

GROUND WATER IN JAFFNA

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GROUND WATER RESOURCES OF THE JAFFNA PENINSULA

BEING PRELIMINARY STUDIES OF THE HYDROLOGICAL
INVESTIGATION SURVEY NOW IN PROGRESS

by

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GROUND WATER IN JAFFNA

Ground Water holds the key to agricultural enterprise in the Jaffna Peninsula; its potential, however has never been systematically investigated. The subject has come into prominence now due to recent reports of the incidence of saline infiltration in wells that have never been saline before. A systematic survey was instituted in 1965 on the advice of Dr. Arnon Arad, Hydrogeological Expert from Israel who was visiting Ceylon at that time.

1. OBJECTS OF THE SURVEY

2. The object of the Survey Investigation was to ascertain the quantity and quality of the Ground Water Resources in the Peninsula, for use in agricultural development.

3. The Survey was expected to reveal indications of the following:—

- (1) The quantity of rain water that percolates annually into the ground water body of the Peninsula;
- (2) The extent of flow of ground water into the sea;
- (3) The quantity of ground water available for use in agricultural enterprise;
- (4) The extent of salinity that tends to infiltrate into the aquifer;
- (5) The direction, duration and sources of saline infiltration.

2. SYSTEMATIC OBTAINMENT OF DATA

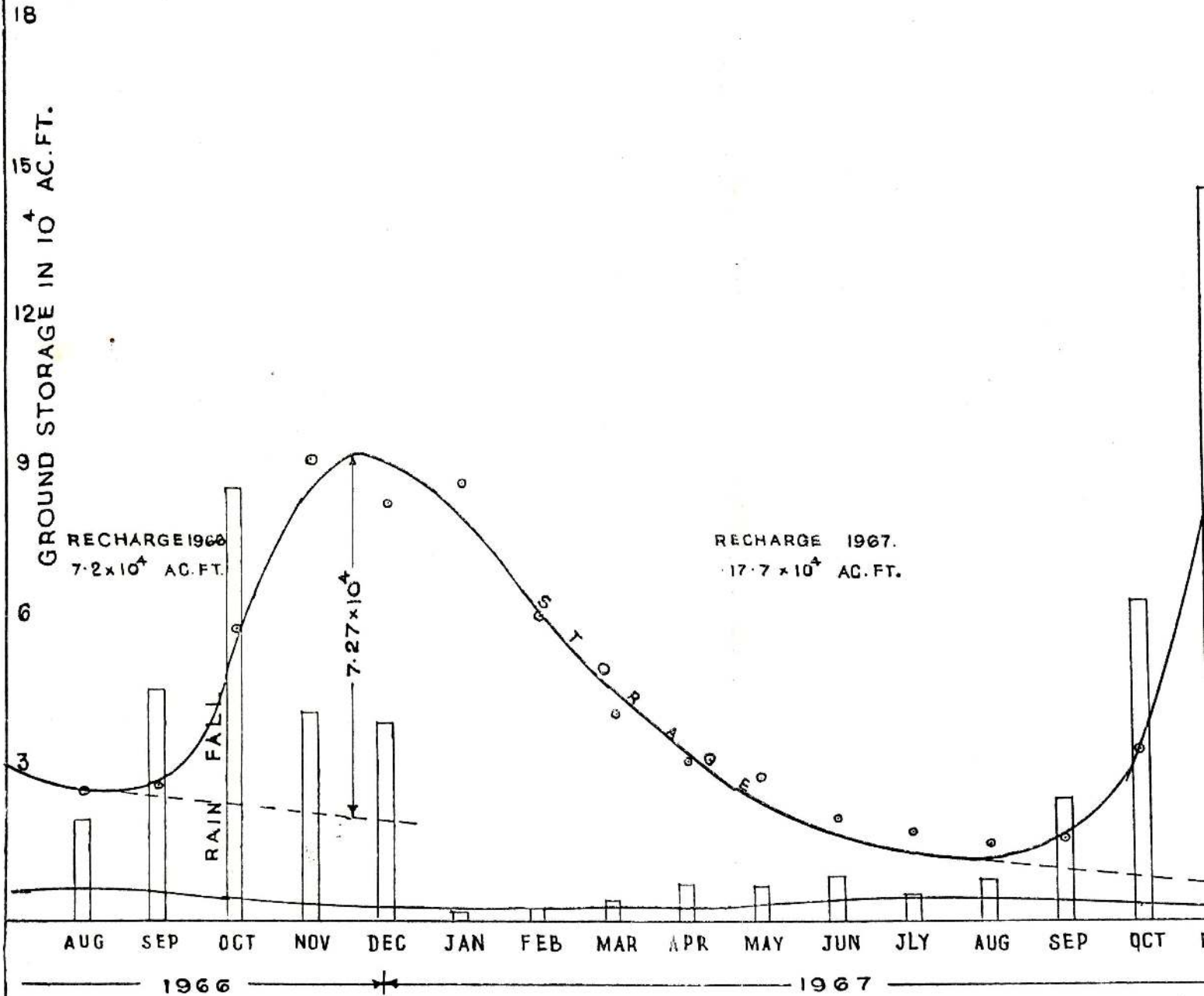
4. It was decided that in the first instance a systematic collection of hydrologic data of the ground water as found in the wells of Jaffna was necessary, for any assessment of the problem.

5. From among the existing wells in Jaffna, over four hundred representative "Observation Wells" were selected over the entire area of the Peninsula as shown in Appendix I, for obtaining data of the ground water. The data to be collected consisted of (a) observing the level of the water in each well and (b) obtaining a sample of water found at the bottom of the well, for chemical analysis.

6. The chemical analysis was undertaken by the Science Masters of the Colleges in the area, working to uniform methods and standards, determined by the Northern Province Science Teachers' Association. The number of observation wells selected in an area was adjusted in keeping with the number of analyses that could be undertaken by the schools in the vicinity; the adoption of a uniform grid pattern of a well per unital area, in the selection of well sites, was therefore not feasible.

