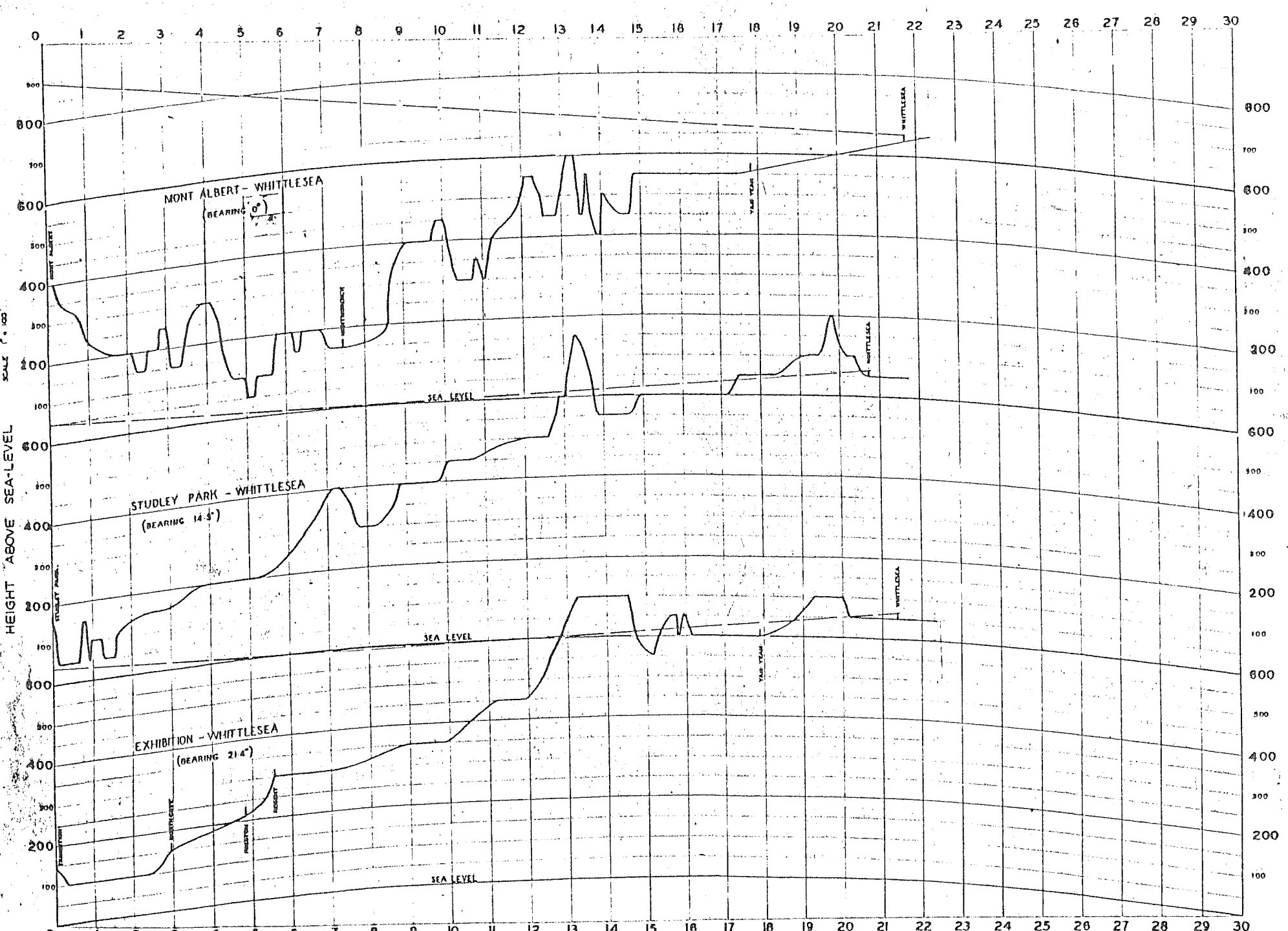
References.

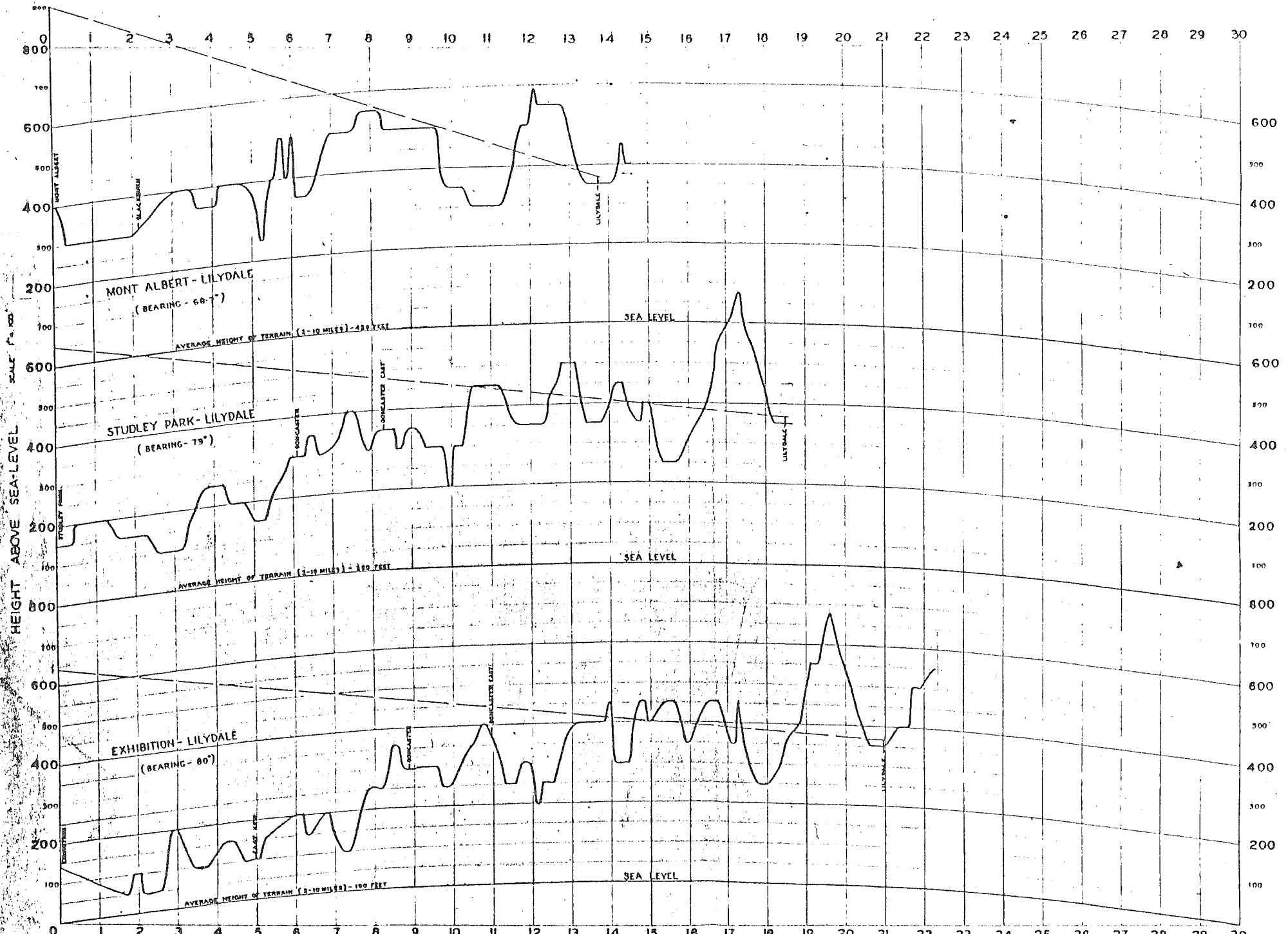
1. Radio Propagation at Frequencies above 30 Megacycles - Kenneth Bullington. Proceedings of the I.R.E., October 1947.

2. Ground-wave Propagation over Irregular Terrain at Frequencies above 50 m.c. - Morton, Schulkin and Kirby, National Bureau of Standards report.

3. F.M. Multiple Path Distortion in the Environs of Melbourne - P.M.G. Research Laboratory Report No. 3075.

