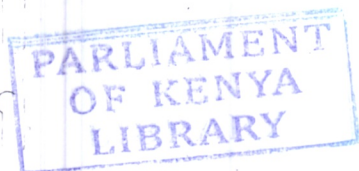


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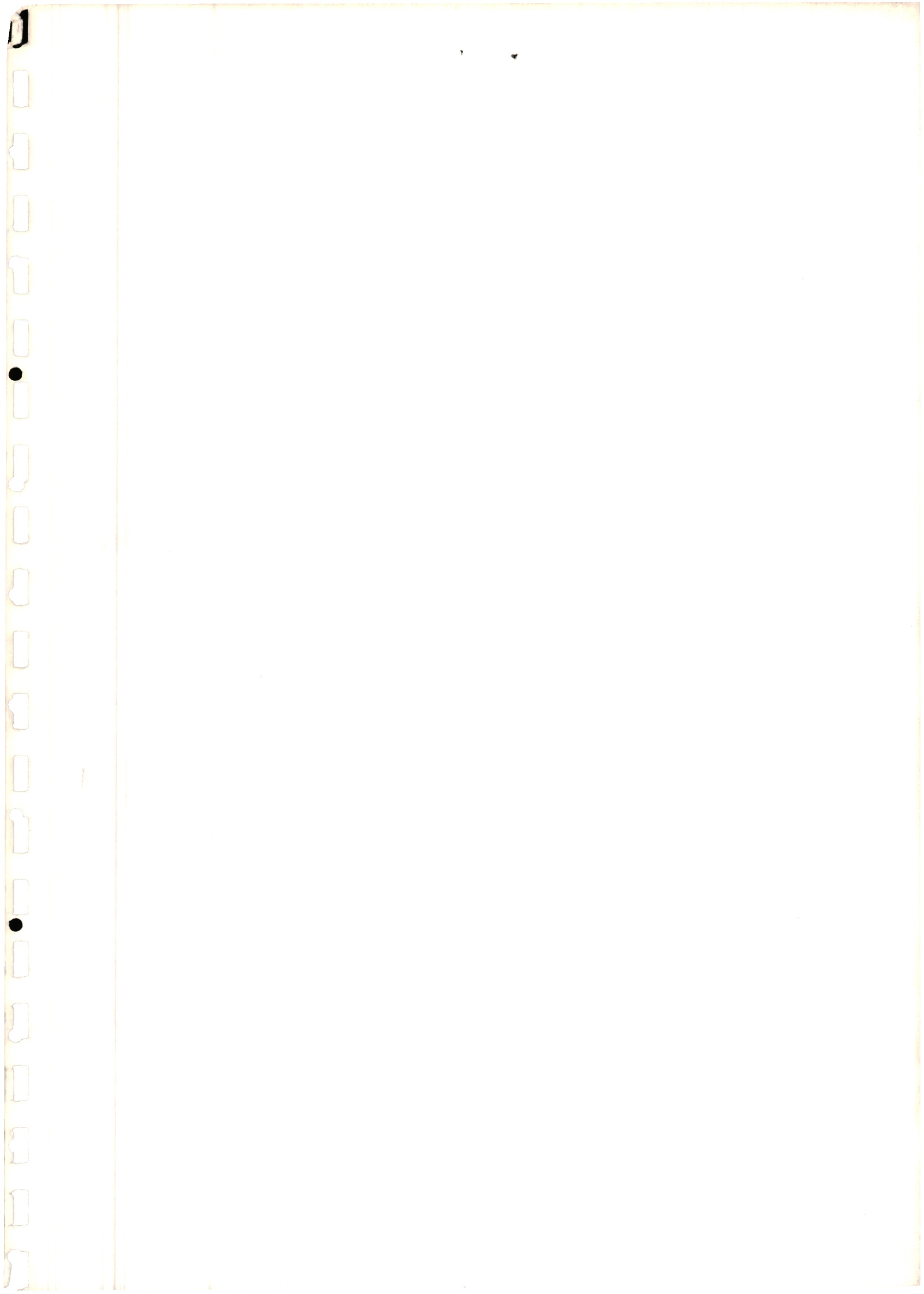
THE
GOVERNMENT OF KENYA
MINISTRY OF ENERGY AND REGIONAL DEVELOPMENT
KERIO VALLEY DEVELOPMENT AUTHORITY

GENERATION AND ECONOMIC STUDY
FOR THE
TURKWELL GORGE PROJECT

PROJECT SUMMARY

October 1984

Preece, Cardew & Rider Ltd
Consulting Engineers
Brighton
United Kingdom





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Ministry of Energy and Regional Development
Kerio Valley Development Authority

TURKWELL GORGE PROJECT

PROJECT SUMMARY

Approved for and on behalf of
Preece Cardew and Rider Ltd



R.G. Whillock, FIMechE, FIEE, FIE, FIPENZ
Director

RGW/25112
October 1984

Preece Cardew and Rider Ltd.
Consulting Engineers
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TURKWELL GORGE PROJECT
GENERATION AND ECONOMIC STUDY

PROJECT SUMMARY

1. INTRODUCTION

This report summarises the engineering, economic and financial features of the Turkwell Gorge Project which is proposed to be brought into service on the Suam River, Kenya, by January 1993.

The Suam River rises on Mount Elgon, on the Kenya/Uganda border, and flows in a north-easterly direction into Lake Turkana, crossing the Rift Valley in its course. While flowing through the Turkwell Gorge, on the borders of the Rift Valley, the river loses 280 metres of head in less than 6 kilometres. This feature suggests that hydro-electric power development may be possible, if a suitable site exists. The flow of the Suam River has pronounced seasonality, so such a development must include a storage reservoir if electricity production is to be maintained throughout the year. The catchment area upstream of the reservoir site covers some 5900 square kilometres. The head of water created by a reservoir enhances the prospects for hydro-electric power development.

Engineering investigations for hydro-electric power development at Turkwell Gorge were initiated by Viak/Norplan in 1975/6. Further studies were carried out by Norconsult, who issued a report in 1979 proposing a concrete gravity dam to create effective reservoir storage of 600 million cubic metres. This dam would be sited immediately downstream of the confluence of the Suam and Alamonges Rivers, close to the entry to the Gorge.

In February 1983 Sogreah prepared a more substantial report on preliminary design phase engineering which presents a well-reasoned argument for constructing a double curvature concrete arch dam at the entry to the Gorge, about 500 metres downstream of the site selected by Norconsult. This thin arch dam would impound water at a level of 1140 metres and provide a storage volume of 1000 million cubic metres. A tunnel 2.8 kilometres long would link the reservoir to an underground power house equipped with two 52.25 MW turbo-generators connected through a new power transmission line able to deliver 100MW to Lessos, located about 225 kilometres south of Turkwell Gorge. The existing power transmission line from Uganda to Nairobi passes through Lessos. Exhibit 1 indicates the transmission line routes.

The lack of good quality hydrological records over an extended period creates some uncertainty concerning the energy yield of the project but the present report concludes that the most secure estimate of mean annual flow at Turkwell Gorge that can be supported by available data is 17 cubic metres per second, which is estimated to give a yield at the power station of approximately 402 GWh in a year of average rainfall. In dry years this yield should not fall below 321 GWh.

Uncertainty concerning site geology means that all conclusions concerning Sogreah's proposed development are strictly subject to receiving the results of the current site investigations. Nonetheless the studies outlined in this report confirm that the construction of an appropriate dam in the Turkwell Gorge area, together with associated power generation and transmission facilities, is amply justified from both engineering and economic considerations.

2. PROJECT OBJECTIVE

The objective of the Turkwell Gorge Project is to provide a source of additional hydro-electric power to supply the increasing demand for electricity within the Republic of Kenya.

As well as achieving this objective, the Project will bring social benefits to a remote area of the Republic, including: employment and settlement opportunities, improvements to communications; scope for development of agriculture and fishing and the encouragement of settled pastoralism.

3. THE NEED FOR THE PROJECT

Electricity is generated now in Kenya by a mix of hydro-electric and thermal (including geothermal), plant. In addition 30 MW of hydro-electric power is imported from Uganda. Our present study determines that a somewhat similar plant mix pattern is likely to be cost-effective during the final decade of this century, which shows that there will be a continuing need to develop those sources of hydro-electric power which are shown to be economic.

The current median load forecast illustrated by Exhibit 2 predicts that the annual demand for electricity will grow at 3.9 per cent in 1984 rising to 6 per cent by 1990 after which growth will continue at 6 per cent each year.

The Kiambere hydro-electric project, now under construction, will be able to supply this forecast growth of demand for electricity only up to 1990. From 1991 onwards additional generation capacity will be required, and the Turkwell project is included in the plan recommended in this report for the necessary expansion of generation capacity in the most cost-effective manner.

A study has been made of the future operation of the hydro-electric power stations in the Tana Cascade, including Kiambere, and of other power stations supplying the Kenya power system, to assess the role of the proposed Turkwell project.

4. THE PROPOSED DEVELOPMENT

The main project features incorporated in the Turkwell project as proposed in 1983 by Sogreah are:-

- a) Reservoir retention level: 1140 m
- b) Maximum net head: 335 m.
- c) Generating capacity: 104.5 MW comprising 2 x 52.25 MW units
- d) Vehicular access across the dam is provided by a bridge at level 1145 m.

- e) Length of headrace tunnel: 2.8 km approx.
- f) Length of tailrace tunnel: 1.3 km approx.
- g) Surge tanks are provided upstream and downstream.

The reservoir will have a storage volume of 1000 million cubic metres.

The next stage of project studies will include a review of the design proposed by Sogreah, and should take account of new hydrological data and of the results of recent site investigations.

5. SITE CONDITIONS

Location

The Turkwell Gorge, indicated on Exhibit 3 is in the north west of Kenya, between Mount Elgon and Lake Turkana, and lies within an economically under-developed area remote from the main urban centres.

Site Access

The selected site for the dam is 120 kilometres by road from Kitale. Kitale is linked by surfaced road and by railway with the port of Mombasa some 880 kilometres away. These links are via Nairobi, which is 400 kilometres distant from Kitale.

An access road some 26 kilometres in length will have to be provided between Twin Islands downstream of the gorge and the surfaced road from Kitale to Lodwar, and the road distance from Kitale to the beginning of the access road would be 94 kilometres. Within the project area a road would have to be constructed from Twin Islands on to the escarpment to gain access to the dam itself, the offtake and various other facilities.

Geology

Sogreah's 1983 report states that the geological investigations which were carried out confirmed that the abutments will support the arch thrusts. Also the watertightness of the basin was confirmed and considered to be better than that at the upstream location. The rock formation is more massive at the downstream site, whereas it is more fractured and broken at the upstream site as it coincides with the edge of the granite intrusion. Sogreah observe that the region has only low seismicity.

