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Item 68 of the preliminary list*
ISRAEL'S DECISION TO BUILD A CANAL LINKING THE MEDITERRANEAN SEA TO THE DEAD SEA

SECURITY COUNCIL
Thirty-seventh year

Report of the Secretary-General

1. This report is submitted in pursuance of General Assembly resolution 36/150 of 16 December 1981, entitled "Israel's decision to build a canal linking the Mediterranean Sea to the Dead Sea", which reads as follows:

"The General Assembly,

"Recalling the Geneva Convention relative to the Protection of Civilian Persons in Time of War, of 12 August 1949, 1/

"Reaffirming the applicability of the Geneva Convention to all Arab territories occupied by Israel since 1967, including Jerusalem,

"Taking into account that the Israeli project to build a canal linking the Mediterranean Sea and the Dead Sea is in violation of the rules of international law, in particular those relating to the fundamental rights and duties of States,

"Also taking into account that this project, if completed, will cause direct and irreparable damage to the rights and the legitimate vital interests of Jordan and of the Palestinian people,

"Expressing concern that the proposed canal, to be constructed partly through the Palestinian territories occupied since 1967, will violate the principles of international law,

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* A/37/50/Rev.1.

1/ United Nations, Treaty Series, vol. 75, No. 973, p. 287.

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"1. Demands that Israel cease forthwith implementation of its project of a canal linking the Mediterranean Sea and the Dead Sea;

"2. Requests the Security Council to consider initiating measures to halt the execution of this project;

"3. Requests the Secretary-General to prepare and submit to the General Assembly and the Security Council, by 30 June 1982, a study on the Israeli canal and its effects on Jordan and the Palestinian territories occupied since 1967;

"4. Calls upon all States not to assist, either directly or indirectly, in the preparation for and the execution of this project and to urge the compliance of national and international corporations to this effect;

"5. Decides to include in the provisional agenda of its thirty-seventh session the item entitled 'Israel's decision to build a canal linking the Mediterranean Sea to the Dead Sea'."

2. It will be recalled that, prior to the adoption of the resolution, a discussion took place in the Special Political Committee. In the course of that discussion, the representatives of Jordan, Israel and Egypt, as well as the observer of the Palestine Liberation Organization, among others, stated their positions on this subject. A verbatim record of the discussion is available (A/SPC/36/PV.49 and 50).

3. In the light of paragraph 3 of the resolution, the Secretary-General on 5 March 1982 addressed a letter to the Permanent Representative of Israel, requesting that, as a first step, the necessary technical data relating to the various aspects of the Israeli project be made available to the Secretariat. He further indicated that he envisaged a small group of technical experts to travel to the area in order to obtain such additional information and clarifications as might be required. The Secretary-General requested the co-operation of the Government of Israel in providing those experts with access to sites that they might need to visit and in arranging the contacts that they might require with the officials directly concerned.

4. On 11 March 1982, the Secretary-General addressed a letter to the Permanent Representative of Jordan, similarly requesting the co-operation of his Government in connexion with the envisaged visit of the technical experts. The Secretary-General had earlier received from Jordan a study entitled "The Mediterranean-Dead Sea Canal: The Israeli project and its dangers", published by the Institute for Palestine Studies in Beirut.

5. On 11 May 1982, the Permanent Representative of Israel forwarded to the Secretary-General a paper entitled "Mediterranean-Dead Sea Project: Outline and appraisal". He informed the Secretary-General that the paper had been prepared by the Mediterranean-Dead Sea Company Limited, the government corporation responsible for the project. At the same time, the Permanent Representative stated that the

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supply by the Government of Israel of material concerning the Mediterranean-Dead Sea project was without prejudice to Israel's attitude to General Assembly resolution 36/150, which had been opposed by Israel. The position of his Government on the subject had been put forward in detail in his statement before the General Assembly on 16 December 1981 (A/36/PV.100).

6. In the latter part of May 1982, three United Nations experts travelled to the area. From 24 to 29 May they visited Jordan and held discussions with Government officials and others concerned. They also visited sites along the Dead Sea in order to study the implications of the project. From 30 May to 1 June they visited Israel and held discussions with Government officials and others involved in the project. They also visited sites at Be'er Sheva' and on the Dead Sea shore, as well as sites at El Qatif in the Gaza Strip.

7. The study prepared by the experts is annexed hereto.

ANNEX

Study on the Mediterranean-Dead Sea Project

CONTENTS

Appendices

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I. OUTLINE OF THE ISRAELI PROJECT a/

1. As envisaged by Israel, the Mediterranean-Dead Sea project essentially consists of a hydro-electric scheme diverting sea water from the Mediterranean to the Dead Sea, the deepest surface point of the earth's crust, in order to produce peak energy.

2. The project is at the pre-feasibility stage. Mapping, geological reconnaissance and further engineering and economic studies are currently in progress. Although formally dedicated by the Israeli Government, the project has not yet been finally approved. The mission was informed by the Israeli authorities that the official decision to proceed with implementation will not be taken before the conclusion of the feasibility study currently being carried out with the help of Israeli engineering firms and foreign consultants.

3. The Dead Sea lies within a closed basin with no natural outlet. In the past, its water level has fluctuated according to climatic variations, within a steady state of balanced inflow and evaporation. The present water surface is 400.5 m below the Mediterranean Sea level (-400.5 MSL). b/

4. The basic concept of the scheme takes into account the evolution of the Dead Sea level, which has dropped by 10 m since the 1950s. A further lowering by about 3.5 m is forecast over the next 10 years, at the time the project would conceivably start operating.

5. The completion of the project is envisaged around 1990. Thereafter, over a period of 12 to 15 years, the Dead Sea would be raised to El (-390.5 MSL); the Sea level would then be stabilized around this elevation. Hydrological simulations over the next thousand years indicate that this could be achieved within a margin of ± 1.8 m around the average target level, provided a proper operational rule is followed.

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a/ Mediterranean-Dead Sea Project: Outline and appraisal, Mediterranean-Dead Sea Company Ltd., April 1982. See also S. Jabour, Y. Al-Batal, R. Haidar, The Mediterranean-Dead Sea Canal: The Israeli project and its dangers, Institute for Palestine Studies, Study No. 60, Beirut, 1981; and Report on the Mediterranean/Dead Sea Canal, Office of the Crown Prince, Amman, 6 January 1982. Additional materials were provided to the mission during its visit to Jordan and Israel. The information contained in those materials is reflected in subsequent sections on specific questions.

b/ A list of units of measurement and abbreviations is contained in appendix I.