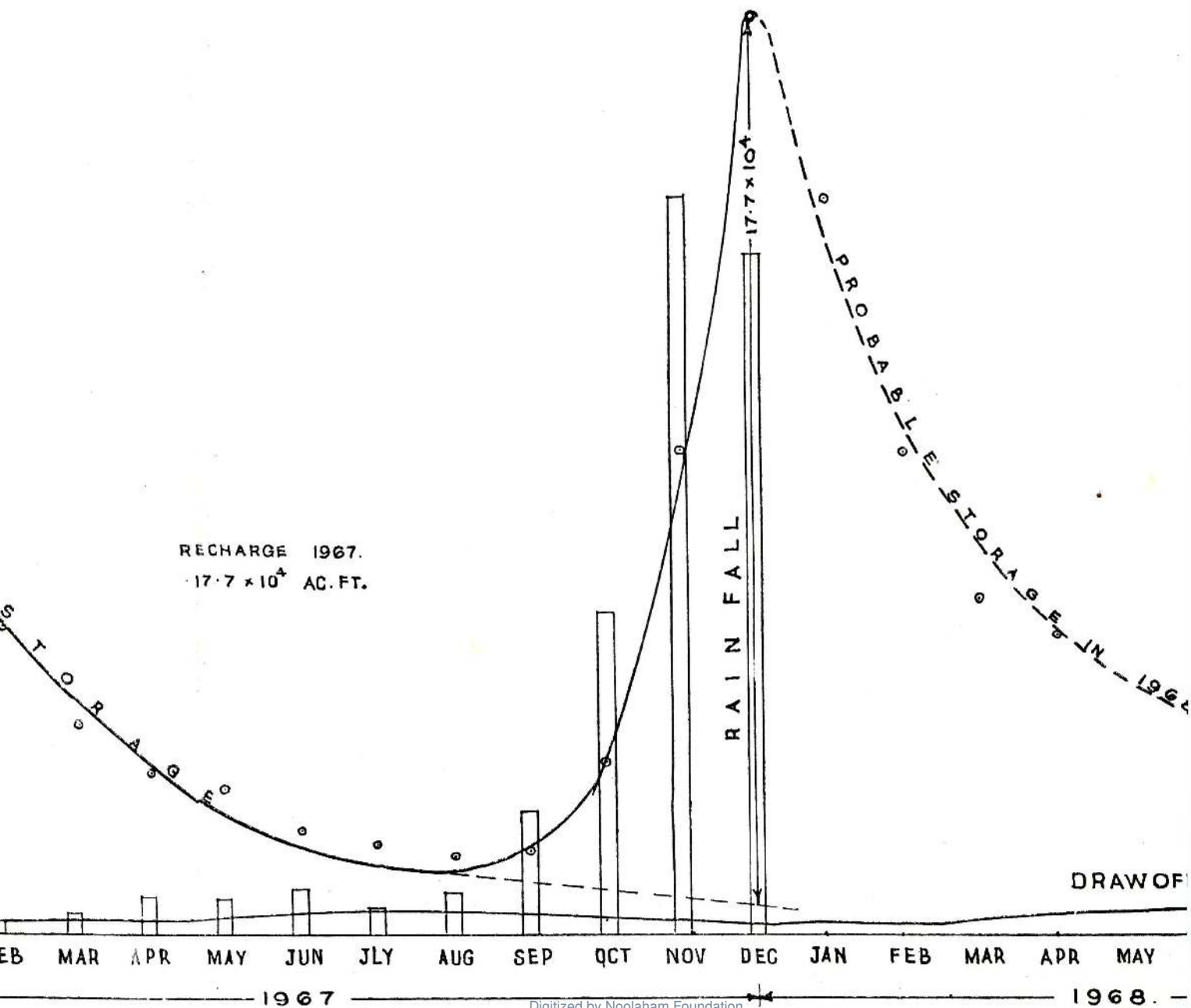
The following parameters, needed for the objectives of the survey, were obtained from the analysis of each sample:—

JAFFNA PENINSULA RECHARGE AND DRAWOFF FROM THE



JAFFNA PENINSULA.

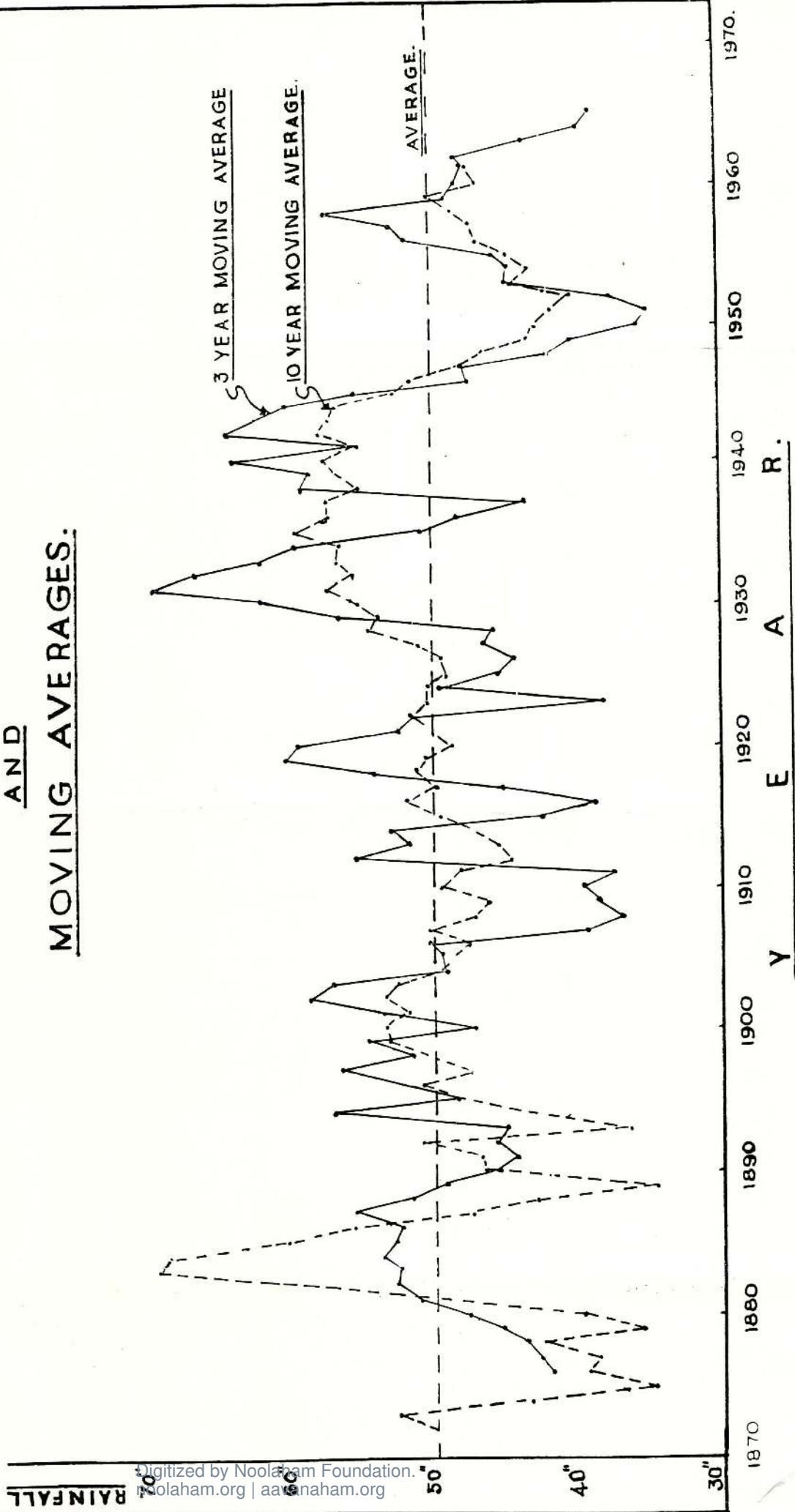
RECHARGE AND DRAWOFF FROM THE AQUIFER.



J A F F N A

RAINFALL VALUES 1870-1966.

AND
MOVING AVERAGES.



Chloride Ions, in parts per million,
 Total hardness as calcium carbonate, in p.p.m.,
 Total dissolved solids present, in p.p.m.,

7. The work of collecting the data, as above though commenced in March 1965, became organised into an uninterrupted regular system only from August, 1966, with the setting up of a Ground Water Investigation Unit with laboratory facilities, for analysis.

3. TOPOGRAPHY AND DRAINAGE

8. The Jaffna Peninsula, Longitude $79^{\circ}45'$ — $80^{\circ}20'$ E Latitude $9^{\circ}30'$ — $9^{\circ}50'$ N, with a land mass of 400 sq. miles forms the northern extremity of Ceylon. It has the sea (Palks Straight) on its western, northern and eastern sides and the Jaffna Lagoon in the South. The Islands of Mandaitivu Karainagar, Kayts, Eluvativu, Analaitivu, Punkudutivu, Nainativu and Delft lie to the west of the Peninsula.

9. A long stretch of water, forming an internal lagoon almost divides the area into two, with the northern outlet at Thondaimanar and the southern at Ariyalai. These two drainage outlets are now controlled and regulated for the prevention of sea water ingress and for the conservation of fresh water within the Peninsula.