The flow in the Suam River is extremely variable and a very high sediment load is carried, giving rise to massive deposition of material including large boulders in the river bed. Thus massive boulders are deposited, particularly at natural constrictions to river flow such as exist at the project site.

Sogreah's report emphasises the uncertainty of the foundation conditions existing at the site selected for the arch dam and suggests there may be up to 40 metres depth of alluvium. Deposits of alluvium in such situations are likely to be strewn with massive boulders. If site investigations confirm the presence of a deep boulder-strewn alluvium formation, this is likely to present especially difficult dam foundation

conditions. To ensure watertightness at the dam site the alluvium and boulders will have to be excavated in order that the concrete arch is founded directly against bedrock. Deep excavations in such conditions do not present insurmountable problems to modern construction techniques and plant; however, they do possess inherent risks and are expensive operations.

The Sogreah report considers that the uncertainties which exist are insufficiently serious to call into question the technical viability of the arch. Additional site investigations have since been undertaken and, although the report on these investigations was still under preparation in September 1984, KVDA have informed us that preliminary results appear to indicate that Sogreah's previous assumptions concerning foundation conditions for the arch dam will be validated in the forthcoming report. It will be important however to review this position following publication of the full results of the current site investigation contract.

Hydrology

Upstream of Turkwell Gorge the Suam river drains a plateau which rises gradually to the surrounding chain of mountains dominated by Mount Elgon (4323m). The most important contribution to river flows comes from the Mount Elgon area, which provides a more or less triangular catchment area measuring 1350 square kilometres down to Kongelai. Another part of the catchment basin comprises the north-western area consisting of plains with a sparse cover of trees and bushes, and measuring 2600 square kilometres down to Kanyao. Apart from the Karamojo hills area rainfall is relatively low but the area probably makes an important contribution to some flood flows. The remaining area measures 1950 square kilometres and consists of the broad Suam plain from Kongelai and Kanyao down to Turkwell Gorge, and has relatively low rainfall.

Previous reports on the Turkwell scheme and its hydrology were produced by Norconsult (1979 and 1983) and Sogreah (1983). Each of these reports comments on the lack of good quality hydrological records over an extended period - most particularly in relation to the Turkwell station where the record is of particularly short duration and where physical conditions for the gauging of river flows are particularly unfavourable.

The present report describes the results of our independent review of Turkwell hydrology, from which we conclude that an estimate for the mean annual flow at Turkwell Gorge of 17 cubic metres per second is the best secure estimate that can be supported by available data. We also give a possible upper estimate of 20 cubic metres per second. Both these estimates lie within the error margins of the estimate proposed by Sogreah. We recommend that the forthcoming detailed design studies should include an update of Turkwell hydrology. Should this update result in an increase in our best secure estimate of the mean annual flow the effect would be to enhance the economic justification of, and to increase the financial return obtainable from, the Turkwell Gorge project.

We judge that Sogreah's estimates of flood flows are likely to be sufficient for the current purposes of cost estimation of the associated works. We recommend that these flood estimates be fully reviewed within future detailed design studies, in view of their importance for the design of the diversion works necessary to permit construction of the dam.

Previous estimates of annual sediment loads are subject to much uncertainty, but we believe that Norconsult's estimate of 7 million tonnes is more likely than the 16 million tonnes cautiously proposed by Sogreah.

We emphasise that all of the above estimates are recommended as credible bases for the present purposes of establishing project viability. They are not proposed as bases for any revision, at this stage, to the project design. Such considerations more properly belong to the next stage of project development.

6. PROJECT DESCRIPTION - SOGREAH PROPOSAL

Dam and Spillway

The dam proposed by Sogreah is a thin concrete arch with a crest length of 100 metres, rising to 100 metres above the river bed. An ungated overflow spillway is provided, with a net effective length of 75 metres.

The normal operating range of the reservoir water levels will be 1095 m to 1140 m giving a freeboard of 5 m when the reservoir is full. Gross storage volume will be 1000 million cubic metres. We recommend that the next stage of project development should seek to resolve present uncertainty concerning sediment loads, so that detailed design studies give further consideration to the allocation of dead storage volumes and the setting of intake levels which in turn will determine the useful storage.

Passage for water through the dam is provided by a low level outlet comprising a water intake, steel lined penstock and a hollow jet valve. Sogreah's design ensures that both discharge from the hollow jet valve and the nappe from the spillway will discharge directly into the river bed without touching the valley sides. It is proposed to limit downstream scouring by including the construction of an afterbay dam, also in the form of a small concrete arch, so creating a stilling basin to dissipate the spillway discharge energy.

Power Facilities

An underground power house is proposed, equipped with 2 x 52.25 MW turbo-generators. The maximum net head on the turbines will be 335 m. The main water intake and the headrace tunnel have been sited near to the upstream cofferdam which is needed for diversion of river flow during the construction period.

This tunnel is 2.8 km long and leads to the underground power house, by way of an initially concrete-lined and subsequently steel-lined penstock and bifurcation. Water discharged from the turbo-generators will be returned to the river through a concrete-lined tailrace tunnel with identical cross-section to that of the headrace tunnel, but only 1.3 km long. The tailrace outlet structure has been sited upstream of Twin Islands and includes a stilling basin to ensure that the tailrace is drowned.

An upstream surge tank is provided in the headrace tunnel, about 100 m upstream of its junction with the concrete-lined penstock. Also a downstream surge tank is provided immediately downstream of and adjacent to the underground powerhouse.

Underground 11/220 kV transformers are proposed by Sogreah, comprising 3x37 MVA single phase units connected to the 2x55 MVA generators driven by 2x53 MW Francis turbines to give an output of 2x52.25 MW. A spare single phase transformer is included. We recommend that 2x55 MVA three phase 11/220 kV transformers should be provided instead of the four single phase transformers recommended by Sogreah.

At the design power factor of 0.95 each 55 MVA generator will produce an output of 52.25 MW, so that a maximum of 100 MW can be delivered at Lessos after allowing for transmission losses.

As already stated, we recommend adopting new values of mean annual flow, so the effect of substituting 17 cubic metres/second for the 20 cubic metres/second used by Sogreah on the ultimate design and arrangement of the proposed power station should be considered during the detailed design studies included in the next stage of project development.

7. PROJECT OPERATION

Our studies show that Turkwell's annual energy yield of 402 GWh, available in a year of average rainfall giving an annual river flow estimated by us to be 17 cubic metres/second, can be fully absorbed by the Kenya power system by the year 1999 while 91 per cent of this energy yield can be absorbed by 1996. The yield of secondary energy available from the power stations of the Tana Cascade in a year of average rainfall from 1988 onwards is estimated to be greater than the total energy yield available from Turkwell, so despite the steady growth of demand for electricity the whole of the 81 GWh of secondary energy available from Turkwell in an average year cannot be fully utilised immediately after Turkwell is brought into service. Secondary energy is additional energy available in years other than dry years.

Turkwell would operate at an annual capacity factor of 44 per cent in an average year, falling to 35 per cent in a dry year when the energy yield reduces to 321 GWh. Thus Turkwell would be able to supply the power system's requirement of peak load energy throughout each year with the high degree of generation reliability assured by the large volume of stored water impounded by the Turkwell dam which we believe permits 80 per cent regulation, rather than the 90 per cent regulation estimated by Sogreah, of the mean annual flow in the river.

The effect of reservoir drawdown is estimated to reduce power output at Turkwell by about 12 per cent, so the dependable peaking capacity available at Turkwell is around 93 MW.

8. ENVIRONMENTAL IMPACT

There is no question that the positive impacts from the Turkwell Gorge project far outweigh any potential negative implications. Identified social benefits obtainable include the employment and cash incomes and revenues created by the project, together with improvements to communications, to agriculture and fishing, and settlement opportunities and encouragement of settled pastoralism, together with the possible enhancement of the prospects for exploitation of mineral deposits and development of agro-industry. The expected negative impacts on a poor

rural society are already well recognised by the Government. The reduction in flooding which will result downstream of the project may create problems for agricultural areas relying on flood-irrigation by Turkwell water, so studies should be made of such effects together with any consequent need to apply fertilisers to land which presently benefits from fertile solids deposited by Turkwell flood water.

The environmental impact of Turkwell should be monitored both during construction and for some years after the project is brought into service. The project will inundate an existing river crossing, so it is essential that a new crossing be included in the project but it could be by a simpler means than the bridge proposed by Sogreah to be incorporated in the dam.

9. CONSTRUCTION SCHEDULE AND COSTS

We propose to schedule the construction of the main civil works in order that impounding of water would commence during January 1992 so that power generation would begin in January 1993. To achieve this, the award of the main contracts would have to be completed by September 1987. If it should prove possible to advance the award of the main contracts to March 1987, this should enable impounding to begin during April 1991 and generation to commence in May or June 1992. Such acceleration of construction would be financially advantageous, as it would permit construction of new geothermal generation capacity to be deferred so that it would be brought into service in 1995 instead of 1992. The Government of Kenya desires to bring the project into service towards the middle of 1990, and it is our opinion that if the Government can mobilise finances and other resources the completion of the project could be earlier than 1992.

The estimate of project cost prepared by Sogreah has been reviewed, using their September 1982 price datum. As a result we conclude that, using September 1982 prices, the cost of the civil works should be increased by 16-33 per cent, the larger increase reflecting greater allowances for present uncertainties. In the case of mechanical and electrical equipment costs we conclude that their cost should be decreased by 10 per cent.

We have also prepared an estimate of the cost of the project at January 1984 price levels. The resultant total of construction costs given in Table 1 is KSh 2111-2315 million, the upper estimate including the higher of the alternative estimates of the cost of civil works. These totals include appropriate allowances for physical contingency ranging from 20 per cent on direct cost items of civil works, to 10 per cent for the transmission facilities from Turkwell to Lessos and 5 per cent for generation plant. The overall allowance included for physical contingency represents 10 per cent of the upper estimate's cost of constructing the project inclusive of engineering, supervision and administration. At this stage final costs are tentatively anticipated to be closer to the lower estimate, although confirmation of this anticipation must await the completion of the detailed design studies which will take account of the current site investigations.

When allowances are added to this upper estimate to provide for future inflation at a nominal rate of 5 per cent each year and for financing charges estimated to be incurred during construction, amounting to KSh 1025 and 697 million respectively, the total investment required is KSh 4037 million. This estimate does not include Kenyan taxes, duties or levies on goods imported for the project. The estimated annual disbursements of

this investment, apportioned between foreign currency and local currency, are given in Table 2. Table 3 expresses the same pattern of investment in US Dollars using an exchange rate of KSh 13.734 to the dollar, and shows that the total investment required is estimated to be US\$ 294 million inclusive of the foregoing allowances for future inflation and for interest during construction. These allowances for future inflation and for financing charges should be reviewed following the receipt of tenders for project construction, and when a detailed financing plan is available. It may be noted that if for example future inflation is at 8 per cent each year, the effect would be to increase these allowances so that the estimated total investment required would rise to KSh 4974 million, equivalent to US\$ 362 million.