4. Location of Television Transmitters to serve greater Melbourne and Victorian Provincial Towns - A Preliminary Survey - P.M.G. Research Laboratory Report No. 3125.


MONT ALBERT - WHITTLESEA
(BEARING 0°)
STUDLEY PARK - WHITTLESEA
(BEARING 14.5°)
EXHIBITION - WHITTLESEA
(BEARING 21.4°)
SEA LEVEL
SEA LEVEL
SEA LEVEL
HEIGHT ABOVE SEA-LEVEL
DISTANCE IN MILES
WHITTLESEA
YAN YEAN
MONT ALBERT
NORTHCROFT
STUDLEY PARK
TRANSITION
BRUNSWICK
PRESTON
ROSEBUD


MONT ALBERT - LILYDALE
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SEA LEVEL
STUDLEY PARK - LILYDALE
(BEARING - 79°)
AVERAGE HEIGHT OF TERRAIN (3-10 MILES) - 380 FEET
SEA LEVEL
EXHIBITION - LILYDALE
(BEARING - 80°)
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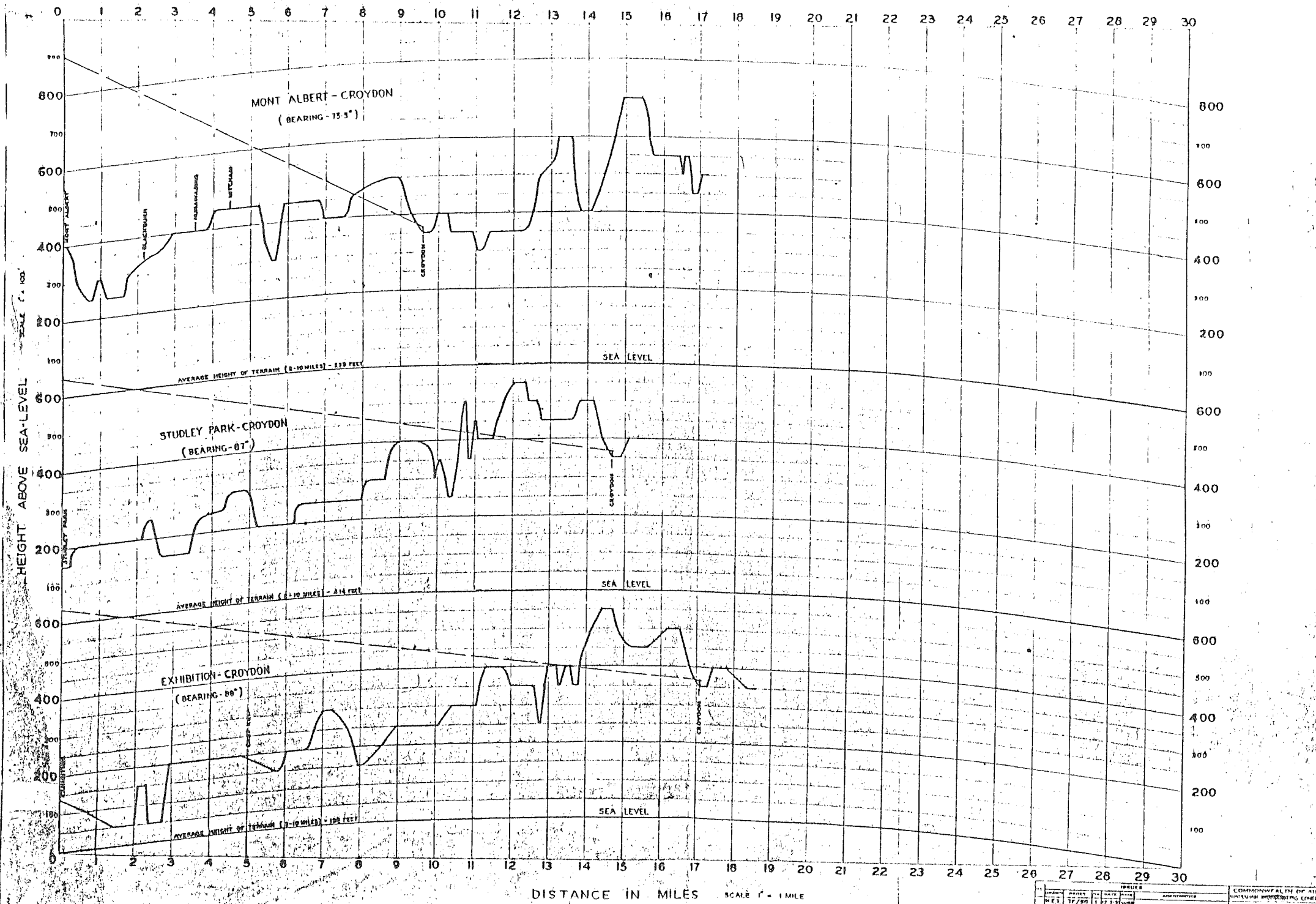
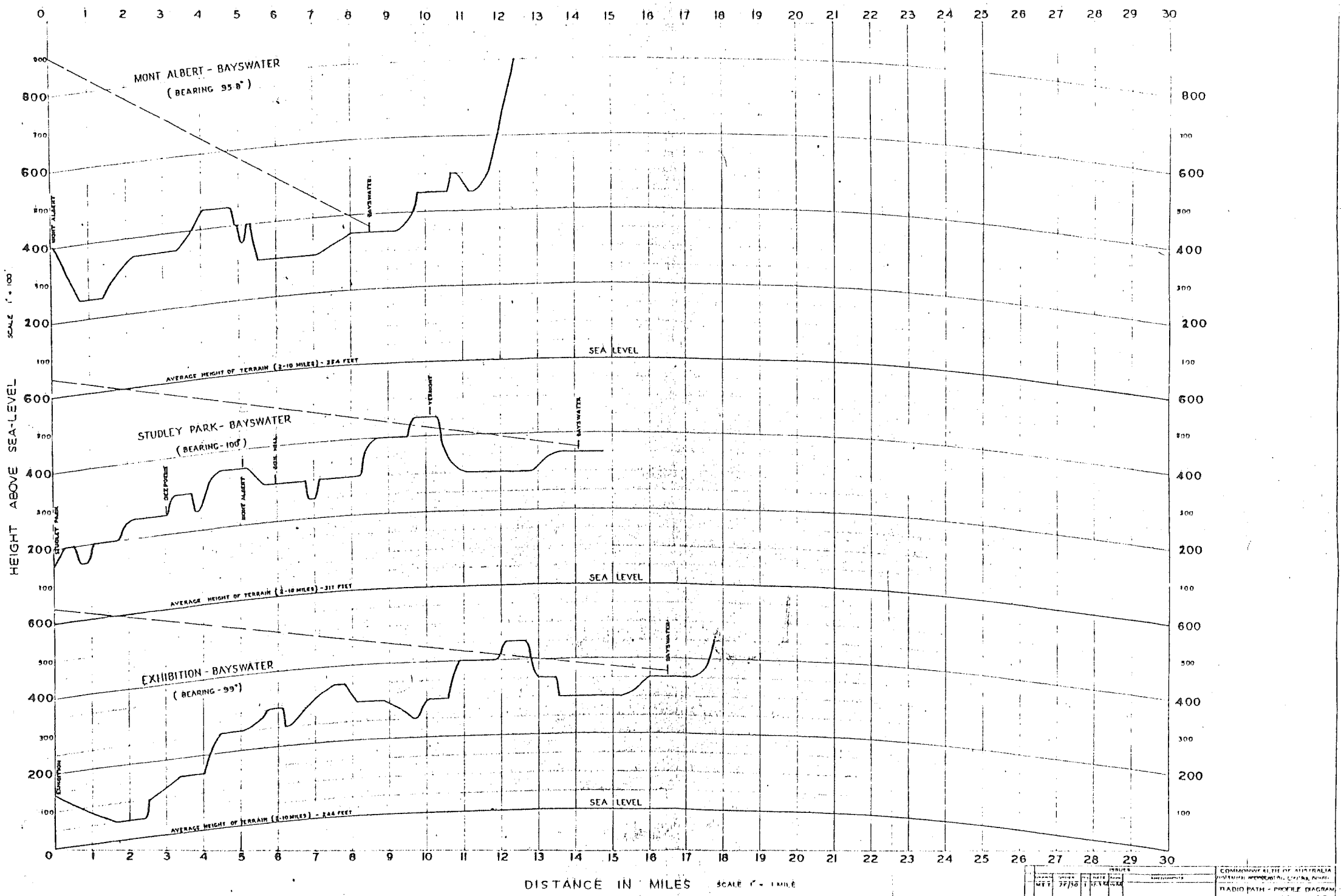
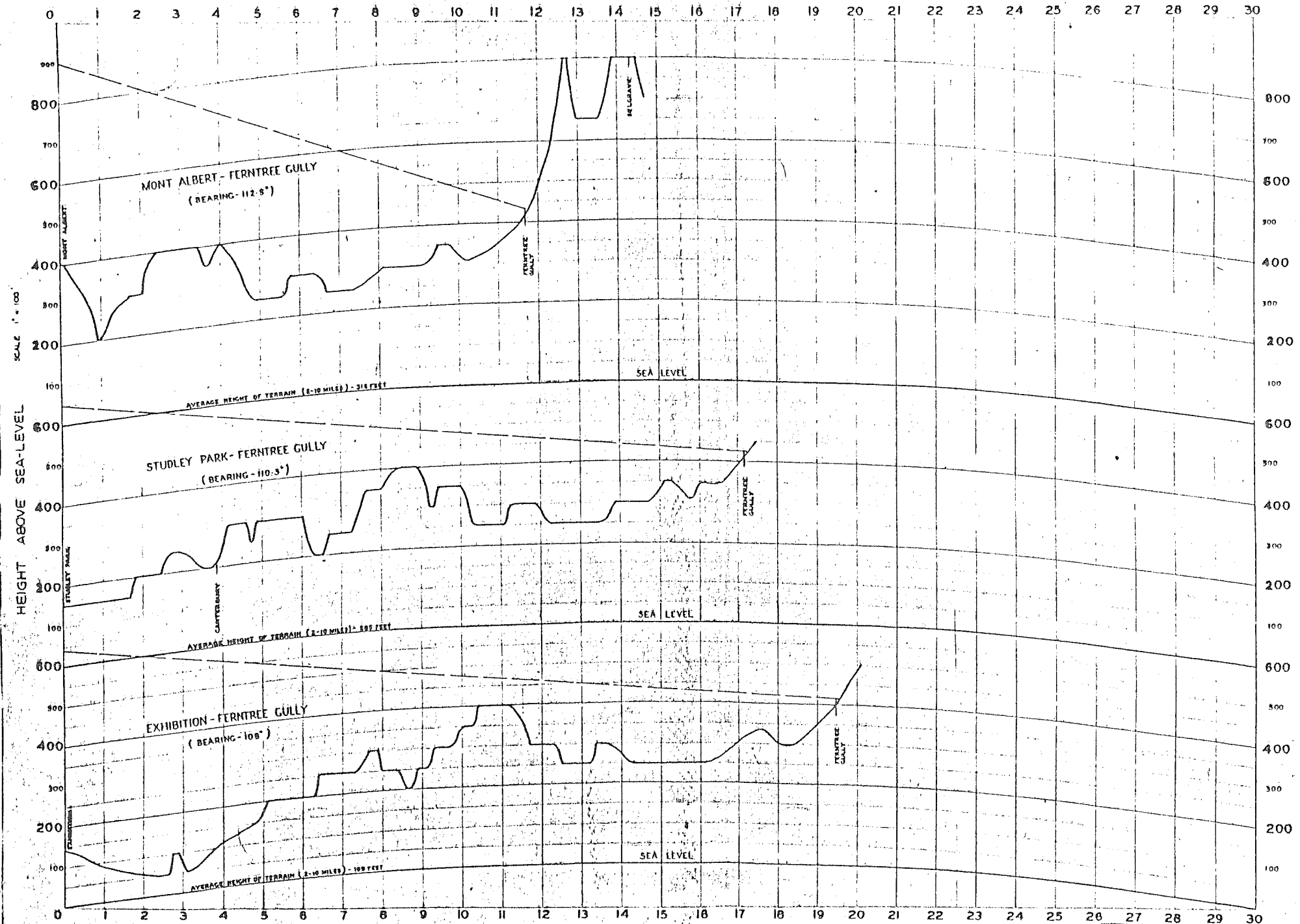
DISTANCE IN MILES SCALE 1" = 1 MILE



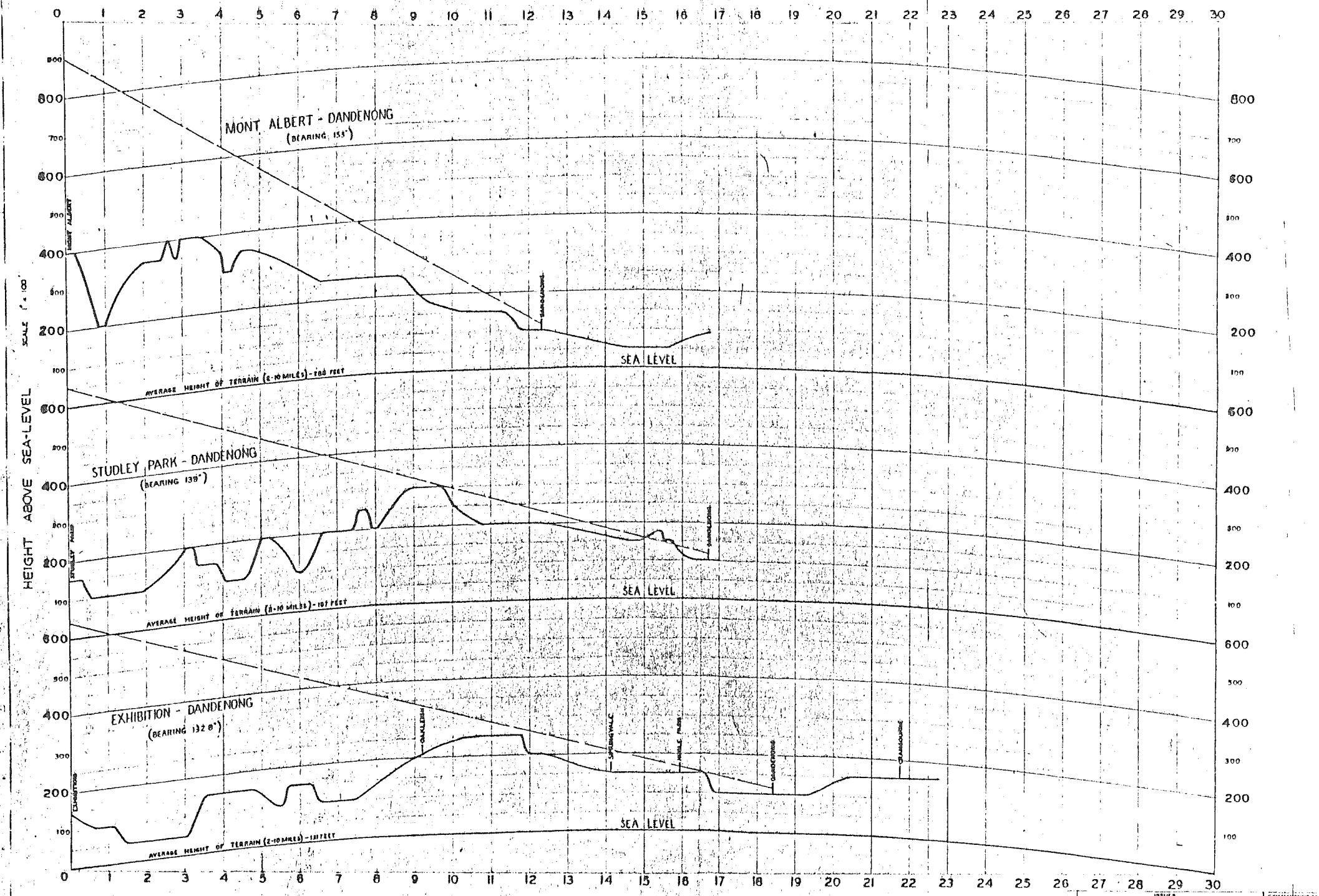
COMMONWEALTH OF AUSTRALIA
RADIO PATH - PROFILE DIAGRAM
THROUGH CROYDON



COMMONWEALTH OF AUSTRALIA
POSTMASTER-GENERAL'S DEPARTMENT