6. At the current conceptual stage, the 114 km-long water conduit (appendices II and III) is to have its intake at El Qatif on the shore of the Gaza Strip, which is to be traversed over its width by a 7 km-long buried penstock. From there, a canal-cum tunnel conveyance would follow on Israeli territory, running south of the town of Be'er Sheva' and discharging into regulating ponds on the slope bordering the Dead Sea. From these a pressure tunnel would lead to an underground power-house, the tail-race tunnel of which would release the turbined waters opposite the Lisan peninsula, not far north of the Israeli and Arab Potash Works on the Dead Sea.

7. As planned, the capacity of the hydro-system, assuming continuous operation, is a discharge of 2,550 Mm^3/year. In the first phase, until the Dead Sea reaches the projected level of (-390.5 MSL), the scheme would be operated on the basis of a yearly discharge of 1,700 Mm^3/year. In the second phase, the flow would be restricted to an average of 1,040 Mm^3/year.

8. The direct benefit expected from the project would be mainly the production of 1,500 GWh/year of net equivalent energy in the first phase and 1,000 GWh/year in the second phase, with an installed capacity of 800 MW. Other expected benefits within Israel could accrue from the cooling of thermal power stations en route, exploitation of shale oils, the establishment of solar ponds on the Dead Sea, tourism and desalination of sea water.

9. The cost of the project is estimated at $US 1,100 million by the end of construction. The cost of the energy produced would be around $0.05/kWh at the step-up station.

II. HYDROLOGICAL ASPECTS

A. History of the Dead Sea water levels

10. The hydrology of the Dead Sea has been handicapped by the lack of long-term precise river flow measurements. However, much may be inferred from long-term level records and evaporation estimates, and these have been studied by J. Neumann c/ and by D. Neev and K. O. Emery. d/

11. Neev and Emery, in the course of an oceanographic study of the Dead Sea, present a diagram showing the water levels since 1800; these (adjusted to MSL) reach a minimum of -399.5 m in 1820, rise to -395.5 m in about 1875 and then rise rapidly to -388.5 m in about 1900; between 1930 and 1936 the Sea fell rapidly from -389.5 to -392.5 m, and again fell rapidly between 1955 and 1963 (appendix IV).

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c/ "Tentative Energy and Water Balances for the Dead Sea", Bulletin of the Research Council of Israel, 1958, vol. 7G.

d/ The Dead Sea Depositional Processes and Environments of Evaporites Geological Survey, Ministry of Development, Jerusalem, 1967.

12. The authors put these fluctuations into a longer perspective using physiographic and historical evidence; they conclude that the level of the North Basin remained about 40 m below its 1967 level for a long time, possibly until 1,500 years ago, when it again began to rise owing to an increased run-off/evaporation ratio which they suggest was due to land use changes and overgrazing. Less than 1,000 years ago the level rose enough for the North Basin to transgress into the South Basin, and at about the beginning of the present century the highest level for the present Dead Sea was reached.

B. Natural water balance of the Dead Sea

13. The natural water balance can be studied in terms of evaporation or of inflows or by comparing the two. The mission understands that the Israeli assessment of the balance was based on fitting a daily conceptual hydrological model to the mean of three long-term rainfall series and adjusting the model to give reasonable estimates of all the components of the balance, which are summarized in the table below:

Summary of annual long-term natural Dead Sea water balance (according to current Israeli estimates)

(Millions of cubic metres)

Jordan inflow to Lake Tiberias	600			
Other inflow to Lake Tiberias	200			
Direct precipitation	60			
Evaporation	-270			
Net outflow	590	590		
Yarmouk inflow to Jordan		460		
East bank tributaries, including Zarqa		200		
West bank tributaries		170		
Evaporation from lower Jordan		-40		
Net inflow to Dead Sea		1380	1380	
East bank inflow, including ground water			250	
West bank inflow			65	
Southern inflow			15	
Precipitation			75	
Total			1785	1785
Evaporation				-1785

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1. Inflows

14. The mission had an opportunity to reanalyse the available data on inflows. The flows of the Jordan have been estimated for the years 1932-1933 to 1962-1963 at King Hussein Bridge (Allenby Bridge) from measurements before large-scale abstractions occurred; these annual run-off estimates have been converted to milimetres over a basin of 17,000 km^2 and are compared with the rainfall record at Jerusalem (Old City) for the same years. The correspondence is reasonable, considering that only one rain gauge is used; although the measured annual run-off is 1,012 Mm^3, this should be adjusted to 1,125 Mm^3 because the period of record was drier than average.

15. On the other hand, the same records are compared with annual Dead Sea level changes in appendix V; again the correspondence is reasonable, and the mean run-off may be deduced from the value corresponding with zero change in level to be about 1,225 Mm^3.

16. Both these figures are less than the sum of the tributary flows given in the table above. Although the recent measured flows of the Yarmouk, Zarqa and side wadis have been less than the estimates in the table, these flows were measured during a period when the Jerusalem rainfall was lower than average, and a linear adjustment to the long-term mean rainfall provides estimates close to those of the table. The addition of the estimated natural run-off in the Jordan below Lake Tiberias (590 Mm^3) and the run-off from the west bank of the Jordan below the confluence with the Yarmouk (170 Mm^3), and an allowance for evaporation in the lower Jordan (40 Mm^3), gives the estimated total of 1,380 Mm^3.

17. The mission supposes that part of the difference between this estimate and the flows at the King Hussein Bridge (Allenby Bridge) is due to the fact that three tributaries join the Jordan between the gauging station and the Dead Sea and also to abstractions before the period of measurement, but it is reasonable to conclude that the long-term natural run-off down the Jordan River is between 1,200 and 1,380 Mm^3.

18. The estimated annual natural input to the Dead Sea is completed by adding 75 Mm^3 for direct precipitation, 65 Mm^3 for inflow from the west bank, 250 Mm^3 for inflow and ground water flow from the east bank and 15 Mm^3 for inflow from the south. Comparison with the flows of the Wadi Hasa suggests that the estimated flow from the east bank may be on the high side.

2. Evaporation

19. The above estimates for the inflows must now be compared to the estimated evaporation from the historic area (1,000 km^2) of the Dead Sea. The evaporation from the Dead Sea is influenced by its salinity. This salinity must vary with the incidence of river inflow, but mixing will ensure that a level is reached at the surface between the outside limits of fresh water and Dead Sea brine. It is useful to consider the variation in open water evaporation between these two limits.

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20. It can be demonstrated that the evaporation would decrease by a factor of 0.48 if fresh water were replaced by brine at the same temperature. The mission understands from both the Jerusalem and Israeli sides that pan-evaporation measurements are compatible with this result.