10. ECONOMIC ASSESSMENT

Alternatives to Turkwell

The economic assessment of the Turkwell Gorge project has been based initially on comparisons of electricity production costs applicable to alternative sources of new generation capacity. The calculation of electricity production costs uses the upper estimate of the construction cost of Turkwell, except where we state that we have substituted the lower estimate.

The first comparison showed that Turkwell is the least cost new source of hydro-electricity within Kenya. A further comparison, illustrated by Exhibit 4, showed that whilst new geothermal generation plant provides the cheapest additional source of energy at high load factors, at the load factor postulated by the combination of the 104.5 MW capacity postulated by Sogreah and the 17m³/s mean annual flow assessed by PCR, Turkwell could provide the cheapest power and energy of the alternatives considered. Thus Turkwell and new geothermal generation plant are not mutually exclusive and the future mix of new generation capacity is likely to include both the Turkwell project and new geothermal plant, as well as gas turbine plant to provide additional generation capacity in dry years.

We have assumed that given the funding for exploration and drilling, 60MW of new geothermal plant could be installed over a period of 8-10 years, with a further 30MW four years later. This means that if the Kenya power system's future requirements of base load and mid load electricity are to be met from Kenyan generation sources other than hydro plant, new geothermal plant must be supplemented by new thermal generation, which we consider should comprise a new steam power station burning imported coal and located on the coast at Mombasa. Thus the alternative to developing the Turkwell Gorge project is likely to be a mixture of coal-burning steam plant complemented by peaking gas turbine plant.

Turkwell and the Optimum Generation Expansion Plan

The main economic assessment of the project has been based on a least cost economic analysis of the long term development of the Kenya power system. Alternative generation expansion sequences both with and without Turkwell, assuming similar plant margins, have been compared using constant 1984 prices. The "without Turkwell" (cost-effective pure thermal) expansion plan, and the mixed hydro-and-thermal expansion plan

with Turkwell brought into service in 1993, both schedule 90MW of new geothermal plant to be brought into service during the period 1992-2000. This new geothermal plant is supplemented by up to 120MW of coal-burning steam plant and by up to 240MW of new gas turbine plant.

The generation plant assumed to be brought into service prior to 1991 has been based on the generation expansion programme now under implementation by the Kenya Power and Lighting Company (KPL). Alternative sequences of generation expansion, including transmission costs, for the period 1991-2000 were formulated for different development scenarios with the assistance of a programme optimisation model established by the computer program OGP6 (developed by the General Electric Company USA). This model took account of the probabilities of energy yields resulting from annual river flows in the Tana River above and below the mean annual flow.

The first scenario postulated a pure thermal expansion sequence, and the others postulated mixed hydro and thermal expansion sequences including a sequence scheduling six new hydro-electric developments which we term the all-hydro sequence. All sequences include sufficient thermal standby generation capacity to ensure that the forecast annual energy requirement of the KPL power system can be satisfied in the event that very dry year conditions are experienced simultaneously in all the rivers used for hydro-electric generation, and that the existing 30 MW bulk supply of hydro power from Uganda is unavailable throughout the same year. The economic life of the Turkwell project was assumed to be 60 years. The total electricity production costs of the Kenya power system were calculated for each sequence using a generation simulation model established by the above-mentioned computer program, with fuel and other operating costs calculated for average-year hydrological conditions at all the hydro power stations, assuming now that the 30 MW bulk supply from Uganda is available. The resultant costs were then compared on a discounted cash flow basis. The evaluation period embraced the 60 years economic life of Turkwell and comprised an expansion period up to the year 2000, and a post-expansion period from 2001 to 2051 during which the fuel and other operating costs of the Kenya power system were held constant at the level calculated for the year 2000 and the original construction costs of short life assets were reinserted into the cost stream at the end of their economic life. All costs were expressed in economic terms to reflect their resource cost to the economy. The optimum generation expansion plan was selected as the sequence with the lowest present value of long term electricity production costs, using the 10 per cent test discount rate. This sequence therefore would offer the greatest net present value of production cost savings compared with the pure thermal sequence. To evaluate the "with Turkwell" scenario four sequences were formulated to permit the optimisation of the year in which Turkwell is to be brought into service.

The results of the comparison of alternative generation sequences show that the 1993 and 1994 in-service years for Turkwell have equal economic merit, and these two Turkwell sequences jointly represent the least cost solution. Exhibit 5 illustrates this conclusion and the 1993 in-service year requires less capital to be raised to cover future inflation of project costs.

Thus the optimum generation plan is the sequence that includes the Turkwell Gorge project, scheduled to be brought into service in 1993, for which the net present value of long term production costs savings is KSh 65 million compared with the pure thermal sequence. This sequence is the least cost solution for all discount rates from zero to 10.8 and 12.2 per cent for the upper and lower estimates of the construction cost of the Turkwell project respectively. These equalising discount rates are a measure of the economic rate of return obtainable on the additional investment required to construct Turkwell instead of the next best alternative development of thermal generation capacity, if cost savings are taken as benefits. Exhibit 6 illustrates the optimum generation expansion plan defined by the least cost solution sequence, which we therefore recommend for implementation. Exhibit 7 illustrates the scheduling of energy production in this sequence for average-year hydro conditions.

The comparative analysis shows also that the Miriu hydro-electric development on the Sondu river would be included in the optimum generation plan if its construction cost were about 12 per cent lower than the cost estimate given by JICA in their February 1984 report. Further studies are required to determine whether Miriu is economically viable so that it would then be scheduled to be brought into service in 1998, instead of a 60MW coal-fired steam plant.

The all-hydro sequence was associated with a very substantial increase in the present value of long term electricity production costs indicating that, on the information at present available concerning construction cost and power and energy yields, identified Kenyan hydro-electric developments other than Turkwell and Miriu appear to be uneconomic.

Effect of Variant Assumptions

The validity of the results of the foregoing inclusion of the Turkwell project in the optimum generation plan has been tested for sensitivity to variant assumptions.

The upper estimate of construction cost of Turkwell could be increased by up to 6.5 per cent before Turkwell is rejected from the optimum generation plan. Decreasing the construction cost of new thermal, including geothermal, generation capacity by 15 per cent does not reject Turkwell from the optimum generation plan, neither does reducing fuel prices by up to 11 per cent. Transmission construction costs could be increased by up to 34 per cent without rejecting Turkwell from the optimum generation plan. If a shadow exchange rate should increase all foreign currency costs by 20 per cent, Turkwell is still included in the optimum generation plan.

Should future growth of demand for electricity be slower than is predicted now, so that the level of demand now forecast for 1998 does not appear until the year 2000 and Turkwell accordingly is rescheduled so that it is brought into service in 1994, Turkwell continues to be included in the optimum generation plan for all discount rates from zero up to 11.5 per cent.

If the test discount rate is increased from 10 to 12 per cent, and if the detailed design study validates using the lower construction cost estimate Turkwell is still included in the optimum generation plan, but it should now be rescheduled so that it is brought into service in 1994.

These results show that the inclusion of Turkwell in the optimum generation plan for the Kenya power system is not unduly sensitive to a credible range of variant assumptions.

Effect of a possible increase in power import from Uganda

Current studies of the future development of the Uganda electricity system indicate that it should be possible to develop a new source of cheap hydro-electricity on the Victoria Nile which would permit an increase in the volume of electricity exported to Kenya. The interim report on these studies does not reach a firm conclusion concerning, nor recommend immediate action for the implementation of development of, any one of the potential sources of additional hydro-electric generation in Uganda, so it has not been possible for us to evaluate an increase in power import in the same detail as the evaluation of Turkwell.

We believe that when the current planning studies in Uganda have selected the best hydro-electric development and optimised its timing, and the necessary detailed feasibility studies in Uganda have been completed so that reliable cost estimates are available, Uganda will be in a position to offer additional electricity to Kenya at a price which is very competitive with the cost of base load electricity produced within Kenya. Technical considerations of security of supply which is dependent upon operational/maintenance factors outside Kenyan control will probably restrict the level of import so that it does not exceed, say, 10 per cent of the peak load on the Kenya power system. On this criterion the predicted growth of demand would nevertheless permit the existing 30MW import to be doubled by 1996 and to rise to 80MW by 2000.

The high cost of power transmission from Uganda to Kenya indicates that imported power should continue to be used to assist in supplying the base load component of the demand for electricity within Kenya. This means that increased import from Uganda would displace new coal-fired generation plant or new geothermal generation plant, rather than new hydro-electric generation plants such as Turkwell and Miriu whose role in the future generation plant mix is to complement new base load generation capacity by supplying the non base load components of demand.

We conclude that a future increase in power import from Uganda would not affect the inclusion of Turkwell in the optimum generation plan for the Kenya power system.

Economic Justification of Turkwell

The least cost analysis of alternatives shows that the Turkwell project is the least cost solution for generation development, and the comparison with the alternative thermal development shows that the economic return obtainable on the additional investment in the Turkwell project instead of the alternative thermal development is more than sufficient to satisfy the usual criteria. The value of this economic rate of return is 10.8 and 12.2 per cent for the PCR upper and lower estimates of the construction cost of the Turkwell project respectively. Should the future design study's update of the Turkwell hydrology warrant an increase in the 17m³/s mean annual flow conservatively assumed in this analysis, the effect could only enhance the economic return obtainable.

Therefore the Turkwell Gorge project is determined to be economically viable.



11. FINANCIAL ASSESSMENT

General Approach

For the purpose of this report, it is assumed that a notional Turkwell Entity will be entrusted with the financial responsibility both for the construction and for the operation of Turkwell. This notional Entity thus combines the various functions which, in the case of the Kiambere hydro-electric project now under construction, are understood to be shared between the Government, the Tana and Athi Rivers Development Authority and KPL. The concept of a notional Turkwell Entity is simply a device for enabling the ownership, operation, sale of electricity and debt service aspects of Turkwell to be represented by a single set of accounts.

Financial forecasts using our upper estimate of construction cost of Turkwell have been made for the base case with Turkwell constructed so that it is brought into service in 1993. Alternative cases evaluate the in-service years 1992 and 1994. Three scenarios taking account of future inflation have been used to evaluate each case, assuming future annual inflation rates of zero, 5 and 8 per cent respectively.

A tentative financing plan has been assumed, which provides for foreign currency to be provided to the Entity in the form of loans bearing interest at 10.5 per cent yearly, and for local currency funding to be provided to the Entity in the form of an equity investment on which an annual return of 8 per cent is to be earned and paid in the form of an annual dividend.

Financial forecasts have been made for each year up to 2014, by which year all the external loans are assumed to have been repaid.