RADIO PATH - PROFILE DIAGRAM
THROUGH BAYSWATER



COMMONWEALTH OF AUSTRALIA
RADIO PATH - PROFILE DIAG
THROUGH FERNTREE GU


MONT ALBERT - DANDENONG
(BEARING 153°)
MONT ALBERT
SANDRINGHAM
SEA LEVEL
AVERAGE HEIGHT OF TERRAIN (2-10 MILES) - 288 FEET
STUDLEY PARK - DANDENONG
(BEARING 139°)
STUDLEY PARK
SANDRINGHAM
SEA LEVEL
AVERAGE HEIGHT OF TERRAIN (2-10 MILES) - 197 FEET
EXHIBITION - DANDENONG
(BEARING 132 8°)
EXHIBITION
CARLTON
SPRINGVALE
NOBLE PARK
SANDRINGHAM
CRANBOURNE
SEA LEVEL
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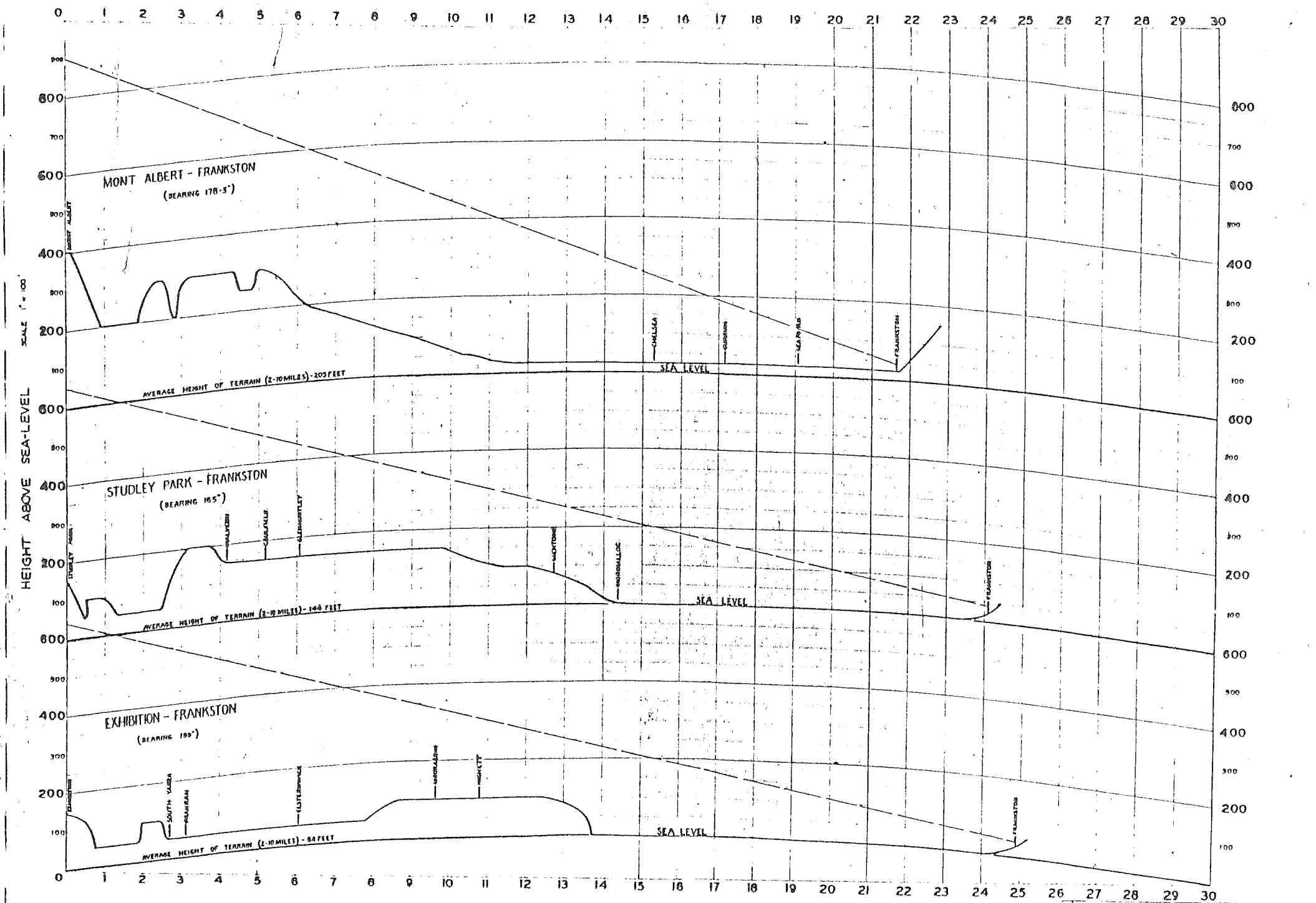
HEIGHT ABOVE SEA-LEVEL SCALE 1" = 100'
DISTANCE IN MILES SCALE 1" = 1 MILE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(BEARING 178·5°)
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SEA LEVEL
STUDLEY PARK - FRANKSTON
(BEARING 165°)
AVERAGE HEIGHT OF TERRAIN (2-10 MILES) - 194 FEET
SEA LEVEL
EXHIBITION - FRANKSTON
(BEARING 159°)
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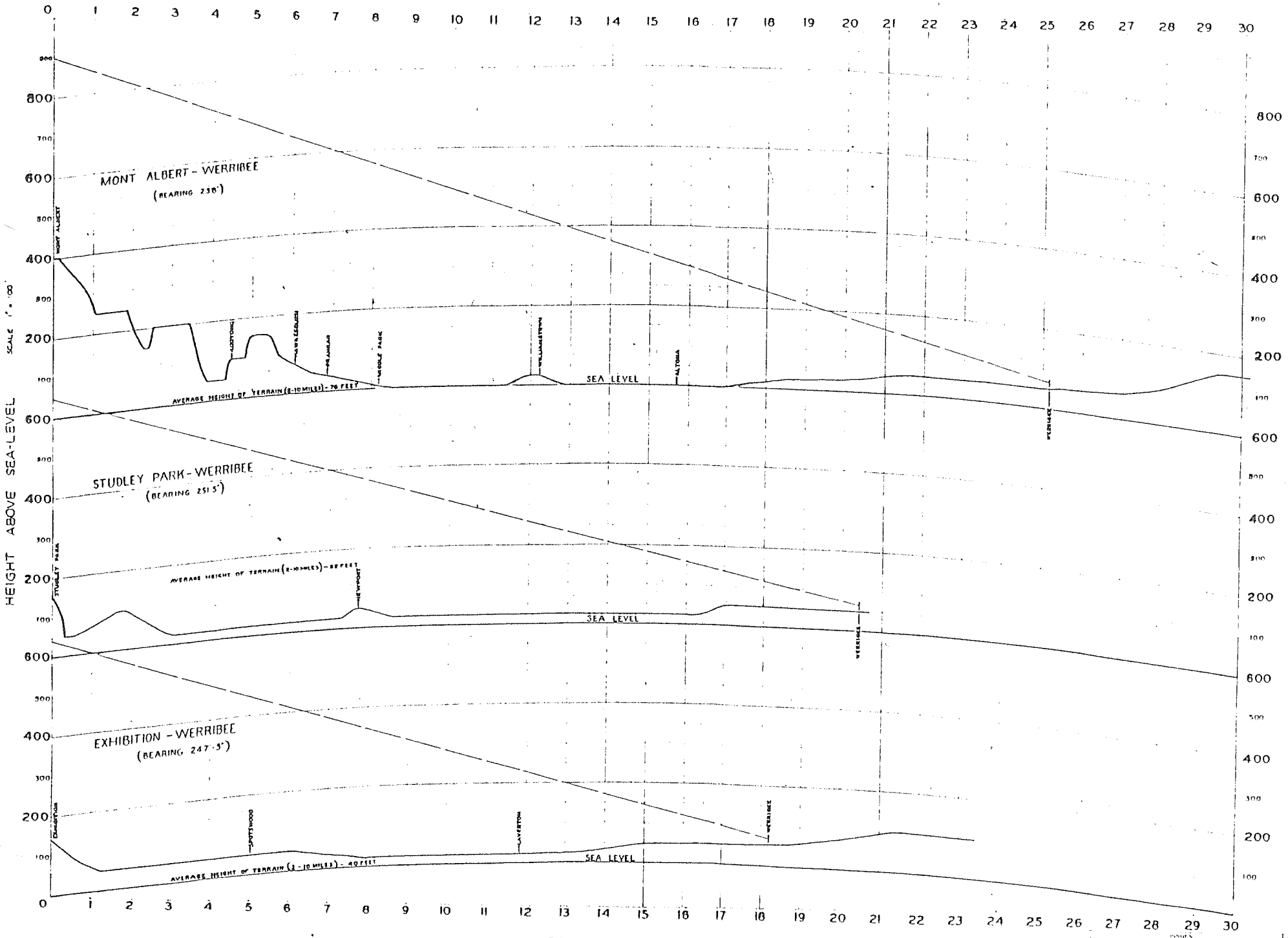