21. However, if the water body were thermally insulated, and there were no horizontal advection of energy, the net short wave radiation plus incoming long wave radiation would balance the sum of evaporation, the heat flux and the long wave back radiation; therefore the temperature of fresh water would remain lower than brine to equate the energy balance.

22. A study of this problem using the Penman-Monteith approach to the estimation of evaporation and available meteorological records suggests that the evaporation from the Dead Sea is about 1,600 mm/year with a surface temperature of 25°C. If the upper zone brine were replaced by pure water the temperature would be 21°C and the evaporation would be about 2,300 mm. Thus the increase in evaporation from the lake would be significant but not as great as implied by the change in vapour pressure alone.

23. This estimate of evaporation corresponds closely with that of Neumann, who, using meteorological measurements and an energy balance approach, taking account of a representative estimate of 1.17 grams per cubic metre for the specific gravity of the surface waters in the northern basin obtained an average evaporation of 1,470 mm/year for the northern basin and 1,800 mm per year for the southern basin; the average for the whole basin is 1,500 mm/year. Both estimates would result in inflow figures which are rather lower than the 1,785 Mm^3/year of the table. The differences are within the limits of uncertainty of such hydrological estimates. An estimate of 1,600 mm/year would correspond with a Jordan inflow of 1,300 Mm^3 and an east bank flow of 150 Mm^3. The mission concluded that the long-term water balance of the Dead Sea, as estimated by the Israelis, is not unreasonable, though perhaps on the high side within the limits of uncertainty.

3. Balance after proposal

24. Having established the natural long-term water balance of the Dead Sea, the question remains how much water should flow from the Mediterranean into the Dead Sea in order to achieve long-term stability of the projected Dead Sea level. In answering this question, allowance has to be made for abstractions from inflows and also for the recent reduction in the area of the Sea.

25. The level of abstractions during the 1970s is estimated at 800 Mm^3, compared with about 200 Mm^3 in the 1950s. e/ The projected annual consumption in various parts of the catchment area is estimated f/ to reach 1,062 Mm^3 in 1985,

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e/ Mediterranean-Dead Sea Project, op. cit., figure 11.

f/ Ibid., p. 20.

1,130 Mm^3 in 1990 and 1,320 Mm^3 in the year 2000. It emerged from dicussion of these estimates that the Israeli planners not only assumed virtually complete abstraction of the outflow from Lake Tiberias, but also a drastic reduction of the other flows to the Dead Sea from the west bank tributaries and from the south. They also assumed not only increased abstraction from the east bank tributaries of the Jordan, involving the completion of a storage dam on the Yarmouk, but also abstraction from the streams flowing directly to the Dead Sea. The mission noted that while earlier abstractions have partly removed water from the Dead Sea basin so that return flow from irrigation is not relevant, the future abstractions would largely be used for irrigation on the east bank of the Jordan and near the west bank tributaries, and therefore irrigation efficiency and return flow have to be taken into account.

26. Additional water is abstracted from the Dead Sea and evaporated in the southern basin by the Israeli Dead Sea Works and by the Arab Potash Works. The net abstraction is estimated f/ as follows:

Net consumption

(Millions of cubic metres/year)

	1984	1990	2000	2010
Israeli Dead Sea Works	131	136	136	136
Arab Potash Company g/	90	90	93	123
Total	221	226	229	259

27. Because these abstractions, and particularly the estimated net river abstractions for irrigation, include a number of hypothetical estimates, it may be simpler to compare the estimated long-term diversion with the other elements of the balance after allowing for abstractions and the reduced area of the Dead Sea. The area of the North Basin is about 750 km^2, and one can reasonably assume that the surface salinity would be similar after the introduction of Mediterranean waters in similar quantities to the historical salinity with the natural inflows of the Jordan; the evaporation rate of 1,600 mm per year would account for 1,200 Mm^3. The net abstraction of the potash plants (230 Mm^3) and the introduction of 1,000 Mm^3 per year would balance with a residual inflow from the Jordan and the direct flow of the Dead Sea of 375 Mm^3 per year, plus direct precipitation of 55 Mm^3 over the smaller area. Allowing for a reduction in direct inflow, this implies a residual Jordan flow of 200 Mm^3, as compared to approximately 1,300 Mm of natural flow.

g/ Slightly higher figures were supplied to the mission by the Arab Potash Company: 109 Mm^3 in 1985, 120 Mm^3 in 1990 and 128 Mm^3 in 2010.

28. This estimate implies a high degree of control of the rivers of the basin by storage, with a small proportion of the average flow spilled during the years of high run-off, and also efficient use of irrigation with low return flows. In particular, it depends on the further development of the Yarmouk River including the construction of the Maqarin reservoir; however, the mission was aware that this development is currently delayed.

29. The mission learned from Jordanian and Israeli officials that the flow of the Jordan is not being measured at present and the mission believes that it would be desirable to test the hypotheses about residual flows by some form of measurement.

30. In the view of the mission, some uncertainties remain regarding the future balance of the Dead Sea. However, provided that the operation is based on Dead Sea target levels, any under-estimation of the Jordan inflows would necessitate lower long-term diversions which would affect the economics of the project.

III. GENERAL EFFECTS OF THE PROJECT

31. This section lists the effects of the project on the Dead Sea considered as an environmental whole.

A. Effects on the level of the Dead Sea

32. The rise in the Dead Sea level would be the most obvious effect of the Israeli project. It is generally agreed, however, that this would counteract a process which is currently under way, as increased abstractions from the inflows and increased consumption by the Israeli and Arab potash works currently result in a relatively fast draw-down of the Dead Sea.

33. With respect to projections of future Dead Sea levels, to the extent that these can be forecast, it has been estimated by Israeli experts that the decrease of the level of the Dead Sea in the northern basin without the project would be in the order of 0.8 to 1.0 m per year after the year 1990 with little sign of an asymptomatic decrease within the next century. Although these figures have not been checked and may be debatable, there is little doubt that a significant lowering of the Dead Sea level is to be expected in future years, which could bring it well below the low levels recorded in the nineteenth century.

34. The projected rise of the Dead Sea level to El (-390.5 MSL) would bring this level back approximately to the 1900-1930 levels, which have been the highest since records are kept. It would have an impact on the level of the dikes which surround and protect the evaporation ponds of the potash works in both countries and on related facilities. It also raises problems regarding the flooding of some infrastructure (roads, tourist resorts, etc.) which surround the Dead Sea, of the newly-emerged lands earmarked for agricultural development, of archaeological sites and of some mining projects. The specific effects on the Jordanian side are examined in section IV.