Cash Flow

In calculating the sales revenue attributable to Turkwell, we have used existing tariff rates adjusted by the 8 cents per kWh yearly increase which KPL is committed to apply up to 1990. Thus the average income per kWh sold in 1990 is estimated to be 131.5 cents. This price then is held constant for the zero-inflation scenario, but it is increased each year after 1990 in the two cum-inflation scenarios. The price increases thus applied each year after 1990 represent about four-fifths of the assumed rate of inflation, as we assume that some items of KPL's expenses are not indexed to inflation and that this will be reflected in the future price of electricity.

Fifteen per cent of the electrical energy produced at Turkwell and delivered to Lessos is assumed to be lost in transmission and distribution between Lessos and the consumers' premises. An addition has been made to the electricity production costs of Turkwell to allow for expenses incurred by KPL in respect of transmission and distribution from Lessos onwards, to justify using KPL's average price per unit sold when calculating attributable revenue.

For the alternative cases with in-service years 1992 and 1994 respectively the sales volume attributable to Turkwell in the early years is greater though for different reasons. Bringing Turkwell into service in 1992 permits the postponement of a new 30MW geothermal plant from 1992 to 1995 so increments of sales do not have to be apportioned between

Turkwell and a preceding generation plant. Bringing Turkwell into service in 1994 means that incremental sales attributable to Turkwell build up more rapidly than for the base case (in-service 1993). The result is that the alternative in-service years 1992 and 1994 produce beneficial effects on production cost/kWh and on cash flow.

For the scenario with future inflation at a rate of 5 per cent per annum, Tables 4 and 5 for the 1993 and 1992 in-service years respectively, show clearly how an estimated cumulative cash deficit in 1995 of KSh 410 million falls to KSh 225 million if the in-service year is 1992 instead of 1993. For both cases the annual cash flow becomes positive from 1996 onwards, but the cumulative deficit disappears sooner in the case of the 1992 in-service year.

The present value (in 1984) of the cash flow of the Turkwell project (in-service 1993) up to and including the year 2014 is KSh 2 million using a discount rate in real terms of 10 per cent. Advancing the in-service year to 1992 increases this present value to KSh 47 million, while deferring it to 1994 results in a present value of KSh 26 million. Thus it would be financially advantageous if Turkwell could be brought into service in 1992 instead of 1993.

Hydro-electric projects often create such problems of short term liquidity. The problem could be mitigated by making suitable arrangements with aid donors concerning commencement of debt service payments. If such arrangements should be insufficient to provide a complete solution, then the foregoing or deferment of dividends on equity capital would reduce remaining deficits to acceptable proportions, and enable liquidity to be restored by bank overdraft or other short term borrowing.

Profitability

Tables 4 and 5 also show the estimated after-tax profit of the Turkwell project for each year up to 2014, for the scenario with future inflation at a rate of 5 per cent per annum. The present value of these after tax profits is KSh 63 million, for the 1993 in-service year. A discount rate of 10 per cent in real terms has been used to calculate these present values. Alternative in-service years 1994 and 1992 increase this present value to KSh 85 and 159 million respectively.

This assessment of profitability confirms that it would be financially advantageous if Turkwell could be brought into service in 1992 instead of 1993.

Effect of Change in future inflation on cash flow and profitability

Applying alternative inflation scenarios, assuming zero and 8 per cent per annum respectively, shows that advancing the in-service year for Turkwell to 1992 remains financially advantageous. High inflation rates impair the liquidity of, and reduce the profitability of, the Turkwell project. Low inflation rates have the opposite effect. These results reflect the inflation-accounting assumptions made for the financial forecasts.

Balance of payments and budgetary effects

A benefit to the national economy is obtainable from Turkwell through the long term savings in foreign currency which would be spent on importing fuel if coal-fired baseload generating plant and oil-fired gas turbine peaking plant were to be installed instead of Turkwell. When these long term savings are discounted at 10 per cent, their net present value at constant 1984 prices is KSh 204 million. The arithmetic (undiscounted) total of each year's net savings during a forty year period after Turkwell, exceeds KSh 2745 million, at constant 1984 prices. This is a measure of the resources of foreign currency which could be allocated to other purposes during the next fifty years, as a result of constructing Turkwell instead of alternative thermal generation capacity.

These estimates of savings in foreign exchange would increase if aid donors provide grants or soft loans to finance part of the foreign exchange needed to construct Turkwell. The effect of allowing for future inflation would likewise increase the foreign exchange benefits of Turkwell.

Benefits to the Government of Kenya that are obtainable from Turkwell include tax revenues levied on the annual profit forecast to be earned by the project after the early years' liquidity problems have been left behind. It is estimated that these tax revenues will eventually rise to more than KSh 100 million each year. Also the Kenya Treasury will enjoy budget support from the on-lending at a higher interest rate of the soft loans and grants portion of the external finance secured for Turkwell. It is estimated that this budget support might well amount to KSh 60 million annually until the loans are repaid by the Turkwell Entity.

Financial Status of the Kerio Valley Development Authority and of KPL

The Kerio Valley Development Authority (KVDA) is a recent creation and the present scope of its operations is small compared with the situation which is expected to exist when the Turkwell Gorge project is completed. Therefore it is not practicable to assess now the financial status of the Authority in relation to its future ownership of the project.

As explained in Section 12 below, it is envisaged that KPL will make an annual "rental" payment to KVDA. In return, KPL will operate the Turkwell power station and sell the electricity produced at Turkwell. Thus the ability of KVDA to discharge its debt service obligations in respect of Turkwell will depend on the financial performance of KPL.

Our examination of KPL's recent annual reports, and of financial forecasts made in 1983 by the World Bank for KPL and its two associated power-producing companies TRDC and KPC, together demonstrate that the existing and expected financial status of KPL provides a sound foundation for the generation of the income required by KVDA to meet the debt service liability created by the construction of the Turkwell project.

Electricity Tariffs

The detailed financial forecasts show that, except for not more than five years of initial operation (the actual number of years depending on the rate of future inflation), income at the prevailing KPL tariff rates from sales of energy produced at Turkwell will be adequate to sustain the cash flow required for debt service and for paying reasonable dividends on

equity capital. The solution adopted for the problem of short term liquidity should avoid imposing any temporary surcharge on tariffs, as the problem can be mitigated by making suitable arrangements with aid donors concerning commencement of debt service payments. Should such arrangements provide only a partial solution, then deferment of dividends on equity capital and/or short term borrowing are preferred remedies.

It is concluded that the KPL tariff rates envisaged for 1990 appear to provide a level of sales revenue that is sufficient to ensure the financial viability of the Turkwell Project.

Cost-Benefit Analysis

The Turkwell project, scheduled so that it is brought into service in 1993, has been subjected to financial cost-benefit analysis. The results obtained show that the internal financial rate of return ranges from 5.7 to 8 per cent, depending on the assumptions made as to the choice between the upper and lower estimates of project construction cost, the average revenue received per kWh sold by KPL in 1984, and the inclusion or exclusion of taxes and duties levied on the project construction cost. These results all are greater than the 3-5 per cent return in real terms (ie. excluding the effect of future inflation) which is normally acceptable. These financial returns can also be expressed as net present values which range from KSh 245 to 759 million calculated using a discount rate of 5 per cent.

Financial Justification of Turkwell

The results of the financial analysis establish that the Turkwell Gorge project is financially viable notwithstanding that, as is often the case with new hydro-electric projects, a problem of short term liquidity is expected to arise during the early years of operation which could be mitigated by suitable arrangements with aid donors concerning commencement of debt service payments.

It would be financially advantageous if Turkwell could be brought into service in 1992 instead of in 1993 provided that 30MW of new geothermal plant, otherwise needed in 1992, is postponed until 1995.

12. ADMINISTRATIVE AND ORGANISATIONAL ASPECTS

Although for the purpose of the Financial Assessment we have assumed a single "Turkwell Entity", it is understood that Turkwell is in fact likely to be constructed, owned and operated in a similar manner to that which has been decided for the Kiambere hydro-electric project. This would mean that Turkwell would be financed and constructed by the Kerio Valley Development Authority (KVDA), which would arrange for the subsequent operation of the Turkwell power station to be undertaken by KPL which would acquire the right to sell electricity from Turkwell in return for an annual "rental" payment to KVDA. We strongly recommend the adoption of this Kiambere type arrangement.

KVDA has no previous experience in administering the construction of a project as large as the Turkwell project, and it is unlikely that any other single project of comparable size would be constructed by the Authority. We therefore recommend that a separate small section should be formed within KVDA to administer the construction of Turkwell.

The staff of this section would include an engineer who would manage the construction project, and a financial controller, both of whom must have previous experience in the detailed administration of a major hydro-electric project on behalf of its owner. The experience gained by TARDA in the implementation of recent and current hydro-electric developments on the Tana river should be drawn on by KVDA for the establishment of the new section. KPL's resources, including a well established staff training school as well as experienced engineers, technicians, craftsmen and artisans, should be adequate for providing experienced personnel to ensure competent staffing of Turkwell.

13. PROJECT IMPLEMENTATION

In order to ensure power production in January 1993 it is necessary to award the main construction contract no later than 30 September 1987, as well as awarding preliminary contracts during December 1986 to ensure that essential work on the improvement of access to the project site and the construction of camp facilities will be completed in readiness for the main contractor.

The implementation programme is illustrated by Exhibit 7 and the overall target schedule for the timely completion of Turkwell includes the following critical elements:

Prepare designs and tender documents	October 84 - December 86
Tender period (civil works)	December 86 - March 87
Civil contract award	September 87
Complete river diversion	October 88
Commence impounding	January 92
Commence generation	January 93

In view of the financial benefits obtainable if Turkwell can be brought into service in 1992 instead of 1993 an accelerated implementation programme is shown in Exhibit 8 which provides for commencement of power production in May/June 1992. Preliminary contracts for improvement of access and the construction of camp facilities now would have to be awarded during September 1986. The overall target schedule for achieving such earlier completion includes the following critical elements:

Prepare designs and tender documents	October 84 - June 86
Tender period (civil works)	July 86 - October 86
Civil contract award	March 87
Complete river diversion	January 88
Commence impounding	April 91
Commence generation	May/June 92

We believe that, for this accelerated programme, special procedures would have to be instituted by the Government of Kenya and by aid donors to permit project finance assurances to be secured early enough to permit the main tenders to be issued in July 1986, so that the civil contract can be awarded in March 1987. Also to ensure that the financial benefits obtainable from accelerated implementation are achieved, it would be necessary to take a decision by March 1987 to postpone construction of new geothermal generation plant so that it will be brought into service in 1995 instead of in 1992.