10. The area is relatively flat and is at low elevation, except in the North Central portion of the Western sector, in the area around Tellipalai, where the elevation reaches up to 35 feet M.S.L. From here it slopes gently towards the South and South East but to the North the elevations tend to drop abruptly as the sea is reached, giving rise to marginal low cliffs.

The North Eastern sector slopes from the 35 ft. elevation down to the South into the sand dune covered South Eastern sector. The sand dunes are generally found to be elongated in a NE-SW direction, due to the prevailing strong monsoonal winds. Some of the sand dunes have accumulated to reach even a height of 50 feet above M.S.L. Further to the South the portion of the Peninsula that lies between Kodikamam and Elephant Pass is a 'low sandy stretch which is relatively flat.

Of the 260,000 acres that form the Peninsula (excluding the island of Delft), over 60% is occupied as residences and home gardens; about 34,000 acres (13%) are cultivated with subsidiary food and other crops; paddy is cultivated in 32,000 acres ($12\frac{1}{2}\%$). The Lagoon takes up about 10% and the balance $4\frac{1}{2}\%$ form waste lands.

11. Apart from the Thondaiman Aru and the Uppu Aru which drain the major lagoon to the North and the South respectively, a small stream called the Valukai Aru rising from the Central 35 feet elevation runs for over 8 miles through Alaveddi, Uduvil and Manipay conveying the drainage from the South Western areas. Apart from these natural drainage courses a few excavated short length canals, e.g. one from Nandavil flowing through Jaffna Town, another from Palali through Myliddy etc. are maintained as extra flood drainage courses.

4. GEOLOGY

12. The Jaffna Peninsula is mainly underlain by Miocene Limestone. This limestone is capped in places by thin layers of residual soil belonging to the Pliocene-Pleistocene Period, and lagoonal and lacustrine deposits like brown sands and loams, wind blown sands and coral reefs belonging to the Quarternary Period.

13. Geographically, the limestones are exposed at the north central part of the Peninsula, extending in a NNE to SSW direction from Urumprai to Palali. Bordering this on the western side are patches of red earth formations. Encompassing these two formations are found the brown sand formation which occupy a larger area on the western side than the eastern side. Enclosing these along the western coast and in the lagoonal areas are found lagoonal deposits. The area east of the lagoon are occupied mainly by brown sandy loams in the south and sand dunes in the north along the eastern coast of the Peninsula, stretching from Thumpalai to Nagarkovil and beyond. Recent Coralline reefs are found along the northern coasts of the Peninsula.

14. The Jaffna limestone belongs to the Lower Miocene Period especially to the Burdigalian stage, as inferred by the presence of micro index fossils such as *Taberina Malabarica*. It is almost flat bedded with a slight dip to the west and consequently it thickens to the west. It has a vertical thickness of at least several hundred feet. From a drill hole put down at Pallai, it was found to be 270 feet thick there, and was underlain by a thick sandstone formation above the Precambrian basement. This sandstone, about 430 feet thick has been tentatively correlated with the Gandwana sediments of Jurassic age and named as the Mannar Sandstone Formation.

15. Lithologically the Jaffna Limestone is a creamy coloured hard compact, indistinctly bedded, partly crystalline rock. It is massive in parts but some layers are richly fossiliferous and weather into a honey combed mass. In places, it is well jointed and has a marked rectangular pattern of closely spaced joints running NW-SE and NE-SW. The easily dissolvable limestone also give rise to a number of underground solution caverns. The Mannar sandstone is mostly grey, coarse grained with minor intercalations of silts and clays. It is argillaceous in the upper part and calcareous in the middle.

16. From the Gondwana Period till the Miocene Period, Ceylon and India were together and remained above sea. About 20 million years ago, an arm of the Tethys sea encroached on the peneplaned landmass between India and Ceylon and turned Ceylon for the first time into an Island, bringing the entire area of the Jaffna Peninsula under sea. In the relatively shallow seas grew extensive coral reefs rich in fauna and several hundred feet of limestones, calcareous clays and sands were accumulated on the sea floor. The tertiary period throughout the earth was marked by great mountain building movements. Ceylon was however far from these intense movements and the miocene rocks were hardly affected by them. There

was only a slight warping of the surface and a continuous uplifting of the sea floor whereby the limestone beds were brought above the sea to form the Peninsula. During the Quarternary Period, the Peninsula had minor upliftments and subsidence which gave rise to the residual, lacustrine and lagoonal deposits.

5. RAINFALL AND HYDROLOGY

17. Rainfall records are available from nine rainfall stations in the Peninsula, recording for over 50 to 95 years. Jaffna Town itself has rainfall records commencing from as far back as 1871. Rainfall guaging has been commenced in 1967 at the following five additional stations, Viz: Puttur, Kondavil, Tolpuram, Ampan and Mirusuvil, in order to have a better net work of guaging stations.

18. Distribution and regime of Rainfall: The mean annual rainfall at the nine stations, during the twelve years 1955 to 1966 appears below:

Station	Mean Annual Rainfall (1955-1966) inches	Mean N.E. Monsoon Rainfall 1955-1966 inches
Jaffna	47.07	38.05
Kankesanturai	49.7	39.7
Kayts	40.7	31.9
Pallai	47.4	43.9
Jaffna College	51.5	39.2
Ramanathan College	51.8	42.2
Jaffna Farm School	51.7	40.9
Point Pedro	42.4	34.8
Delft	37.1	29.5

From the Isoheytal Map drawn from this data, it is found that the mean annual weighted average rainfall during this period works out to 47.7 inches per annum whereas the standard annual average for the period 1911-1940 as appearing on the Report of Colombo Observatory is 52.1 inches. It is also found that the north east monsoonal rainfall in the Peninsula (32 inches) forms 82% of the total annual rainfall.

19. *Variation of Rainfall:* While the seasonal rainfall exhibits a definite rhythmic pattern, there is however considerable variation in it from year to year. This variability of rainfall has always been a major hazard in agricultural enterprise in the area. It has been found convenient for the study of the hydrology to consider rainfall regime from September of one year to the end of August of the following year; at the end of August, water tables are generally at their lowest and the salinity of water at its highest.

20. Our investigations commenced, in 1964, immediately after Jaffna experienced the lowest annual rainfall of 24.6 inches recorded in 95 years. This figure of 24.6 inches is about 50% of the long term average. The lowest rainfalls of two consecutive dry years with 30 inches per year was recorded in 1875 and 1876. The lowest record of rainfall for three consecutive dry years average 35 inches per annum. The long term variation of rainfall was studied by means of a "three year" and "ten year" moving average and indicates a cyclic pattern of variation; it does not indicate a tendency to increase or decrease over the period 1871 to 1966, as would be seen in the Graph.

Dr. G. Thambyahpillay in his article on "Dry Zone Climatology" (Journal of the National Agricultural Society of Ceylon, Vol. 2., No. 1. 1965) refers to an overall pattern of the Island's rainfall, as showing a twenty year cycle of wet and dry phases somewhat as follows:—

Up to	1880 s	:	dry phase
1880 s to	1900 s	:	wet phase
1900 s to	1920 s	:	dry phase
1920 s to	1940 s	:	wet phase
1940 s to	1960 s	:	dry phase
post 1960	period	:	wet phase

The above graph also indicates this cycle; accordingly we are now getting into a wet phase.

21. *Run-Off*: Due to the relatively flat topographical nature of the area and its geological structure, the surface drainage of the Peninsula, under normal rainfall, is meagre. Heavy run-off and flooding however takes place after heavy and abnormal rains, through the drainage courses mentioned earlier.