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35. There have also been concerns expressed by the Jordanian side about induced seismicity resulting from the refilling of the Dead Sea. The Dead Sea graben is a major tectonic feature bordered by longitudinal faults and crossed by tensional transverse faults. The mission noted that the area is subject to moderate, but rather infrequent, seismic activity. The maximum magnitude recorded on the Richter scale was 6.5 (Jericho, 1927). All foci are shallow (less than 15 km deep). A number of new seismographs have been installed along the western shores since 1964. Given this situation, the possibility of the filling of the Dead Sea triggering a potential earthquake cannot be ruled out. However, it appears that such an event is not very likely, given the relatively small overload and the fact that the Dead Sea level had already been at the proposed ultimate level (-390.5 MSL) for a number of years in the recent past.

B. Effects on the quality of Dead Sea water

36. The introduction of sea water from the Mediterranean would have an impact on the quality of the Dead Sea water. The mission's understanding of the complex phenomena involved can be summarized as follows:

(a) The horizontal and vertical mixing of Mediterranean waters with the Dead Sea waters has been studied by the planners of the project. Whereas there were previously two distinct zones - an upper zone of lower density (ranging from 1.16 to 1.22) about 40 m deep, with a transition down to a lower zone of higher density (1.23) at about 100 m - it appears that in about 1979 an "overturn" occurred after a period of reduced fresh water inflow and the vertical density gradient was gradually eliminated. Recent high run-off caused restratification which is slowly disappearing. The annual changes in the composition of brines in the mixed layer resulting from the two sea waters during the operation of the project have been simulated by computer.

(b) In particular, a phenomenon known as "whitening" has been observed on occasion and found to consist mainly of gypsum ($CaSO_4$) and aragonite ($CaCO_3$) and is thought to be due to an influx of sulphate from flood and spring waters. The introduction of Mediterranean Sea water is considered by the planners to be likely to result in gypsum precipitation and not to affect the surface reflectivity and thus the evaporation of the Dead Sea, or to affect the potash industry.

37. The Israeli authorities have indicated that research into these problems is continuing. It is quite evident that, should the evaporation of the Dead Sea be reduced, the very basis of the project would become questionable. Further research is therefore needed into all aspects of this complex phenomenon where other parameters may also be involved (temperature, dust, etc.).

38. In the course of discussions, the Israeli planners brought to the attention of the mission the fact that the diversion of Mediterranean waters may have some beneficial consequences for the potash works. They stated that, out of the 2,000 Mt of potash contained in the Dead Sea, only 600 Mt can be extracted from the present brine, but that this figure could be raised to 1,000 Mt if Mediterranean water was introduced. Given the present rates of production, this matter relates to a distant future and was not further discussed.

39. It was also pointed out to the mission by the Israelis that the Mediterranean water could be used to flush the bed of the evaporation ponds and of the flood channel as well, instead of raising the dikes. This method was not altogether ruled out by the consultants to the Arab Potash Company; they however pointed out that prior tests would be needed before it could be considered.

IV. SPECIFIC EFFECTS ON JORDAN

A. Effects on the Arab Potash Works

1. Changes in the level of the Dead Sea

40. The Arab Potash Works are located symmetrically opposite to the Israeli Dead Sea Works. Together, they cover the whole area of the Dead Sea southern basin (220 km^2), leaving between them a 500 m-wide channel for the passage of the floods from the southern catchment.

41. Essentially, the Arab Potash Works consist of various evaporating ponds to where the Dead Sea brine is pumped up through an intake system (appendix VI). The larger of these ponds is the "Salt Pan" where ordinary salt (NaCl) deposits, after which it is transferred to a "Precarnallite Pan" and then to three "Carnallite Pans". From these, the deposits are pumped to the processing plant where magnesium is separated from potassium. The total investment in the Arab Potash Works is in the order of $US 500 million. Operations are planned to commence at the end of the current year, with an expected production of 1.2 Mt/year of potash, the market place of which varies between $85 and $100 per ton.

42. The peripherical dike around the Arab ponds has its crest at El (-395.0 MSL), 2.5 m lower than the Israeli one. The embankment of the Arab Potash Works is about 29 km long with an average height of 5 m (appendix VII). It has been built with some difficulty, owing to delicate foundations. According to the consulting engineers, its cost has been in the order of $US 30 million.

43. From this figure, it can be estimated that raising the existing dike by 7 m to match the projected sea level of (-390.5) could cost roughly $US 140 million. However, it is recognized by both sides that some raising of the dikes protecting the salt pan and the precarnallite pan (involving a length of about 18 km) will have to be carried out in due course, because of the accumulation of deposits of salt in the evaporation pans. The rate of deposition in these pans, and hence the required raising of the corresponding dikes, is estimated by the Arab Potash Company h/ to be 0.275 m/year, a figure which is more or less confirmed by the Israeli side.

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h/ Indicated in their drawing No. 7733/3/403.B.

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44. It can therefore be estimated that, 25 years from now, 60 per cent of the length of the dikes will need to have been raised in any case by about 7 m due to the level of the evaporation pans expected at that time. The project would make it necessary to raise the remaining section of the dikes, and perhaps that along the Wadi Hudeira flood channel, at a cost which was roughly estimated by the mission at $US 50 to 60 million.

45. In the course of discussions, the Israeli planners also suggested that the provision of an adequate channel for flood flows in the Wadi Araba, based on their calculation of river flood levels, already required raising the dikes at the upper end of the flood channel.

46. On the other hand, the mission was informed by the Jordanian side of a related problem concerning the obstruction of the flood channel. It appears that salt is deposited where the brine effluents from both potash works flow down this channel. If the level of the Dead Sea were raised and the quality were changed by the introduction of Mediterranean water, such deposits might increase and occur at a higher level, and this could affect the hydraulic capacity of the flood channel to pass the flood flows from the catchment to the south and east, in particular the Wadis Hasa, Araba, Qunaiya and Hudeira.

47. The rise in the Dead Sea level might therefore require that the channel bed be dredged or flushed or that the lateral dikes be suitably raised.

48. A second major issue connected with the level of the Sea is the layout of the intake system to the Arab Potash Works, located on the west shore of the Lisan peninsula (fig. 4 and 5).

49. A one kilometre-long dredged channel was needed to locate a pump off-shore at El (-408.6 MSL), barely 8 m below the present water surface. A jetty above this channel is at El (-397.9 MSL). The pumped water is released into a 10 km-long open channel which roughly follows ground contour (-393 MSL) until it overflows into the salt pan, where the present operating brine level is at El (398.75 MSL).