TABLE 1
TURKWELL GORGE HYDRO-ELECTRIC DEVELOPMENT
PROJECT COST ESTIMATE (JAN.1984 PRICES)

	Lower Estimate KSh.m	Upper Estimate KSh.m
<u>CIVIL ENGINEERING COSTS</u>		
Cofferdam and Diversion	108.19	112.86
Arch Dam and Afterbay Dam	305.88	379.89
Water Intake	14.35	15.08
Headrace Tunnel	101.69	109.04
Powerhouse and Associated Works includes Sogreah's:-	119.19	127.60
Upstream Surge Tank		
Penstock + junction gallery No.2		
Access gallery + gallery Nos.1&3		
Powerhouse + junction gallery No.4		
Downstream surge tank		
Cable shaft		
Switchyard		
Tailrace and Outlet	48.07	49.31
 SUB-TOTALS	 697.37	 794.44
Allowance for Physical Contingency (20%)	139.47	158.90
Contractor's Plant (P&G)	103.47	142.99
 Total of Main Civil Works	 940.31	 1 096.33
(Preliminary Works)	Lower	Upper
Access Road	95.87	95.87
Site Road	55.52	79.83
Camp Facilities	118.48	118.48
	269.87	294.18
Allowance for Physical Contingency on Preliminaries (20%)	53.98	58.84
 Total of Preliminary Works	 323.85	 353.02
 TOTALS	 1 264.16	 1 449.35

TABLE 1 (Cont.)
TURKWELL GORGE HYDRO-ELECTRIC DEVELOPMENT
PROJECT COST ESTIMATE (JAN.1984 PRICES)

	Lower Estimate KSh.m	Upper Estimate KSh.m
<u>ELECTRICAL AND MECHANICAL EQUIPMENT AND ASSOCIATED TRANSMISSION WORKS COSTS</u>		
Water Intake	8.73	8.73
Penstock	22.48	22.48
Spherical Valves	13.10	13.10
Turbines	41.53	41.53
Overhead Crane	5.59	5.59
Draft Tube Bulkhead Gate	1.26	1.26
Tail Race Stoplog	1.24	1.24
Dam and Reservoir		
Trash Rack	1.28	1.28
U/S Gate	5.29	5.29
Steel Lining	1.54	1.54
Hollow Jet Valve	2.26	2.26
Lift	2.80	2.80
Generators	50.56	50.56
P/S Main Transformers	9.22	9.22
Other P/S Electrical Equipment		
Station Cabling	7.79	7.79
Auxiliary Transformers	1.02	1.02
Batteries/Chargers	1.55	1.55
Services Boards	2.29	2.29
Drainage/Dewater	2.04	2.04
Fire Fighting	3.56	3.56
Ventilation	12.20	12.20
Lighting and Small Power	5.30	5.30
Oil Handling	1.33	1.33
Compressed Air	1.34	1.34
Workshop	2.20	2.20
Diesel Generator	1.93	1.93
Miscellaneous and Spares	11.05	11.05
11kV O/H Line to Dam	0.78	0.78
Transmission	291.72	291.72
Co-ordination	7.19	7.19
Sub-Totals	520.17	520.17
Allowance for Physical Contingency*	42.05	42.05
Totals	562.22	562.22

TABLE 1 (Cont.)
TURKWELL GORGE HYDRO-ELECTRIC DEVELOPMENT
PROJECT COST ESTIMATE
(JAN.1984 PRICES)

	Lower Estimate KSh.m	Upper Estimate KSh.m
<u>SUMMARY OF COSTS</u>		
Civil Engineering Works	1,264.16	1,449.36
Electrical, Mechanical and Transmission Works	562.21	562.21
TOTAL	1,826.37	2,011.57
Engineering and Supervision	159.00	177.52
Further Investigations	33.85	33.85
Cleaning of Reservoir	27.08	27.08
Erosion Control	65.00	65.00
GRAND TOTAL (excluding allowances for Future Inflation, and Interest during Construction)	2,111.30	2,315.02
Equivalent US \$ million**	153.73	168.56
US \$/kW.SO***	1,537.28	1,685.61

* For the electro-mechanical element of construction cost, past experience in the estimation of costs for hydropower generation plant, based on actual budget estimates from international manufacturers and from our own tabulations for a variety of projects, indicates that physical contingency allowances of the order of 5% are adequate. However for transmission work where a greater degree of uncertainty is possible, particularly in respect of foundation conditions and route clearance, a contingency factor of 10% has been allowed.

** Rate of exchange taken as 1 US\$ = 13.734 KSh.

*** Based on 100MW SO, at Lessos

TABLE 2

SUMMARY PROJECT FINANCIAL COST ESTIMATE - KENYA SHILLINGS X MILLION

Year	Construction Costs in Constant Jan. 1984 Prices			Allowance for Price Contingency (Future inflation) at 5% p.a.			Allowance for Interest During Construction			Grand Totals		
	Offshore	Onshore	Sub-Total	Offshore	Onshore	Sub-Total	Offshore	Onshore	Sub-Total	Offshore	Onshore	Total
1987	5.69	3.21	8.90	0.91	0.50	1.41	0.35	0.15	0.50	6.95	3.86	10.81
1988	45.29	25.52	70.81	9.77	5.50	15.27	3.62	1.55	5.17	58.68	32.57	91.25
1989	97.93	55.18	153.11	27.02	15.25	42.27	13.45	5.73	19.18	138.40	76.16	214.56
1990	270.24	152.27	422.51	91.85	51.80	143.65	40.43	17.17	57.60	402.52	221.24	623.76
1991	256.07	144.29	400.36	104.29	58.74	163.03	82.61	34.83	117.44	442.97	237.86	680.83
1992	376.10	210.39	586.49	179.42	100.46	279.88	139.36	58.17	197.53	694.88	369.02	1,063.90
1993	359.45	198.60	558.05	198.25	109.49	307.74	212.44	87.58	300.02	770.14	395.67	1,165.81
1994	73.81	40.99	114.80	46.40	25.77	72.17	0.00	0.00	0.00	120.21	66.76	186.97
Total	1,484.58	830.46	2,315.03	657.91	367.51	1,025.42	492.26	205.18	697.44	2,634.75	1,403.14	4,037.87

Notes:

- Costs, applicable to the PCR Upper Estimate, include:
Engineering, Supervision and Administration
Further Investigations
Reservoir Cleaning and Erosion Control
- The present allowance for Price Contingency is nominal only, and should be reviewed when tenders have been received for the construction of the Project.
- Interest During Construction has been calculated on the basis of an interest rate of 10.5% for the Offshore portion, and 8.0% for the Onshore portion.

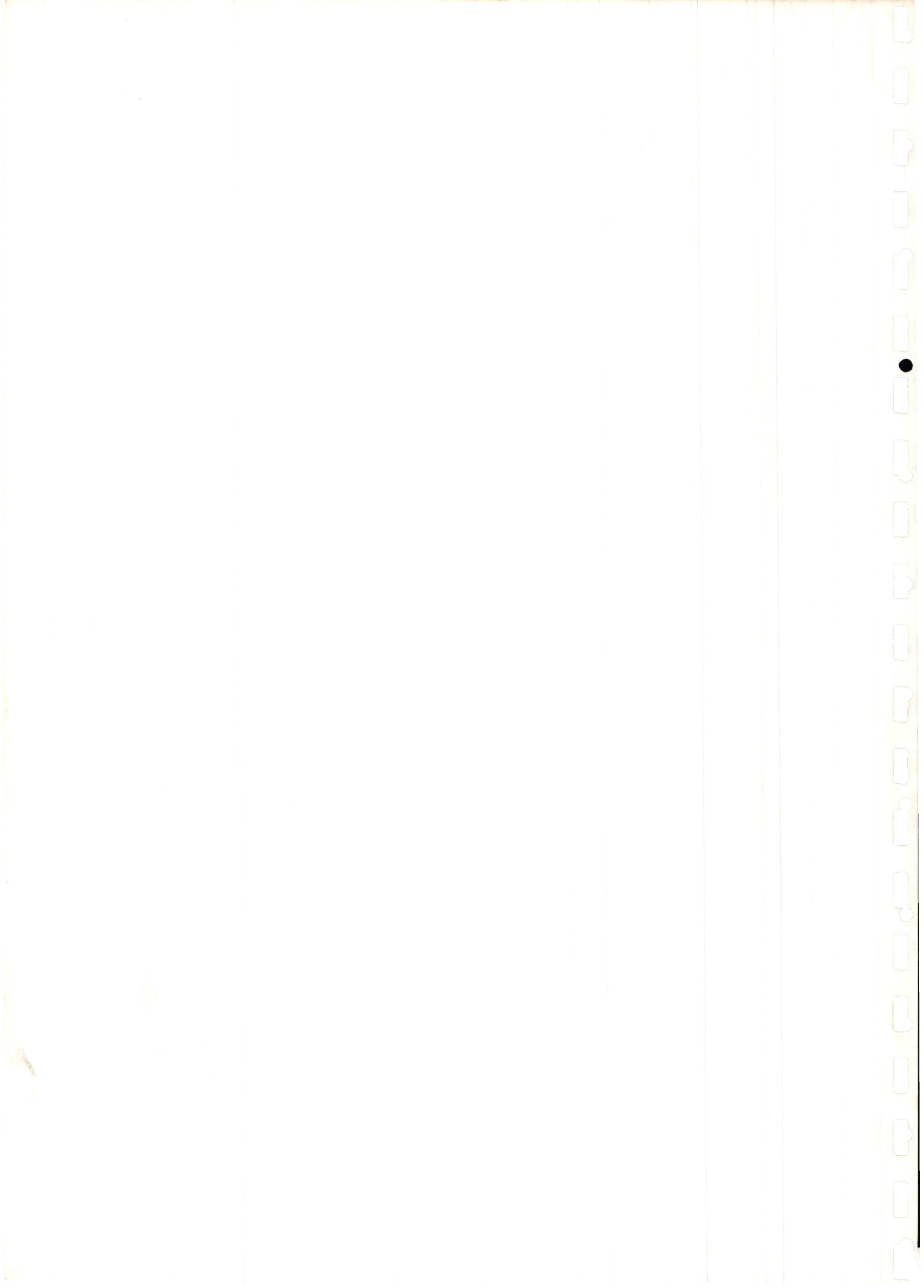


TABLE 3

SUMMARY PROJECT FINANCIAL COST ESTIMATE - US DOLLARS X MILLION

Year	Construction Costs in Constant Jan. 1984 Prices			Allowance for Price Contingency (Future inflation) at 5% p.a.			Allowance for Interest During Construction			Grand Totals		
	Offshore	Onshore	Sub-Total	Offshore	Onshore	Sub-Total	Offshore	Onshore	Sub-Total	Offshore	Onshore	Total
1987	0.41	0.23	0.65	0.07	0.04	0.10	0.03	0.01	0.04	0.51	0.28	0.78
1988	3.30	1.86	5.16	0.71	0.40	1.11	0.26	0.11	0.38	4.27	2.37	6.64
1989	7.13	4.02	11.15	1.97	1.11	3.08	0.98	0.42	1.40	10.08	5.55	15.62
1990	19.68	11.09	30.76	6.69	3.77	10.46	2.94	1.25	4.19	29.31	16.11	45.42
1991	18.64	10.51	29.15	7.59	4.28	11.87	6.01	2.54	8.55	32.25	17.32	49.57
1992	27.38	15.32	42.70	13.06	7.31	20.38	10.15	4.24	14.38	50.60	26.87	77.46
1993	26.17	14.46	40.63	14.43	7.97	22.41	15.47	6.38	21.85	56.08	28.81	84.88
1994	5.37	2.98	8.36	3.38	1.88	5.25	0.00	0.00	0.00	8.75	4.86	13.61
Totals	108.10	60.47	168.56	47.90	26.76	74.66	35.84	14.94	50.78	191.84	102.17	294.01

Notes:

- Costs, applicable to the PCR Upper Estimate, include:
Engineering, Supervision and Administration
Further Investigations
Reservoir Cleaning and Erosion Control
- The present allowance for Price Contingency is nominal only, and should be reviewed when tenders have been received for the construction of the Project.
- Interest During Construction has been calculated on the basis of an interest rate of 10.5% for the Offshore portion, and 8.0% for the Onshore portion.
- Rate of exchange taken as 1 US\$ = 13.734 KSh.