2. *Re-charge from Rainfall*: The recharge to ground water in the Peninsula is almost entirely from rainfall percolation; any significant contribution by lateral percolation from the basement is very unlikely. The water table oscillations in relation to the rainfall and its depletion during the dry season have been studied now from observation, of Ground Water as found in the "observation Wells" of this Investigation Survey, during the period 1965 to 1967. The date of the 411 wells, as collected, appear in a separate compilation: "Ground Water Observations, Data Book". On appendix II sheets 1-3 are shown the data of over forty representative wells.

23. The behaviour of the ground water table during the years 1965, 1966 to December 1967 enables us to compute the increase in ground storage, above sea level, as a result of rainfall recharge each year. These contours enable the computation of the volume of water stored in the aquifer, by integrating the incremental layers of the saturated aquifer each month and assuming a storage coefficient (effective porosity) of 0.15. The porosity of the Jaffna limestone has been found to vary between 4.5% and 27%, with a mean value of 15%. We thus get the following:—

Rainfall and Recharge

Period	Rainfall	Recharge in Ac. Ft.
Sept. '64—Jan. '65	22 inches	50,000 (estimated)
Sept. '65—Jan. '66	40 inches	90,000 (computed)
Sept. '66—Jan. '67	36 inches	73,000 (computed)
Sept. '67—Jan. '68	62 inches	177,000 (computed)

This is shown on the graph.

6. GROUND WATER EXPLOITATION IN THE PENINSULA

24. A census of all domestic and agricultural wells in the Peninsula was made, with the assistance of the Census and Statistics Section at the Jaffna Kachcheri; there are in all over 84,000 wells in the area. Of these, about 66,000 are domestic wells where water is drawn for domestic purposes only and the balance 18,000 are Farm or Agricultural wells.

25. The concentration of wells in an area is an indication of the heavy draw off practised in the area. A well intensity map of the Peninsula showing the farm or agricultural wells and the domestic wells separately per unit area of 100 acre was prepared. The intensity of agricultural wells is very high in the Urumpirai, Urelu, Mallakam, Uduvil areas where there are over 30 such wells in every 100 acres. These coincide with areas of heavy draw-off. As would be expected, largest number of domestic wells are to be found in Jaffna Town and the neighbouring Kokkuvil areas with intensities of 152 and 129 per 100 acre respectively. These are areas of heavy draw off for domestic purposes.

26. The ground water storage in December 1967 as shown on Graph No. 1. amounts to 17.7×10^4 Ac. Ft. The probable curve for the year 1968 is shown dotted on the same diagram. Based on the data available, a table indicating the monthly draw off has been prepared and the draw off plotted on the ground water storage; this indicates that in the year 1968 there will be no overdrawing when the Peninsula is considered as a whole. But agricultural lands are not evenly distributed over the Peninsula and there is the possibility that localized overdrawing may occur in some areas.

27. If the extent in cultivation with vegetables and other subsidiary crops, which require irrigation is only 13%, as mentioned in para 10, one may ask the question how the 13% could cause excessive draw off to cause the sea water interface to rise up?

28. The total quantity of water drawn off for agriculture is computed by sources of the Agricultural Department to be 28,000 ac. ft. per year and this would be mostly from the 18,000 agricultural wells. The annual draw off from each well is about $1\frac{1}{2}$ acre feet.

7. SALINITY STUDIES

29. As mentioned earlier in para 6, every sample of water obtained from each of the 411 observations wells is chemically analysed to determine the chloride ions etc. in it. On the basis of the results obtained from such analyses, isochlor maps have been prepared; these show the distribution

of chlorides, in parts per million, as found in the well waters of the Peninsula at the end of the months of August during each of the years 1965, 1966 and 1967. For the year 1965, data from 85% of the wells only is available.

30. A combination of the three isochlor maps enables us to delineate the areas or zones where salinity prevailed during the period 1965-1967. This is shown on the Salinity Map, adopting different colours for

- (a) areas free from salinity (less than 500 p. p.m.)
- (b) areas with moderate salinity (500 to 1000 p. p.m.)
- (c) areas of moderate salinity which would increase with draw off (1000 to 1500 p. p.m.)
- (d) areas liable to salinity in the dry seasons (1500 to 2000)
- (e) saline areas (above 2000 p. p.m.)

Wherever possible, the directional trend along which salinity is likely to percolate inland, is indicated by arrows; the distribution of salinity and its trend appear to be controlled by recharge from rainfall, withdrawal from ground storage from wells, and by the variation of transmissibility of the limestone aquifer.

Vertical Distribution of Salinity

31. The vertical distribution of salinity has been under observation by the Department of Geological Surveys from October 1964, in bore holes at Kondavil and at Kankasanturai. The results of these observations in respect of the Kondavil bore hole have been studied.

These show that the general pattern of change is indicated by improvement in the quality of the water at all levels, during and after each wet season and by deterioration of quality during the dry periods.

The observations are being continued for determining the long term trend.

8. EVALUATION

32. Extents of the salinity zones, referred to in para 30, as obtained from the maps are as follows:—

	1965/66	1966/67	During the 3 years 1965-66-67
Areas free from salinity in acres	128,100	142,780	145,000
Areas moderately free from salinity in acres	64,200	64,000	60,350
Areas liable to salinity only in the dry season in acres	46,480	43,800	47,800
Saline areas—acres	17,290	11,000	12,450

The areas consistently free from salinity have increased from 128,100 acres to 142,780 acres and finally to 145,000 acres—increase of 13%

The areas moderately free from salinity have decreased from 64,200 acres to 64,000 acres and finally to 60,350 acres—6% decrease.

The areas liable to salinity only in the dry season have decreased from 46,480 acres to 43,800 acres and then increased to 47,800 acres.

The saline areas have decreased from 17,290 acres to 11,000 acres and then increased to 12,450 acres—overall decrease of 28%.

33. A comparison of the salinity distribution map with that indicating the total estimated draw-off shows that a large area of the Peninsula is not being drawn on, on any extended scale. Increased extraction from these areas should be possible such as for instance in the zone free from salinity in the centre of the Peninsula, where only 10,000 acre feet of water were drawn off from about 62,400 acres. In the eastern part of the Peninsula, in the Pallai sandy region, only 600 acres feet were drawn off in about 70,000 acres.

In the Islands about 3,300 acre feet were pumped from about 12,000 acres. These rates ignoring the Pallai area, vary from about one sixth to one fourth of an acre foot per acre.

34. In the saline areas of about 12,450 acres the estimated draw off is 6350 acre feet or about half an acre foot per acre.

It becomes evident then, that these saline areas indicate a certain degree of **over extraction**

The above was computed on the presumption that the draw off from an agricultural well is 1.5 acre feet per annum and from a domestic well 0.3 acre feet per annum.

9. WATER BALANCE

35. A very generalised and tentative water balance can now be prepared on the basis of data available. The present **consumption** of water for domestic and agricultural uses is estimated at 40,000 acre feet per annum. The recharge of rainfall in a normal year such as 1966, is 90,000 acre feet with a discharge to the sea of 50,000 acre feet. In a lean year however as in 1965, when only about 50,000 acre feet of rainfall recharge was available, the discharge to the sea would have been of the order of 10,000 acre feet, but with the prevalence of the same rate of consumptive use. The recharge for 1967, rainy season is about 177,000 acre feet. A 137,000 acre feet of water is available to augment the ground storage by depressing the interface and discharge to the sea. It would thus be evident that ground storage of large amounts of water capable of maintaining supplies during a continuous spell of consecutive dry years, is not possible, and drastic reductions in rates of extractions of water from wells would have to be made, to tide over such spells. During wet spells such as during the heavy rainfall in the 1967 season a very large proportion of the recharge will discharge to the sea.