50. It is obvious that the project, if executed, would submerge the whole intake system even before the end of the contemplated rise of the sea level. The necessary adjustments would involve a higher jetty, the relocation of the pumping station and a protection of the brine canal by a lateral dike some 9 to 10 m high, with due protection of the slope facing the open sea.

51. A rough estimate by the mission is that such remedial works, which require serious engineering studies, would cost between $US 40 to 50 million. This high cost might lead to a complete relocation of the intake works, in conjunction with the possible requirement of having a deeper intake, as discussed in paragraph 53 below.

2. Changes in the quality of water

52. The manner in which the Mediterranean waters would mix with the surface layers of the saline Dead Sea waters was a major concern for both sides, as it would affect the concentration of the brine at the intakes and thus could critically affect the economics of potash production. The Arab Potash Company expressed concern regarding the efficiency in recovery which, in their estimate, would be reduced by 15 per cent. This problem would be compounded by the proximity of the present brine intake to the proposed site of the tail-race discharging Mediterranean Sea water into the Dead Sea. In the past, the main inflow through the Jordan River has been discharged at the northern end of the Sea, and a distinct upper layer existed. At present, quality changes are already being observed after heavy rainfall and run-off through the Jordan.

53. The mission is aware that this problem of mixing is also of importance to the Dead Sea Works, even though their intake is at a greater depth than the intake of the Arab Potash Works, and that further research into the problem is given a high priority by the Board of Review for the Mediterranean-Dead Sea Project. The mission was informed that such research is being carried out at present. Nevertheless, it is of particular concern to the Arab Potash Company because its brine intake is at a relatively shallow depth and the shape of the Dead Sea bed in relation to the Armistice Demarcation Line could make it difficult to extend into deeper water. In the mission's view, however, this is a problem which would also require a solution if levels continued to recede.

B. Other effects

1. Effects on agricultural areas

54. Jordanian officials expressed concern that, at the proposed level of (-390.5 MSL), areas of present or potential agriculture would be flooded. The mission was able to visit most of the periphery of the Sea and the main agricultural areas. The information gained on that visit was most usefully supplemented by published colour satellite imagery of February 1978. i/

55. The principal agricultural areas on the Jordanian coast of the Dead Sea are currently in Ghor Safi and near Mazra at the south-east of the Sea, and plans to extend the irrigated areas using water from the Wadi Mujib are at present at an advanced stage. Because land suitable for agriculture is limited to topography, it is planned to extend the agricultural areas to lower levels, and the proposed operating level of the Dead Sea would flood part of these agricultural areas and would, in addition, raise the water table and the level of saline water thus affecting ground water abstraction and drainage. In that area, some 330 ha out of a project command area of 9,500 ha would be inundated, but the indirect effects of such flooding cannot be estimated without detailed study.

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i/ C. Sheffield, Earth Watch: A survey of the world from space, London, 1981, pp. 89-91.

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56. Near the north-east shore of the lake there are at present areas of vegetation apparently watered by ground water seepage. The extension of irrigated agriculture into this area forms part of the Jordan Valley irrigation project which includes the development of water resources through storage and transmission throughout the East Ghor Canal starting from the Yarmouk River. The raising of water levels would inundate part of this area, but it was not possible to estimate the area affected in the time available.

57. An indication of the total area which would be inundated in the northern basin of the Dead Sea may be obtained from an elevation-area curve presented to the team in Jerusalem. This suggests that 100 km^2 would be submerged between the present level of (-400.5) and the proposed level of (-390.5 MSL).

2. Effects on existing infrastructure

58. The rise of the Sea level would jeopardize some existing infrastructure around the Sea. As far as could be seen during the visits, the damage on the Jordanian shore would be related to tourist facilities, consisting of a shower house and a seaside restaurant at Swameh. The mission also observed that it would be necessary to relocate some stretches of new road extending 25 km south of Swameh as a part of the planned trans-Arabian highway. The works on this stretch are now interrupted but are scheduled to be resumed in the near future.

3. Effects on mining and oil exploration

59. The mission was informed that Jordanian plans for the abstraction of industrial rock salt and potash in the vicinity of the Lisan peninsula could be affected by the raising of the Dead Sea level, but was not able in its brief visit to compare the locations and levels at which mining is planned with present and proposed Dead Sea levels.

60. The mission was also told that oil and natural gas exploration is proposed and that its cost could be affected by raised Dead Sea levels.

4. Effects on archaeological sites

61. Concern was expressed on both sides that archaeological sites could be submerged by the sustained high Dead Sea levels proposed, but the mission was unable in the time available to obtain details. Although the projected Sea level would be about the same as attained in 1900, this was the maximum reached in recent times, and there is also evidence that "the Dead Sea during Biblical through Crusader times was limited to the North Basin, and that the transgressing lake reached the South Basin only a few hundred years ago". j/ Thus it is possible that any archaeological sites which were temporarily submerged in about 1900 could be more permanently submerged as a result of the project.

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j/ D. Neev and K. O. Emery, op. cit., p. 30.

V. SPECIFIC EFFECTS ON THE WEST BANK AND THE GAZA STRIP

A. Ground water resources

62. The proposed route of the tunnel section of the water conduit passes to the south of Be'er Sheva'. The mission was informed by the Israeli planners that the piezometric levels and ground water flows are from north to south in the limestone aquifers in this region, in accordance with the pronounced rainfall gradient. It follows that any leakage which might occur would not be likely to affect the ground water resources of the West Bank, which lie up-gradient. Studies of the effect of any leakage are being carried out.

63. Further to the west, the flows in the various limestone layers are said to turn west and north, finally emerging as powerful springs. One of the reasons for the choice of the route is said to be the quality of the aquifer, which becomes brackish as one goes southward. Thus the Israeli planners sought to minimize the harmful effect of any leakage from the conveyance of sea water, however improbable such an occurrence is thought to be.

64. As regards the aquifer in the Gaza Strip, Israeli experts indicated that it is situated in sandstones and alluvium, at a relatively shallow depth, and was not connected with the aquifers mentioned above. This aquifer is traversed by the proposed penstock and canal sections of the conveyance. Because of the drainage and slope in this area, which are towards the sea, and because of the shallowness of the aquifer, any significant leakage could reach this ground water.

65. After examining the preliminary designs in Jerusalem, the mission observed that the necessary engineering precautions were planned by the Israelis to prevent leakage in this section of the aqueduct.

66. Leakage is not to be expected along the penstock stretch traversing the Gaza Strip if it is properly manufactured and erected and if corrosion by sea water is well taken care of.

67. Outside the Gaza Strip, but perhaps still above the same water table, the canal involves the most delicate stretch of the aqueduct. The designers showed the mission a number of tentative cross-sections, some of which were quite elaborate with double sandwiches plastic membranes within an asphalt lining. Any residual leakage would then be collected through filters leading to a drainage system from where it would be pumped back into the canal.