168.56
45.42

213.98
294.01
213.9

81
109.

85
86
4 1/2
90 1/2 - 1

TABLE 4

REF: TURKE4
DATE: 03/07/84

5% INFLATION; YEAR OF COMMISSIONING-1992

TURKWELL, GORGE-TOTAL PROFIT/LOSS CALCULATION

INTEREST RATES: OFFSHORE: 10.50
INFLATION RATES: OFFSHORE: 5.00
TOTAL COST OF PROJECT IN 1992 PRICES: 3845.66; IN 1984 PRICES: 2602.89
YEAR OF COMMISSIONING: 1992

YEAR	GMI OPERATING SOLD	ONSHORE RESULT K\$Hm	ONSHORE DIVIDEND K\$Hm	TAXABLE PROFIT K\$Hm	TAXATION AT 45% K\$Hm	RESULT AFTER TAX K\$Hm	DEP'N K\$Hm	LOAN REPMT K\$Hm	CASH DIFF K\$Hm	CASH DIFF CUM K\$Hm	CASH DIFF 1984 PRICES K\$Hm
1992	119.45	-32.37	50.91	18.54	8.34	-40.71	.00	18.65	-59.36	-59.36	-40.18
1993	252.04	-165.26	104.37	-60.89	.00	-165.26	121.14	41.29	-85.41	-144.77	-55.06
1994	268.83	-142.60	106.91	-35.69	.00	-142.60	127.20	46.79	-62.19	-206.97	-38.18
1995	291.97	-100.13	106.91	6.78	.00	-100.13	133.55	51.83	-18.41	-225.37	-10.76
1996	310.94	-60.86	106.91	46.05	.00	-60.86	140.23	57.42	21.95	-203.42	12.22
1997	329.47	-19.47	106.91	87.44	19.66	-39.13	147.24	63.60	44.51	-158.91	23.61
1998	339.56	11.61	106.91	118.52	53.33	-41.72	154.61	70.46	42.42	-116.48	21.43
1999	341.04	30.97	106.91	137.88	62.05	-31.08	162.34	78.05	53.21	-63.27	25.60
2000	341.04	49.30	106.91	156.21	70.29	-20.99	170.45	86.46	63.00	-2.27	28.86
2001	341.04	69.04	106.91	175.95	79.18	-10.14	178.98	93.78	73.06	72.78	31.88
2002	341.04	90.30	106.91	197.21	88.74	1.56	187.93	106.10	83.38	156.16	34.65
2003	341.04	113.22	106.91	220.13	99.06	14.16	197.32	117.53	93.95	250.12	37.18
2004	341.04	137.95	106.91	244.86	110.19	27.76	207.19	130.20	104.75	354.87	39.48
2005	341.04	164.65	106.91	271.56	122.20	42.45	217.55	144.23	115.76	470.63	41.55
2006	341.04	193.49	106.91	300.40	135.18	58.31	228.42	159.77	126.96	597.60	43.40
2007	341.04	224.67	106.91	331.58	149.21	75.46	239.85	176.98	138.32	735.92	45.03
2008	341.04	258.40	106.91	365.31	164.39	94.01	251.84	196.05	149.80	885.72	46.45
2009	341.04	294.92	106.91	401.83	180.82	114.10	264.41	217.18	161.35	1047.07	47.65
2010	341.04	334.49	106.91	441.40	198.63	135.86	277.65	240.58	172.93	1220.00	48.64
2011	341.04	377.38	106.91	484.29	217.93	159.45	291.53	266.51	184.47	1404.47	49.41
2012	341.04	423.92	106.91	530.83	238.87	185.05	306.11	143.84	347.32	1751.79	88.60
2013	341.04	450.19	106.91	557.10	250.70	199.50	321.42		520.91	2272.70	126.55
2014	341.04	469.83	106.91	576.74	259.53	210.30	337.49		547.78	2820.48	126.74

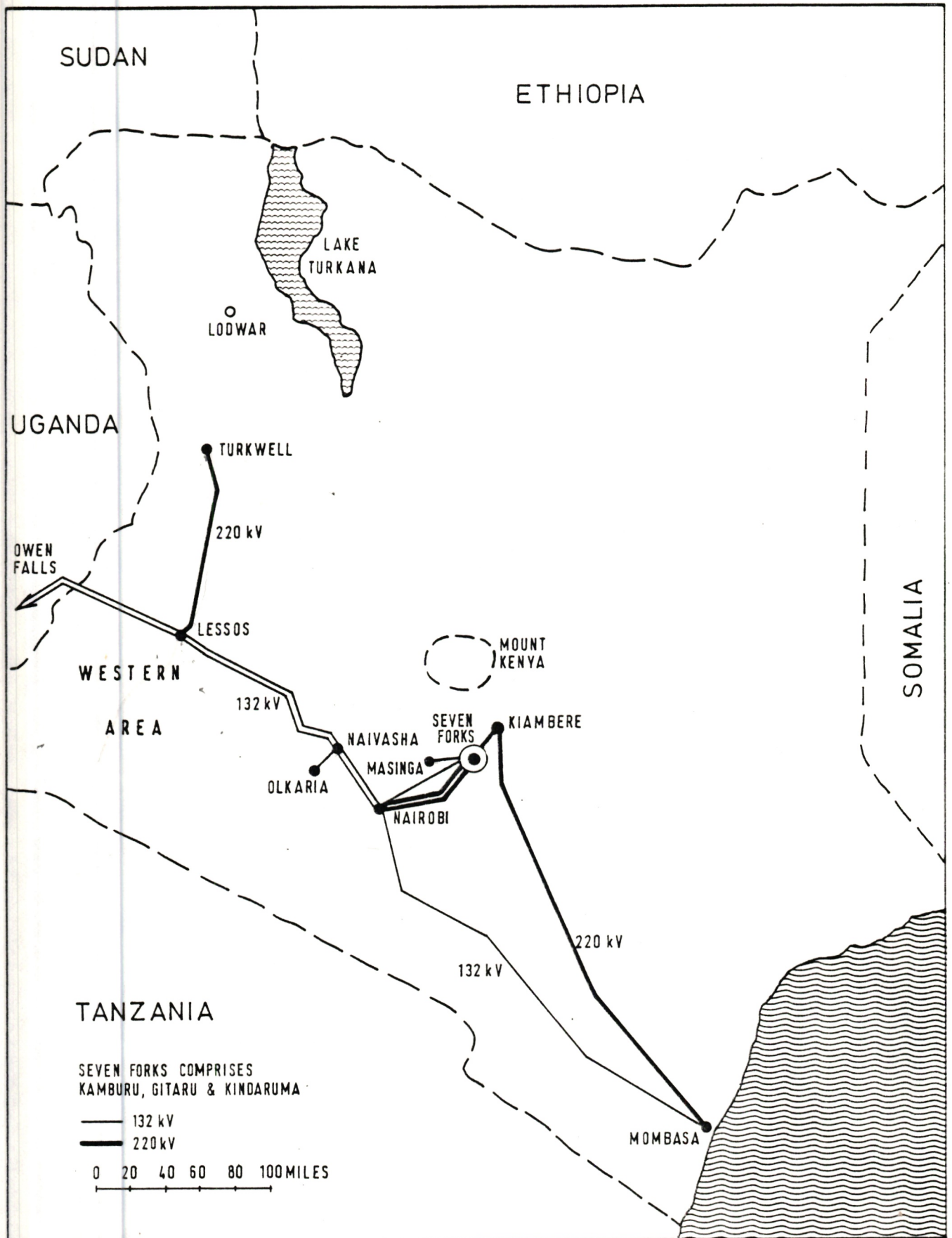
TURKWELL GORGE-TOTAL PROFIT/LOSS CALCULATION

5% INFLATION; YEAR OF COMMISSIONING-1993

REF: TURKB4
DATE: 03/07/84

INTEREST RATES: OFFSHORE: 10.50 ONSHORE: 8.00
INFLATION RATES: OFFSHORE: 5.00 ONSHORE: 5.00
TOTAL COST OF PROJECT IN 1993 PRICES: 4037.93; IN 1984 PRICES: 2602.89
YEAR OF COMMISSIONING: 1993

YEAR	G&M SOLD	OPERATING RESULT KSHm	ONSHORE DIVIDEND KSHm	TAXABLE PROFIT KSHm	TAXATION AT 45% KSHm	RESULT AFTER TAX KSHm	DEP'N KSHm	LOAN REPMT KSHm	CASH DIFF KSHm	CASH DIFF CUM KSHm	CASH DIFF 1984 PRICES KSHm
1992	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1993	87.70	-79.20	53.46	-25.74	.00	-79.20	.00	19.58	-98.78	-98.78	-63.67
1994	170.69	-291.49	109.58	-181.91	.00	-291.49	127.19	43.35	-207.65	-306.43	-127.48
1995	246.47	-187.95	112.25	-75.70	.00	-187.95	133.55	49.13	-103.53	-409.95	-60.53
1996	310.94	-84.33	112.25	27.92	.00	-84.33	140.23	54.42	1.48	-408.47	.83
1997	329.47	-43.27	112.25	68.98	.00	-43.27	147.24	60.29	43.68	-364.78	23.17
1998	339.56	-12.54	112.25	99.71	.00	-12.54	154.61	66.79	75.28	-289.51	38.02
1999	341.04	6.43	112.25	118.68	14.37	-7.94	162.34	73.98	80.42	-209.09	38.68
2000	341.04	24.32	112.25	136.57	61.46	-37.14	170.45	81.95	51.37	-157.73	23.53
2001	341.04	43.57	112.25	155.82	70.12	-26.55	178.98	90.78	61.65	-96.08	26.90
2002	341.04	64.29	112.25	176.54	79.44	-15.15	187.92	100.57	72.20	-23.88	30.00
2003	341.04	86.62	112.25	198.87	89.49	-2.87	197.32	111.40	83.05	59.17	32.87
2004	341.04	110.68	112.25	222.93	100.32	10.36	207.19	123.41	94.14	153.31	35.48
2005	341.04	136.65	112.25	248.90	112.01	24.65	217.55	136.71	105.48	258.79	37.86
2006	341.04	164.68	112.25	276.93	124.62	40.06	228.42	151.44	117.05	375.84	40.01
2007	341.04	191.96	112.25	307.21	138.24	56.72	239.84	167.76	128.80	504.64	41.93
2008	341.04	227.70	112.25	339.95	152.98	74.72	251.84	185.83	140.73	645.37	43.64
2009	341.04	263.12	112.25	375.37	168.92	94.20	264.43	205.86	152.77	798.14	45.11
2010	341.04	301.46	112.25	413.71	186.17	115.29	277.65	228.04	164.90	963.04	46.38
2011	341.04	343.01	112.25	455.26	204.87	138.14	291.53	252.61	177.07	1140.11	47.43
2012	341.04	388.06	112.25	500.31	225.14	162.92	306.11	279.83	189.20	1329.31	48.26
2013	341.04	436.92	112.25	549.17	247.13	189.79	321.41	315.03	205.18	1689.48	49.50
2014	341.04	464.50	112.25	576.75	259.54	204.96	337.49	337.49	221.63	1911.11	50.75