36. It should thus be possible, by keeping accurate records of: rainfall data, water table fluctuations, rates of extraction and salinity of water from wells for a number of years, to compute safe yearly rates of withdrawal from the aquifer. More accurate values of the storage coefficient from field as well as laboratory determinations have also to be determined.

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The Geological Survey Department,

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G. M. Anghie, former Deputy Director of Irrigation,

S. Rajendran, Irrigation Engineer, Ground Water Section.

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Interim Report of the Hydrological Survey in Jaffna Peninsula, presented by the Technical Sub-Committee of the District Committee (7-2-1968).

APPENDIX I

OBSERVATION WELLS

PACHILLAI PALI—D.R.O's DIVISION (16 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
1.	Chundikulam	6.	Muhavil	11.	Kilaley
2.	Mulliyam	7.	Soran Pattu	12.	Kilaley
3.	Mulliyam	8.	Ittavil	13.	Muhamalai
4.	Koil Vayal	9.	Puloppallai	14.	Muhamalai
5.	Koil Vayal	10.	Puloppallai	15.	Chempian Pattu
				16.	Maruthankerni

THENMARACHCHY—D.R.O's DIVISION (44 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
17.	Eluthumaduvil	32.	Iyattalai, Sarasalai	47.	Thanan Kilappu
18.	Eluthumaduvil	33.	Manthuvil	48.	Madduvil North
19.	Usan	34.	Kodigammam	49.	Meesalai South
20.	Mirusuvil	35.	Meesalai North	50.	Meesalai South
21.	Mirusuvil	36.	Manthuvil	51.	Chavakachcheri
22.	Usan	37.	Meesalai North	52.	Kachchai North
23.	Kodigammam	38.	Iyattalai, Sarasalai	53.	Kachchai North
24.	Navat Kadu	39.	Madduvil North	54.	Madduvil Nunavil
25.	Varany North	40.	Kaithady	55.	Chavakachcheri
26.	Varany North	41.	Kaithady	56.	Chavakachcheri South
27.	Idaikurichy	42.	Koilakandy	57.	Chavakachcheri South
28.	Idaikurichy	43.	Koilakandy	58.	Nunavil
29.	Varany, Thavalai	44.	Maravan Pulam	59.	Nunavil
30.	Varany, Thavalai	45.	Maravan Pulam	60.	Madduvil Nunavil
31.	Navat Kadu	46.	Thanan Kilappu		

VADAMARACHCHI—D.R.O's DIVISION (100 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
61.	Nagarkovil	72.	Ampan	83.	Point Pedro
62.	Nagarkovil	73.	Thunnalai North	84.	Alavai North
63.	Nagarkovil	74.	Thumpalai	85.	Puloly West
64.	Nagarkovil	75.	Kalkovilam	86.	Puloly West
65.	Kudathanai Karaiyoor	76.	Kalkovilam	87.	Puloly East
66.	Kudathanai Karaiyoor	77.	Kalkovilam	88.	Puloly East
67.	Kudathanai Karaiyoor	78.	Thumpalai	89.	Puloly East
68.	Ampan	79.	Thumpalai	90.	Thumpalai
69.	Ampan	80.	Thumpalai	91.	Puloly East
70.	Kudathanai Karaiyoor	81.	Point Pedro	92.	Puloly East
71.	Ampan	82.	Point Pedro	93.	Puloly South

Well No.	Location	Well No.	Location	Well No.	Location
94.	Puloly South	116.	Karaveddi West	138.	Polikandy
95.	Thunnalai North	117.	Karaveddi East	139.	Polikandy
96.	Thunnalai South	118.	Karaveddi West	140.	Polikandy
97.	Thunnalai North	119.	Karaveddi East	141.	Valvetty
98.	Thunnalai North	120.	Karaveddi East	142.	Udupiddy
99.	Thunnalai South	121.	Alvai West	143.	Valvetty
100.	Alvai North	122.	Karanawai North	144.	Valvetty
101.	Alvai West	123.	Alvai West	145.	Udupiddy
102.	Alvai North	124.	Polikandy	146.	Udupiddy
103.	Alvai South	125.	Karaveddi North	147.	Udupiddy
104.	Puloly West	126.	Karaveddi North	148.	Kerudavil
105.	Alvai North	127.	Karanawai North	149.	Udupiddy
106.	Puloly West	128.	Karaveddi North	150.	Thonda Manaru
107.	Puloly South	129.	Karaveddi West	151.	Udupiddy
108.	Puloly South	130.	Karanawai North	152.	Kerudavil
109.	Alvai South	131.	Karanawai South	153.	Thonda Manaru
110.	Alvai South	132.	Karanawai North	154.	Thonda Manaru
111.	Alvai South	133.	Karanawai South	155.	Kerudavil
112.	Thunnalai South	134.	Karanawai North	156.	Udupiddy
113.	Thunnalai South	135.	Karanawai South	157.	Udupiddy
114.	Karaveddi West	136.	Karanawai South	158.	Valvettithurai
115.	Karaveddi West	137.	Karanawai South	159.	Udupiddy
				160.	Valvettithurai

VALLIKAMMAM EAST D.R.O's DIVISION (40 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
161.	Pathaimany	174.	Puttur East	187.	Urumpirai
162.	Pathaimany	175.	Puttur East	188.	Kopay North
163.	Pathaimany	176.	Sirupiddy	189.	Kopay North
164.	Pathaimany	177.	Sirupiddy	190.	Neervely
165.	Atchuvely	178.	Sirupiddy	191.	Kopay South
166.	Atchuvely	179.	Sirupiddy	192.	Kopay North
167.	Atchuvely	180.	Neervely	193.	Kopay South
168.	Atchuvely	181.	Neervely	194.	Kopay South
169.	Puttur West	182.	Neervely	195.	Kopay South
170.	Puttur West	183.	Urumpirai	196.	Kopay South
171.	Puttur East	184.	Urelu	197.	Urumpirai
172.	Puttur East	185.	Urumpirai	198.	Urelu
173.	Puttur West	186.	Urumpirai	199.	Urelu
				200.	Puttur West

VALIKAMMAM NORTH D.R.O's DIVISION (100 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
201.	Palaly	204.	Palaly	207.	Vasavilan
202.	Palaly	205.	Vasavilan	208.	Vasavilan
203.	Palaly	206.	Vasavilan	209.	Punnalaikadduvan