68. In the view of the mission, such arrangements could be sufficient to prevent significant harm to the water table in the case of normal settling and cracking; but there is no doubt that a major destruction or tectonic shear would also rupture the protective layers. This would, however, force the operators to shut off the pumping station immediately, thus limiting the damage to the time it will take the canal to empty.

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B. Disturbance of lands

69. A strip of land all across the Gaza Strip would have to be cleared to permit the open-air excavation of the trench where the penstock section is to be buried. It is estimated by the mission that the related works would take some two to three years. The Israeli authorities indicated that they planned to restore the disturbed lands to agricultural use. In the view of the mission some areas would, however, remain permanently occupied (atop the underground pumping station, for instance). The width of the strip which would be affected by the works depends on the depth of the cut. The mission estimated that this width would be in the order of 50 to 100 metres.

C. Effects on agricultural areas

70. On the West Bank the raising of the Dead Sea level would affect certain areas suitable for agriculture, currently irrigated from ground water seepage or the flow in certain wadi channels. On the basis of the mission's visit and satellite imagery these areas would appear to be of limited size.

APPENDIX I

Units of measurement and abbreviations

1. All elevations (El) in this report are referred to the Mean (Mediterranean or Red Sea) level (MSL) which are very close. Negative elevations denote depths below MSL.

2. Units used:

Distances:	m:	metre
	km:	kilometre
Surfaces:	km^2:	square kilometre
	ha:	hectare = 0.1 km^2
Volume:	m^3:	cubic metre
	Mm^3:	megacubic metre = million cubic metres
Weights:	t:	metric ton
	Mt:	megaton = million tons
Power:	MW:	megawatt = 1,000 kilowatts
Energy:	kWh:	kilowatt hour
	GWh:	gigawatt hour = million kilowatt hours

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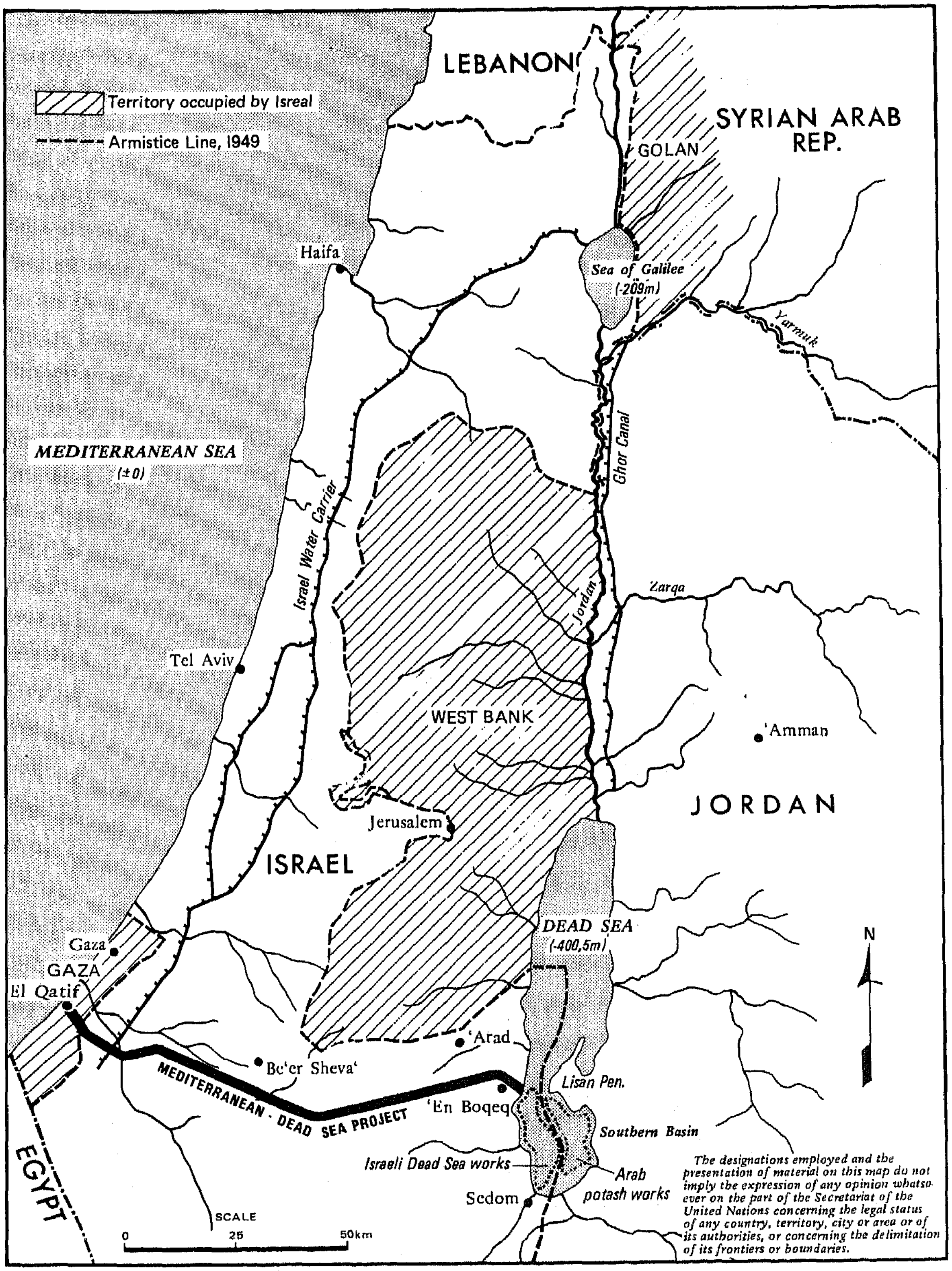
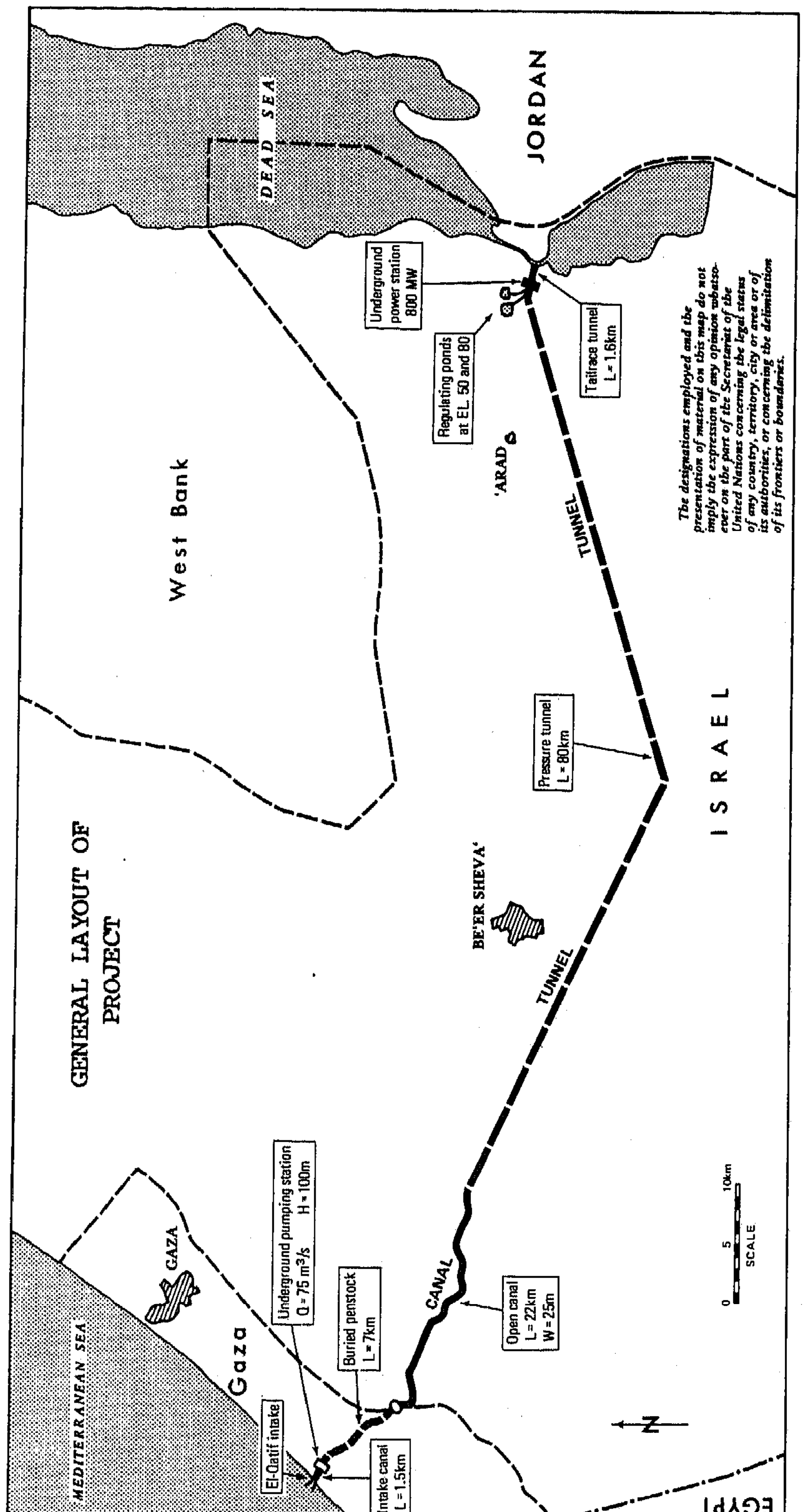
APPENDIX II