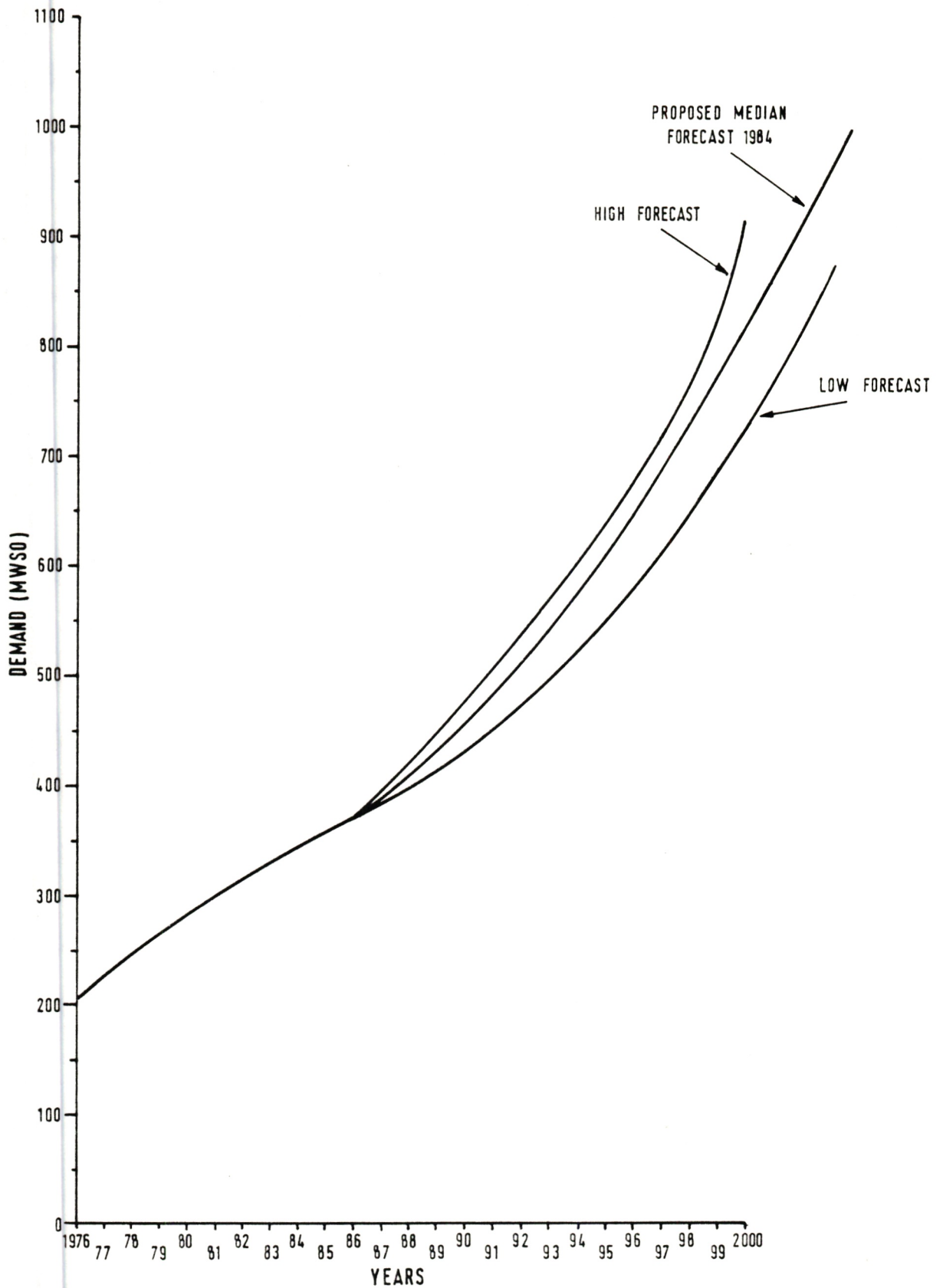


PREECE CARDEW & RIDER
 CONSULTING ENGINEERS
 Prudential House
 North Street
 Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY

220 kV & 132 kV LINE ROUTES
 INCLUDING COMMITTED WORKS

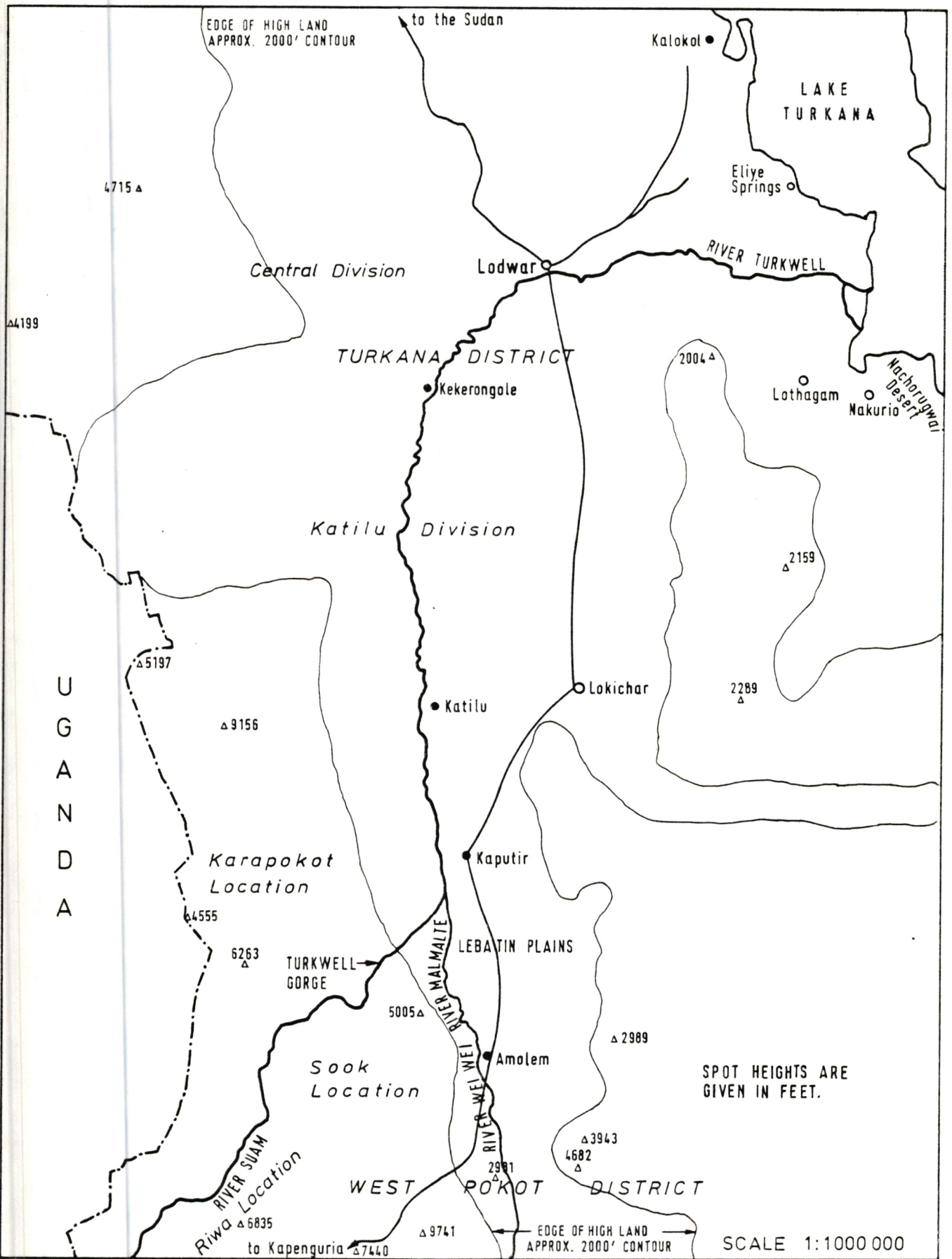
EXHIBIT 1



PREECE CARDEW & RIDER
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 Prudential House
 North Street
 Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY
 HIGH MEDIAN AND LOW ELECTRICITY DEMAND
 FORECASTS (MWSO)
 USED FOR PLANNING PURPOSES IN THIS STUDY