Well No.	Location	Well No.	Location	Well No.	Location
210.	Punnalaikadduvan	240.	Myliddy North	270.	Tellippalai South West
211.	Punnalaikadduvan	241.	Myliddy North	271.	Tellippalai South West
212.	Punnalaikadduvan	242.	Palaly Veemankamam	272.	Tellippalai South West
213.	Myliddy East	243.	Palaly Veemankamam	273.	Tellippalai South West
214.	Myliddy East	244.	Myliddy North	274.	Tellippalai East
215.	Myliddy North	245.	Kadduvan	275.	Tellippalai East
216.	Palaly	246.	Myliddy South	276.	Tellippalai East
217.	Myliddy South	247.	Tellippalai East	277.	Alaveddy
218.	Myliddy South	248.	Kadduvan	278.	Alaveddy
219.	Myliddy South	249.	Kadduvan	279.	Alaveddy
220.	Myliddy South	250.	Kadduvan	280.	Mallakam
221.	Vasavilan	251.	Tellippalai East	281.	Mallakam
222.	Kadduvan	252.	Kankesanthurai	282.	Alaveddy
223.	Kuppilan	253.	Kankesanthurai	283.	Mallakam
224.	Kuppilan	254.	Kankesanthurai	284.	Mallakam
225.	Punnalai Kadduvan	255.	Kankesanthurai	285.	Mallakam
226.	Kuppilan	256.	Palaly Veemankamam	286.	Chunnakam
227.	Kuppilan	257.	Palaly Veemankamam	287.	Chunnakam
228.	Kuppilan	258.	Maviddapuram	288.	Chunnakam
229.	Earlalai	259.	Palaly Veemankamam	289.	Uduvil
230.	Eralalai	260.	Maviddapuram	290.	Uduvil
231.	Eralalai	261.	Tellippalai North West	291.	Uduvil
232.	Eralalai	262.	Maviddapuram	292.	Chunnakam
233.	Earlalai	263.	Tellippalai North West	293.	Inuvil
234.	Chunnakam	264.	Tellippalai North West	294.	Inuvil
235.	Myliddy East	265.	Maviddapuram	295.	Uduvil
236.	Myliddy East	266.	Maviddapuram	296.	Uduvil
237.	Myliddy East	267.	Tellippalai South West	297.	Inuvil
238.	Kankesanthurai	268.	Tellippalai North West	298.	Inuvil
239.	Myliddy North	269.	Tellippalai North West	299.	Inuvil
				300.	Alaveddy

VALIKAMAM WEST D.R.O's DIVISION (36 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
301.	Periyavilan	313.	Chulipuram	325.	Araly South East
302.	Periyavilan	314.	Chulipuram	326.	Araly South East
303.	Sandilipay	315.	Chankanai West	327.	Araly North West
304.	Mathagal	316.	Chankanai East	328.	Manipay
305.	Mathagal	317.	Vaddu East	329.	Navaly
306.	Pandaitharippu	318.	Moolai	330.	Manipay
307.	Pandaitharippu	319.	Moolai	331.	Suthumalai
308.	Chankanai West	320.	Vaddukoddai West	332.	Suthumalai
309.	Chankanai East	321.	Vaddu East	333.	Anaikoddai
310.	Sandilipay	322.	Vaddukoddai West	334.	Anaikoddai
311.	Chulipuram	323.	Araly North West	335.	Navaly
312.	Chulipuram	324.	Araly North West	336.	Navaly

ISLAND'S D.R.O's DIVISIONS (32 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
337.	Karainagar North	348.	Naranthanai	359.	Eluvativu
338.	Karainagar North	349.	Saravanai	360.	Eluvativu
339.	Karainagar West	350.	Saravanai	361.	Analativu
340.	Karainagar East	351.	Velanai West	362.	Analativu
341.	Karainagar West	352.	Velanai West	363.	Nainativu
342.	Karainagar East	353.	Velanai East	364.	Nainativu
343.	Kayts	354.	Velanai East	365.	Pungudutivu East
344.	Kayts	355.	Allaipiddy	366.	Pungudutivu West
345.	Naranthanai	356.	Allaipiddy	367.	Pungudutivu West
346.	Karampan	357.	Mandaitivu	368.	Pungudutivu East
347.	Karampan	358.	Mandaitivu		

JAFFNA D.R.O's DIVISION (36 WELLS)

Well No.	Location	Well No.	Location	Well No.	Location
369.	Kondavil	383.	Vannarponnai S.W.	397.	Gurunagar
370.	Kondavil	384.	Vannarponnai S.W.	398.	Gurunagar
371.	Kokuvil	385.	Vannarponnai S.W.	399.	Colombuthurai
372.	Vannarponnai N.W.	386.	Vannarponnai N.E.	400.	Chiviyatheru
373.	Vannarponnai N. W.	387.	Vannarponnai N.E.	401.	Chiviyatheru
374.	Kondavil	388.	Thiruvelveli	402.	Colombuthurai
375.	Kokuvil	389.	Nallur	403.	Colombuthurai
376.	Thiruvelveli	390.	Chiviyatheru	404.	Kokuvil
377.	Thiruvelveli	391.	Vannarponnai S.W.	405.	Delft
378.	Vannarponnai, N. E.	392.	Vannarponnai S.W.	406.	Delft
379.	Kokuvil	393.	Nallur	407.	Delft
380.	Vannarponnai S. W.	394.	Nallur	408.	Delft
381.	Moor Street	395.	Chiviyatheru	409.	Delft
382.	Moor Street	396.	Gurunagar	410.	Delft

APPENDIX II—SHEET I

DATA OF SOME SELECTD WELLS

WATER IN THE WELL (in feet)

D.R.O's Division Village	Well No.	1965—1966		1966—1967		1967—1968	
		1-8-65	1-1-66	1-8-66	1-1-67	1-8-67	1-1-68
Koil Vayal	5	1.42	11.98	4.42	6.67	2.67	12.67
Ittaval	8	—	—	5.00	7.94	3.06	10.11
Puloppallai	9	1.00	—	3.04	4.83	0.65	9.67
Maruthankerni	16	1.01	3.43	1.01	2.64	1.60	3.35
Eluthumaduvil	17	2.41	9.37	2.37	6.20	1.87	9.66
Varany, Thavalai	30	2.08	7.29	2.38	6.60	2.15	7.33
Kodigammam	34	0.92	6.75	0.88	4.12	1.17	6.67
Iyattalai, Sarasalai	38	3.25	6.37	3.04	5.54	3.23	6.25
Kaithady	40	—	5.50	3.75	4.50	4.75	5.42
Koilakandy	42	2.87	5.95	2.87	5.33	2.99	5.66
Maravan Pulam	45	2.25	7.42	2.17	6.67	1.96	7.25
Kachchai North	53	3.50	11.92	4.56	10.17	6.67	13.09
Nagarkovil	61	1.32	4.84	1.17	3.75	1.04	4.58
Kudathannai K'yoor	70	0.42	3.09	0.51	1.63	0.58	3.16
Thumpalai	80	5.67	8.33	5.25	7.25	5.31	8.00
Alvai North	100	0.08	3.33	0.08	1.58	0.08	1.83
Udupiddy	146	3.29	4.46	3.21	4.71	3.15	4.46
Kerudavil	155	2.74	5.33	2.66	4.66	2.58	4.91
Pathaimany	163	—	3.71	0.96	3.04	1.13	3.25
Puttur East	174	—	6.92	3.75	7.42	5.42	7.04
Neervely	181	—	6.75	3.83	6.03	3.95	6.33
Urumpirai	187	—	2.13	2.60	3.13	1.43	3.47
Vasavilan	205	2.00	4.58	1.78	3.96	1.92	4.08
Vasavilan	208	3.09	5.17	2.80	5.29	2.81	3.66
Myliiddy East	214	1.08	1.83	7.84	3.75	1.54	3.92
Chunnakam	234	4.89	8.14	4.81	7.64	5.33	5.58
Tellippalai East	247	0.84	2.17	1.38	4.38	2.38	4.63
Pandaitharippu	307	3.40	7.57	3.09	6.42	3.84	7.61
Chulipuram	314	3.08	7.54	2.92	6.67	2.92	8.00
Araly North West	327	1.00	5.92	1.00	5.42	1.33	6.00
Manipay	328	5.63	11.67	5.42	4.50	5.00	13.08
Karainagar North	337	1.58	8.16	2.16	8.08	3.91	7.83
Karainagar East	340	0.17	1.63	3.17	9.67	6.12	10.38
Kayts	343	1.11	7.55	1.26	6.72	2.01	8.30
Saravanai	349	3.40	10.07	3.57	9.45	1.55	11.67
Analativu	361	0.54	2.79	0.49	2.75	0.67	2.83
Pungudutivu West	367	5.38	10.50	5.92	9.17	4.17	9.67
Thiruvvelvi	377	—	8.33	4.75	5.65	4.92	8.08
Delft	408	—	—	—	6.85	0.39	6.48
Delft	410	—	—	1.93	5.09	1.12	2.68