ROUTE OF PROJECT

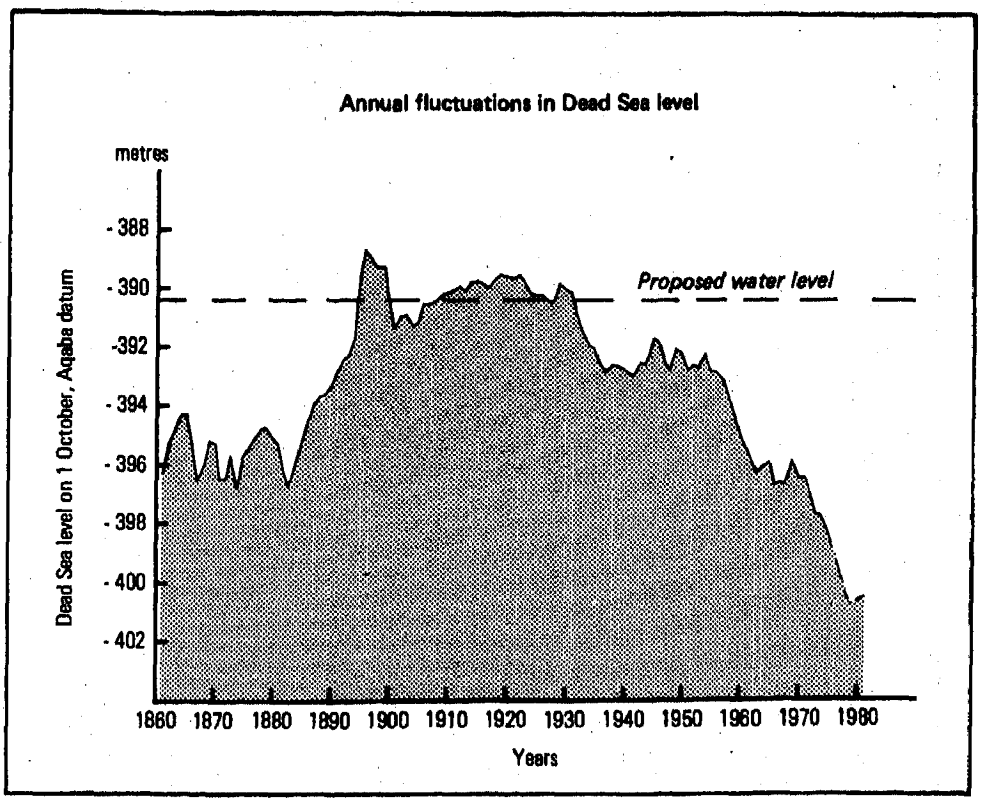


APPENDIX III

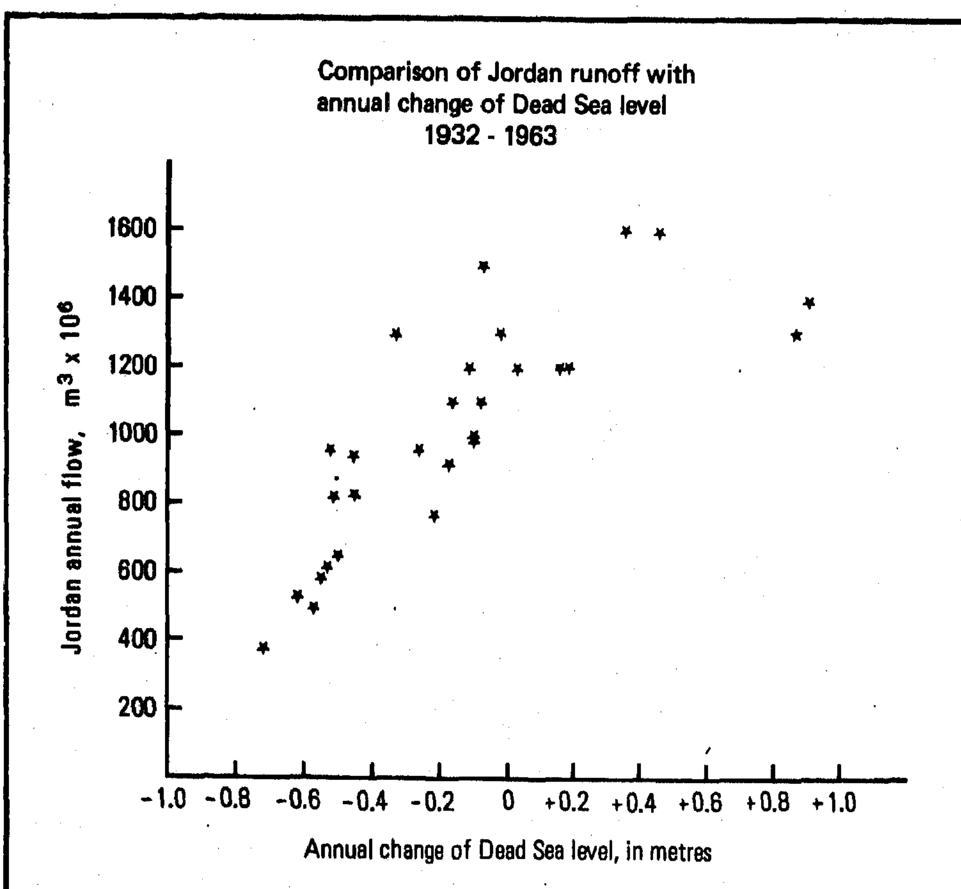
GENERAL LAYOUT OF PROJECT



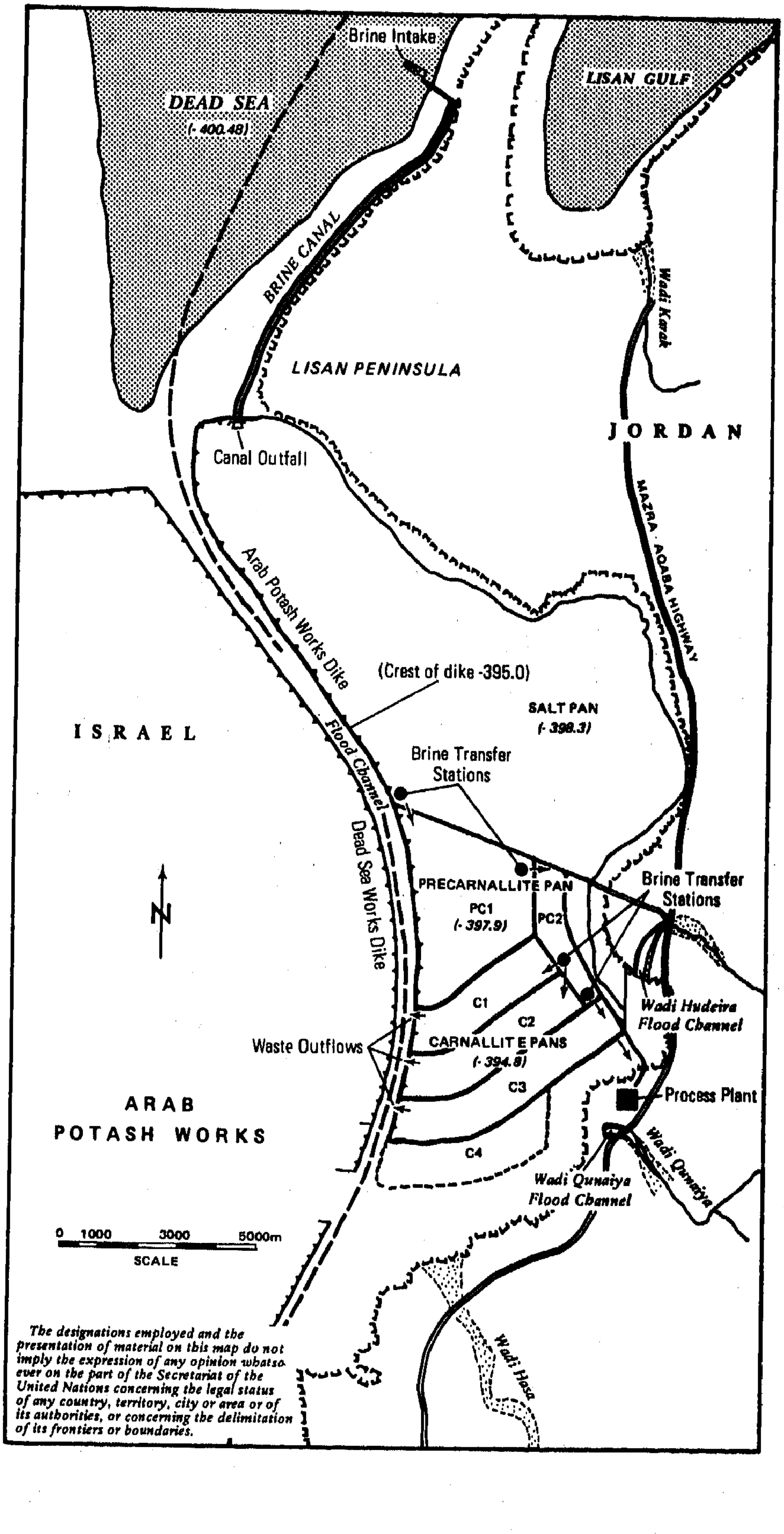
APPENDIX IV


Annual fluctuations in Dead Sea level
metres
- 388
- 390
-392
- 394
- 396
- 398
- 400
- 402
Dead Sea level on 1 October, Aqaba datum
Proposed water level
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
Years

APPENDIX V


Comparison of Jordan runoff with
annual change of Dead Sea level
1932 - 1963
Jordan annual flow, m3 x 106
1600
1400
1200
1000
800
600
400
200
-1.0
-0.8
-0.6
-0.4
-0.2
0
+0.2
+0.4
+0.6
+0.8
+1.0
Annual change of Dead Sea level, in metres

APPENDIX VI



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

APPENDIX VII

Typical cross-section of the dike and the intake channel of the Arab Potash Works