DISTANCE IN MILES SCALE 1" = 1 MILE


MONT ALBERT - WERRIBEE
(BEARING 238°)
MONT ALBERT
GLENFERRIE
ALMEIDA
WILLIAMSTOWN
ALTONA
SEA LEVEL
AVERAGE HEIGHT OF TERRAIN (8-10 MILES) - 70 FEET
WERRIBEE
STUDLEY PARK - WERRIBEE
(BEARING 251·5°)
STUDLEY PARK
NEWPORT
AVERAGE HEIGHT OF TERRAIN (8-10 MILES) - 80 FEET
SEA LEVEL
WERRIBEE
EXHIBITION - WERRIBEE
(BEARING 247·5°)
EXHIBITION
SPOTSWOOD
LAVERTON
WERRIBEE
AVERAGE HEIGHT OF TERRAIN (3-10 MILES) - 40 FEET
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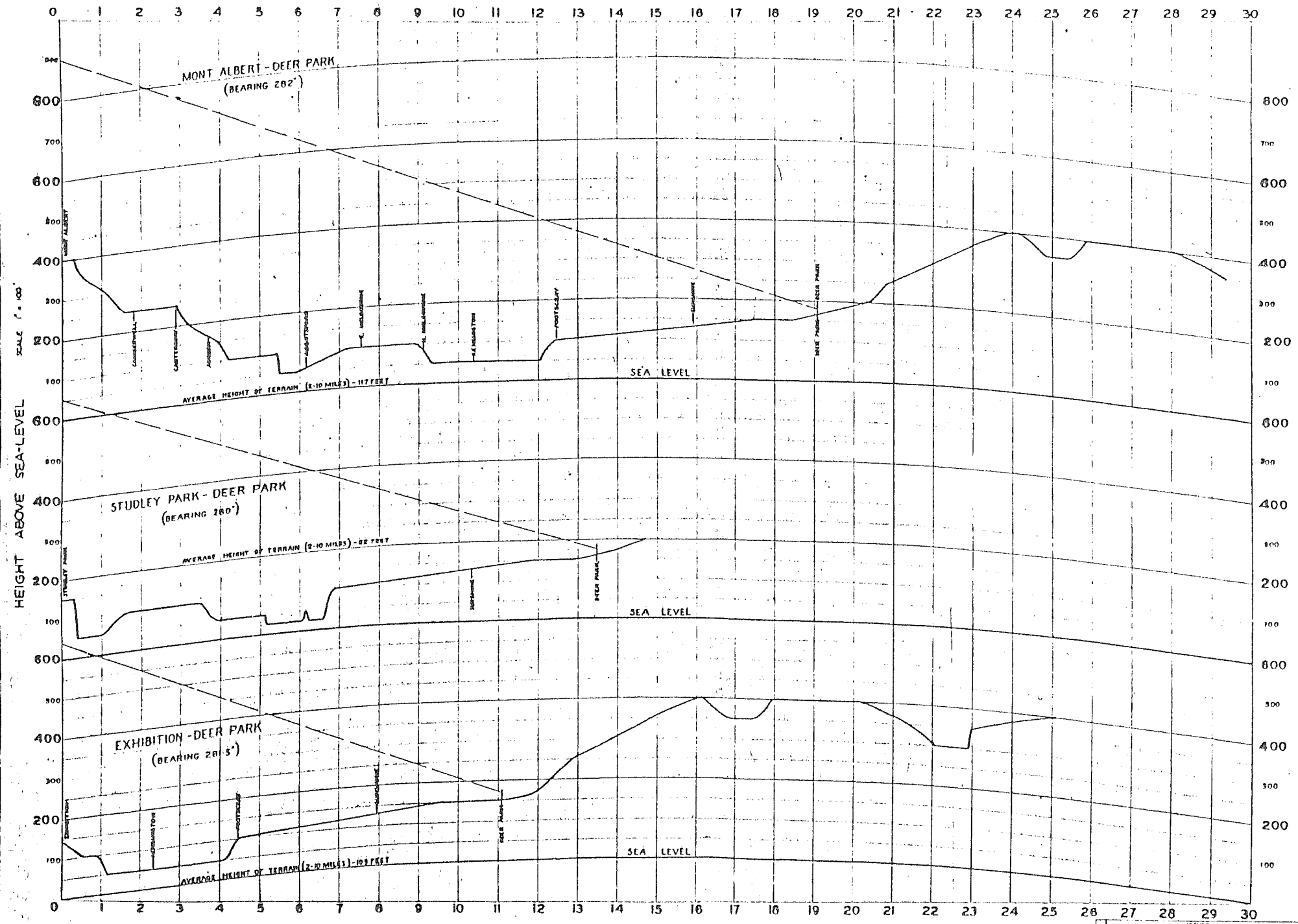
HEIGHT ABOVE SEA-LEVEL
SCALE 1" = 100'
DISTANCE IN MILES
SCALE 1" = 1 MILE


MONT ALBERT - DEER PARK
(BEARING 282°)
SEA LEVEL
AVERAGE HEIGHT OF TERRAIN (2-10 MILES) - 117 FEET
STUDLEY PARK - DEER PARK
(BEARING 280°)
AVERAGE HEIGHT OF TERRAIN (2-10 MILES) - 82 FEET
SEA LEVEL
EXHIBITION - DEER PARK
(BEARING 281.5°)
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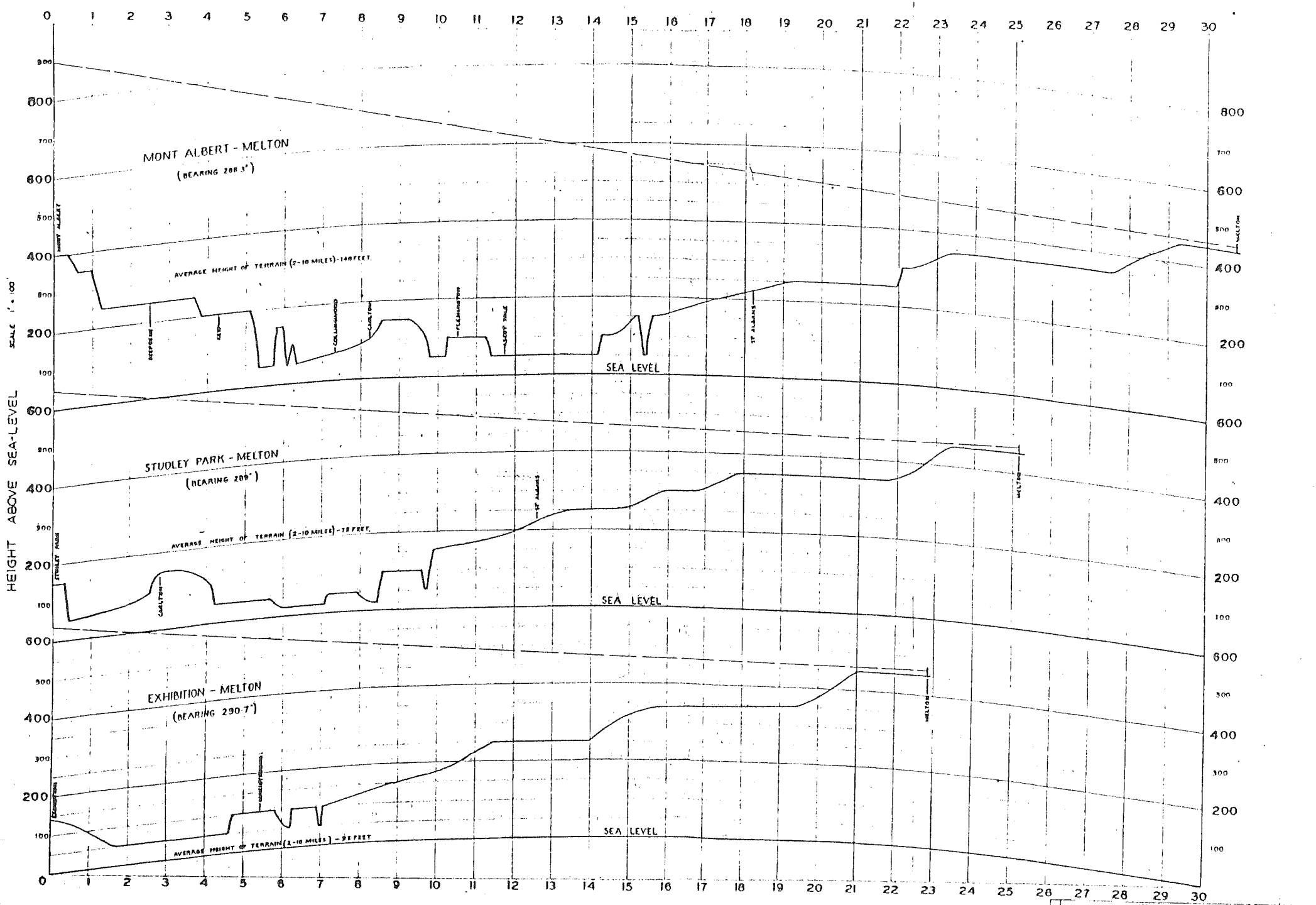
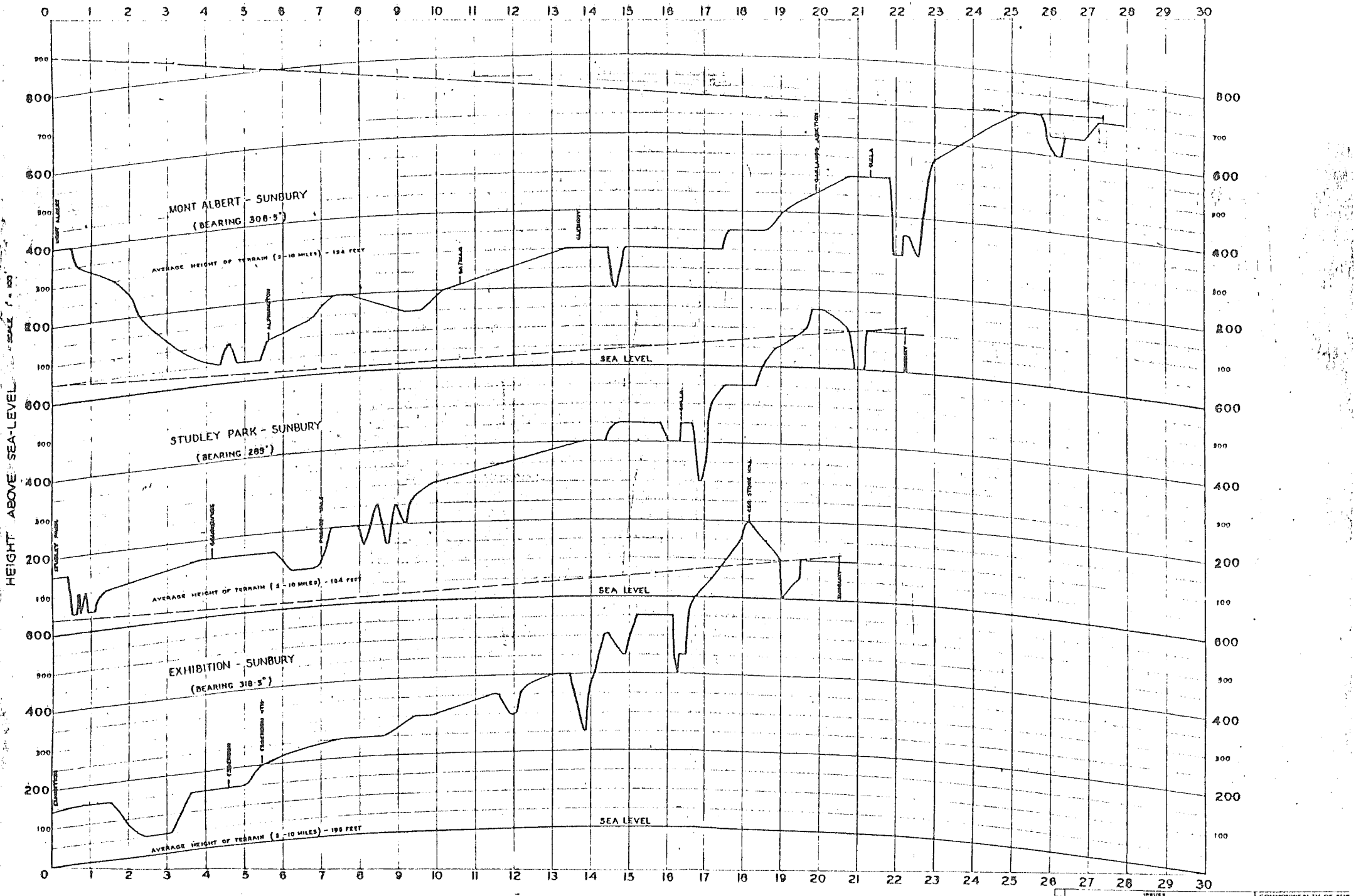
HEIGHT ABOVE SEA-LEVEL
SCALE 1" = 100'
DISTANCE IN MILES SCALE 1" = 1 MILE



COMMONWEALTH OF AUSTR...
RADIO PATH - PROFILE DIA...
MELTON


MONT ALBERT - SUNBURY
(BEARING 306·5°)
AVERAGE HEIGHT OF TERRAIN (2 - 10 MILES) - 194 FEET
SEA LEVEL
STUDLEY PARK - SUNBURY
(BEARING 289°)
AVERAGE HEIGHT OF TERRAIN (2 - 10 MILES) - 184 FEET
SEA LEVEL
EXHIBITION - SUNBURY
(BEARING 318·5°)
AVERAGE HEIGHT OF TERRAIN (2 - 10 MILES) - 198 FEET
SEA LEVEL
HEIGHT ABOVE SEA-LEVEL SCALE 1" = 100'
DISTANCE IN MILES SCALE 1" = 1 MILE