APPENDIX II—SHEET II

DATA OF SOME SELECTED WELLS

ELEVATION OF WATER SURFACE IN WELL-M.S.L. DATUM

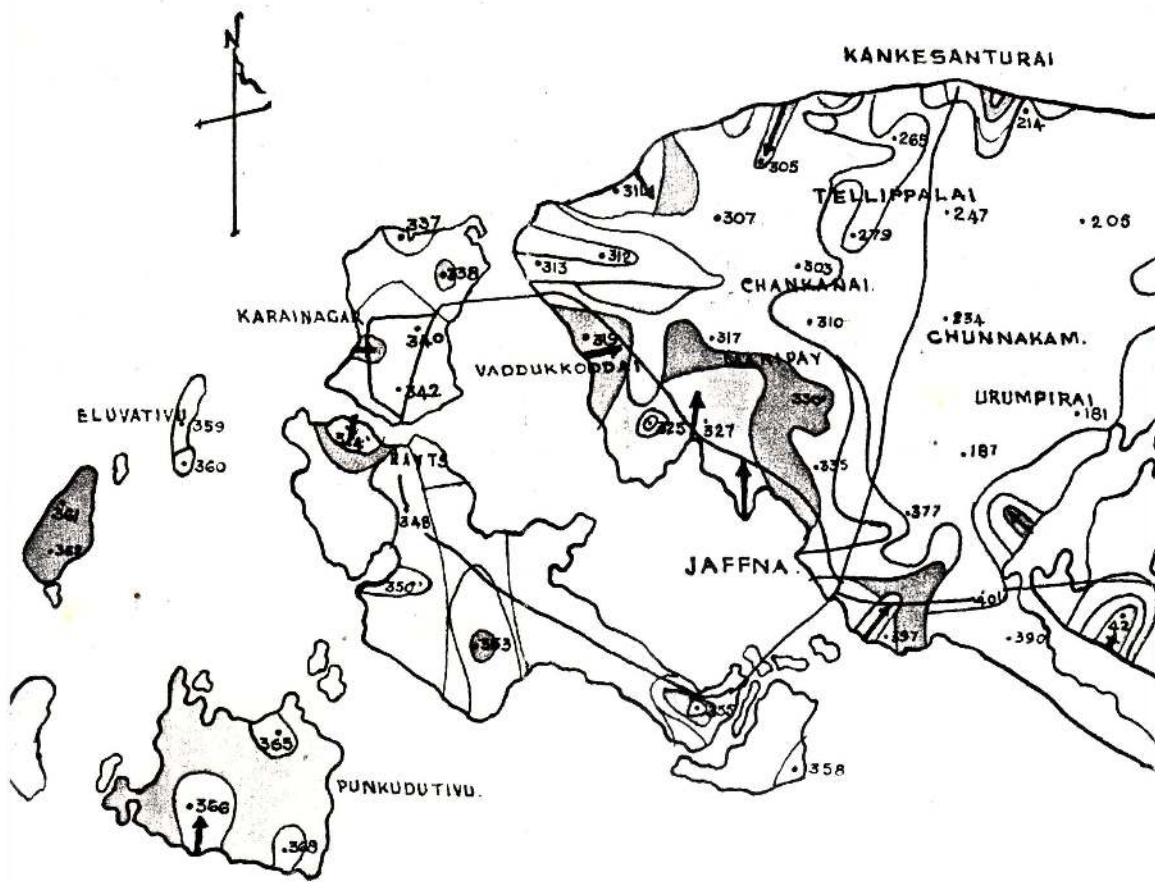
D.R.O's Division Village	Well No.	1965—1966		1966—1967		1967—1968	
		1-8-65	1-1-66	1-8-66	1-1-67	1-8-67	1-1-68
Kovil Vayal	5	1.27	11.83	4.27	6.52	2.52	12.52
Ittavil	8	—	—	3.49	6.43	1.55	8.60
Puloppalai	9	-1.20	—	0.84	2.63	-1.55	7.47
Maruthankerni	16	0.92	3.34	0.92	2.55	1.51	3.26
Eluthumaduvil	17	0.08	7.04	0.04	3.87	-0.46	7.33
Varany Thavalai	30	-1.38	3.83	-1.08	3.14	-1.31	3.87
Kodigammam	34	-0.93	4.90	-0.97	2.27	-0.68	4.82
Iyattalai, Sarasalai	38	0.32	3.44	0.11	2.61	0.28	3.32
Kaithady	40	—	2.83	1.08	1.83	2.08	2.75
Koilakandy	42	-0.26	2.82	-0.26	2.20	-0.14	2.53
Maravan Pulam	45	-1.95	3.22	-2.03	2.47	-2.24	3.05
Kachchi North	53	-2.03	6.39	0.97	4.64	1.14	7.56
Nagarkovil	61	4.06	7.58	3.91	6.49	3.78	7.62
Kudathnai K'yoor	70	-0.20	2.47	0.11	1.01	0.04	2.54
Thumpalai	80	2.17	4.83	1.75	3.75	1.81	4.50
Alvai North	100	0.00	3.25	0.00	1.50	0.00	1.75
Udupiddy	146	0.94	2.11	0.86	1.36	0.77	2.11
Kerudavil	155	0.27	2.86	0.19	2.19	0.11	2.44
Pathaimany	163	—	2.80	0.05	2.13	0.22	2.34
Puttur East	174	—	3.40	0.23	3.90	1.90	3.52
Neervely	181	—	3.16	0.24	2.44	0.33	2.74
Urumpirai	187	—	1.86	0.53	2.86	1.16	3.20
Vasavilan	205	-0.60	1.98	-0.82	1.36	-0.68	1.48
Vasavilan	208	-0.22	1.86	-0.51	1.98	-0.47	0.35
Milyddy East	214	-3.64	-2.89	3.12	-0.97	-3.18	-0.80
Chunnakam	234	0.16	3.41	0.08	2.91	0.60	0.85
Tellippalai East	247	0.70	2.03	0.14	2.86	0.86	3.11
Pandaitharippu	307	0.13	4.30	-0.18	3.15	0.57	4.34
Chulipuram	314	0.22	4.68	0.06	3.81	0.06	5.14
Araly North West	327	-1.14	3.78	-1.14	3.28	-0.81	3.86
Manipay	328	0.42	5.62	-0.63	4.45	-1.05	7.03
Karainagar North	337	-2.68	3.90	-2.10	3.82	-0.35	3.57
Karainagar East	340	-5.90	-4.44	-2.90	3.60	0.05	4.31
Kayts	343	-2.02	4.43	-1.86	3.60	-1.11	5.18
Saravanai	349	-1.24	5.43	-1.07	4.85	-3.09	6.43
Analativu	361	1.21	3.46	1.16	3.42	1.34	3.50
Pungudutivu West	367	0.64	5.76	1.18	4.43	-0.57	4.93
Thiruvelvili	377	—	3.90	0.32	1.22	0.49	3.65
Delft	408	—	—	—	5.01	-1.45	4.64
Delft	410	—	—	0.65	3.81	-0.16	1.40

APPENDIX II—SHEET III

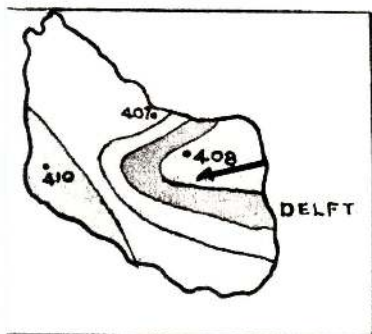
DATA OF SOME SELECTED WELLS

DATA OF SALINITY FROM SAMPLE OF WATER FOUND AT
BOTTOM OF WELL (CHLORIDE IONS IN PARTS PER MILLION)

D.R.O's Division Village	Well No.	1965—1966		1966—1967		1967—1968	
		1-8-65	1-1-66	1-8-66	1-1-67	1-8-67	1-1-68
Koil Vayal	5	—	—	90	75	170	160
Ittivil	8	—	—	40	55	35	25
Puloppallai	9	—	—	110	105	115	340
Maruthankerni	16	—	—	45	25	25	30
Eluthumaduviel	17	—	—	200	210	90	110
Varani Thavalai	30	—	—	7750	225	760	330
Kodigammam	34	—	—	125	90	150	20
Iyathalai Sarasalai	38	—	—	975	890	930	1010
Kaithady	40	—	—	250	175	350	90
Koilakandy	42	—	—	3175	1905	1880	1590
Maravan Pulam	45	—	—	1625	172.5	1540	1300
Kachchi North	53	—	—	62.5	37.5	20	40
Nagarkovil	61	—	—	403	60	50	15
Kudathanai Kara'or	70	—	—	65	110	20	20
Thumpalai	80	—	—	2362.5	2225	2590	980
Alvai North	100	—	—	1878	2075	2150	3060
Udupiddy	146	—	—	410	750	1130	580
Kerudavil	155	—	—	180	150	210	70
Pathaimany	163	—	—	1850	1520	1930	1560
Puttur East	174	—	—	850	625	870	650
Neervely	181	—	—	470	250	490	420
Urumpirai	187	—	—	110	137.5	195	270
Vasavilan	205	—	—	75	125	75	200
Vasavilan	208	—	—	—	175	190	275
Myliddy East	214	—	—	120	87.5	120	60
Chunnakam	234	—	—	75	112.5	70	150
Tellippalai East	247	—	—	5.33	200	190	275
Pandaitharippu	307	—	—	—	200	200	510
Chulipuram	314	—	—	275	50	290	30
Araly North West	327	—	—	1650	7000	5850	2420
Manipay	328	—	—	425	375	450	430
Karainagar North	337	—	—	—	280	450	220
Karainagar East	340	—	—	—	510	650	310
Kayts	343	—	—	6037	2825	5625	1800
Saravanai	349	—	—	1175	700	1075	675
Analativu	361	—	—	1850	125	2000	125
Pungudutivu West	367	—	—	2210	700	2200	600
Thiruvelvely	377	—	—	300	975	300	1150
Delft	408	—	—	—	8140	15200	3850
Delft	410	—	—	477.1	145	430	170



SCALE : 4 MILES TO ONE



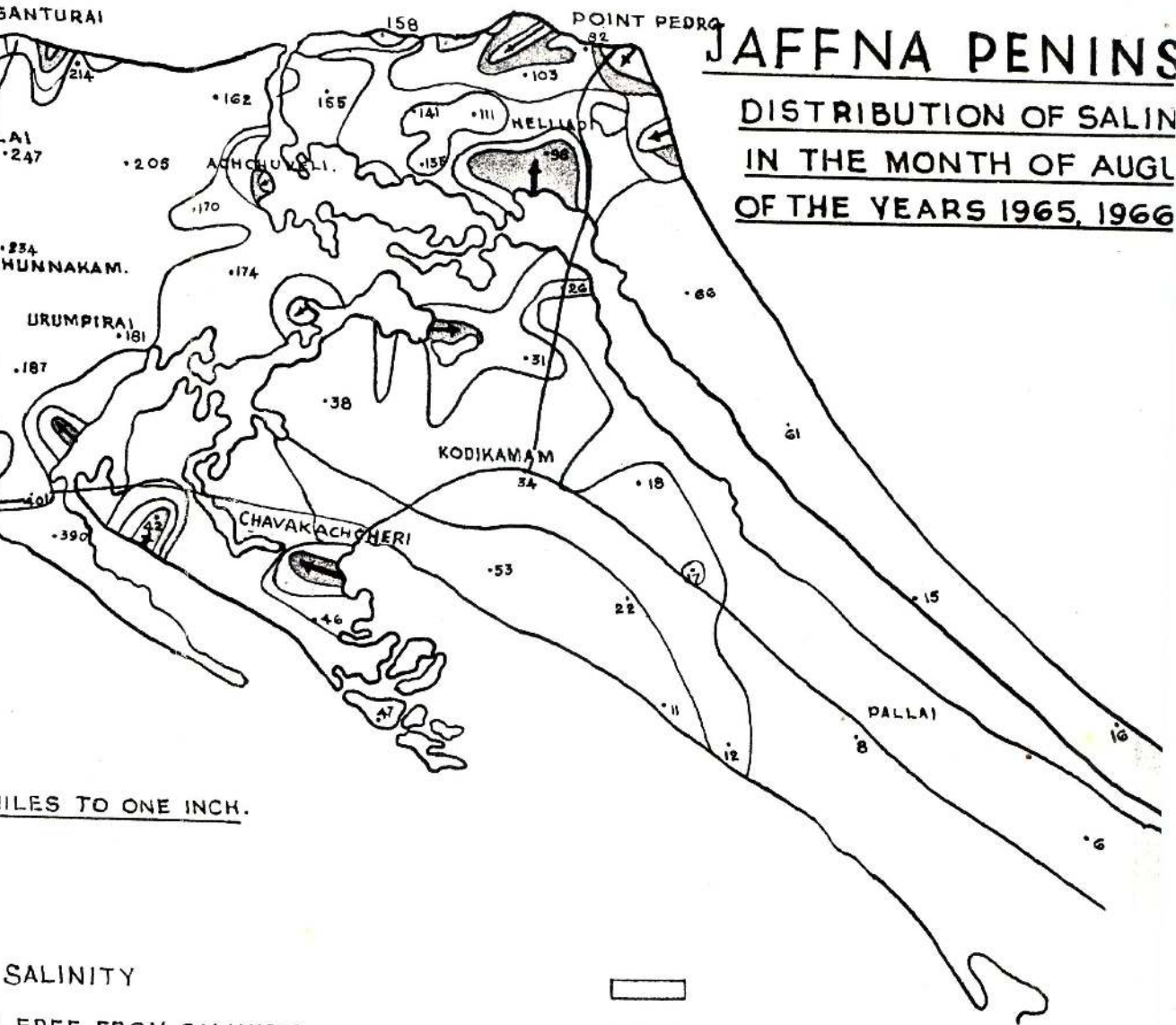
INDEX

AREAS FREE FROM SALINITY
 AREAS MODERATELY FREE FROM
 AREAS MODERATELY FREE FROM
 BUT LIABLE TO SALINITY WITH
 AREAS LIABLE TO SALINITY IN
 SALINE AREAS.
 DIRECTION OF SALINITY TREN

A.S.P.

JAFFNA PENINS

DISTRIBUTION OF SALIN IN THE MONTH OF AUGU OF THE YEARS 1965, 1966



1 MILE TO ONE INCH.

SALINITY

FREE FROM SALINITY.

FREE FROM SALINITY

SALINITY WITH SLIGHT INCREASE IN DRAW OFF

SALINITY IN DRY SEASON

SALINITY TREND