EXHIBIT 2



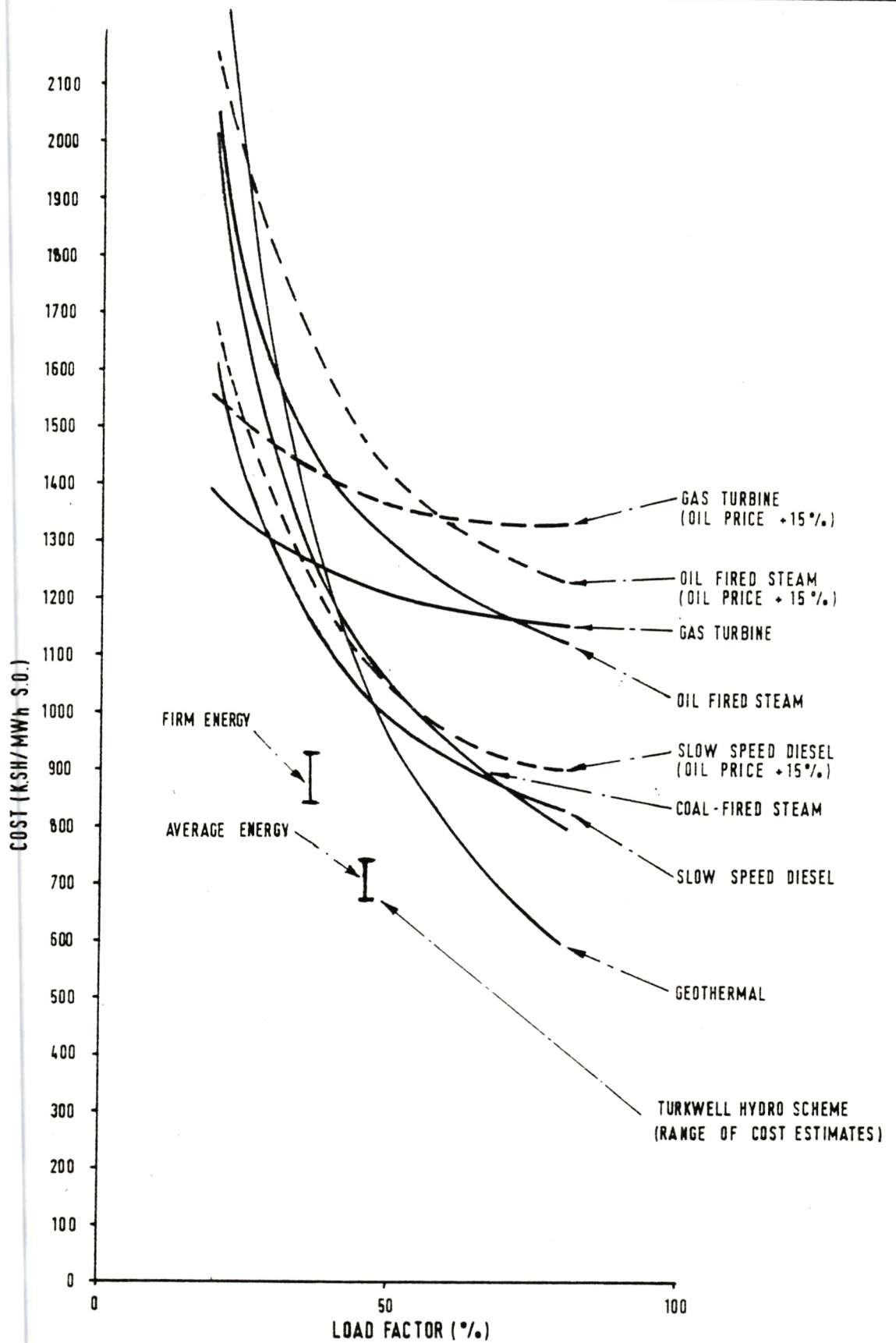
SPOT HEIGHTS ARE GIVEN IN FEET.

SCALE 1:1000 000

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 Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY
 THE COURSE OF THE TURKWELL RIVER

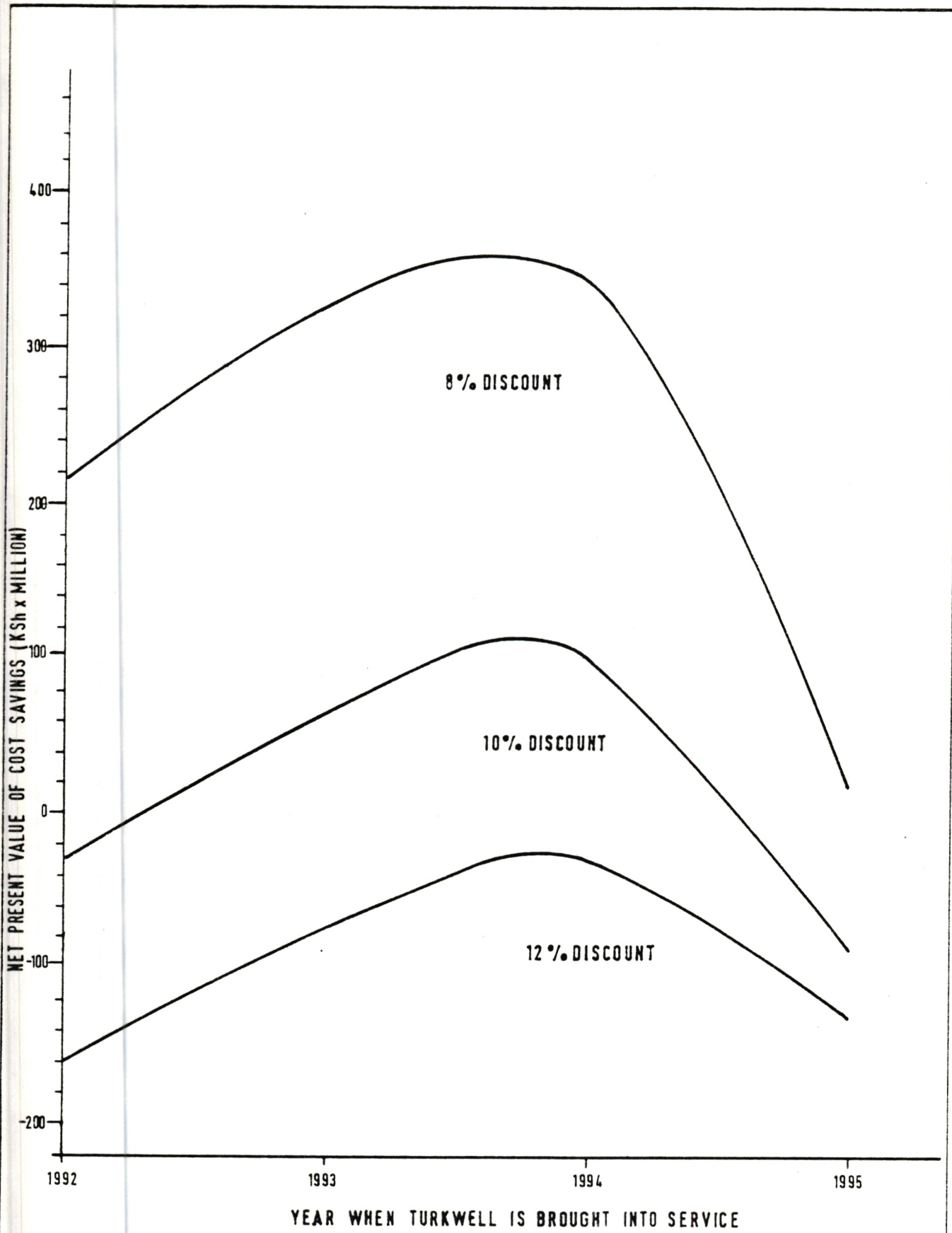
EXHIBIT 3



PREECE CARDEW & RIDER
CONSULTING ENGINEERS
Prudential House
North Street
Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY
COST PER MWh SENT - OUT OF TURKWELL PROJECT
COMPARED WITH INCREMENTAL COSTS OF
ALTERNATIVE THERMAL GENERATION

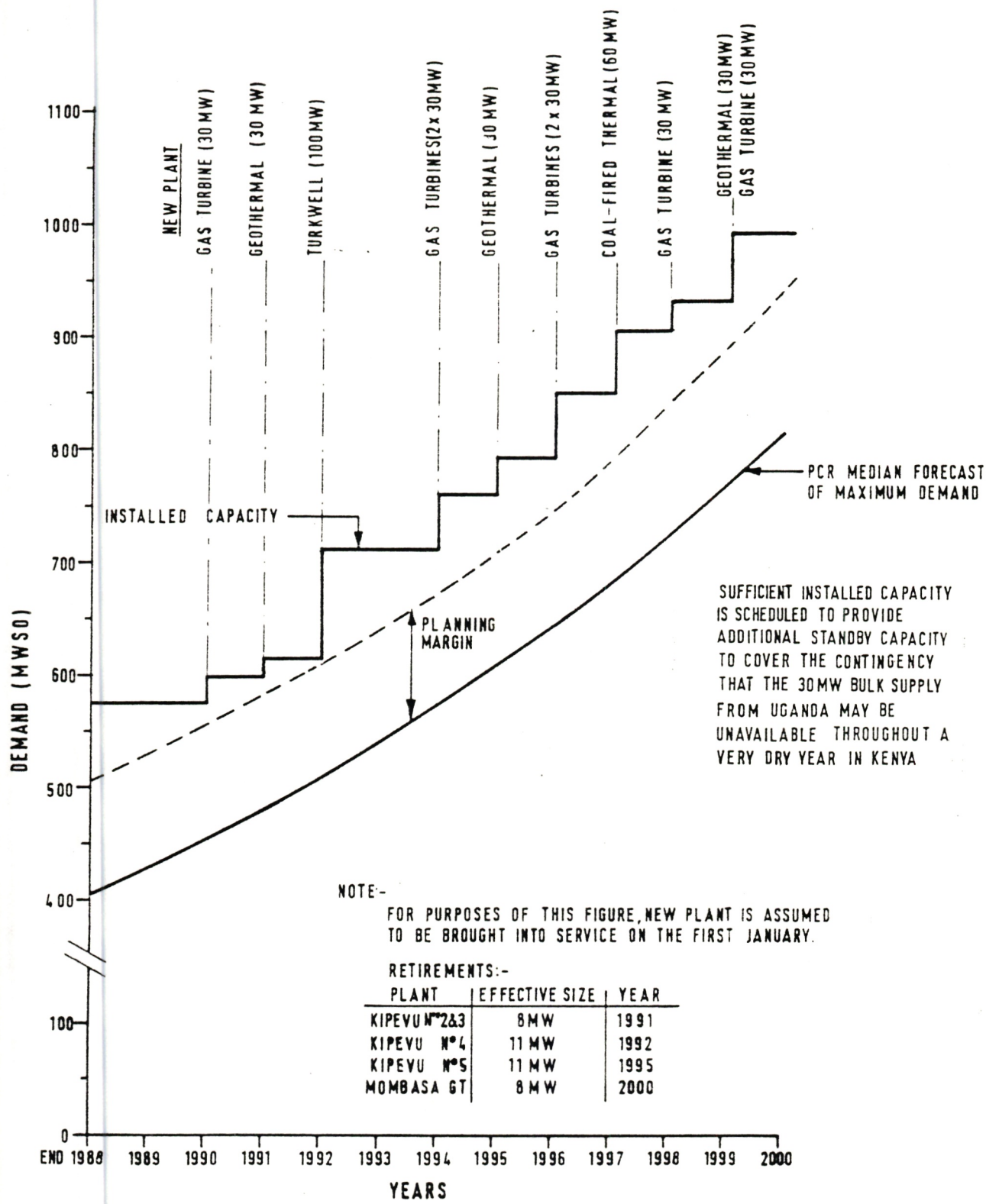
EXHIBIT 4



PREECE CARDEW & RIDER
CONSULTING ENGINEERS
Prudential House
North Street
Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY
OPTIMISATION OF IN-SERVICE YEAR OF
TURKWELL GORGE PROJECT-MEDIAN FORECAST

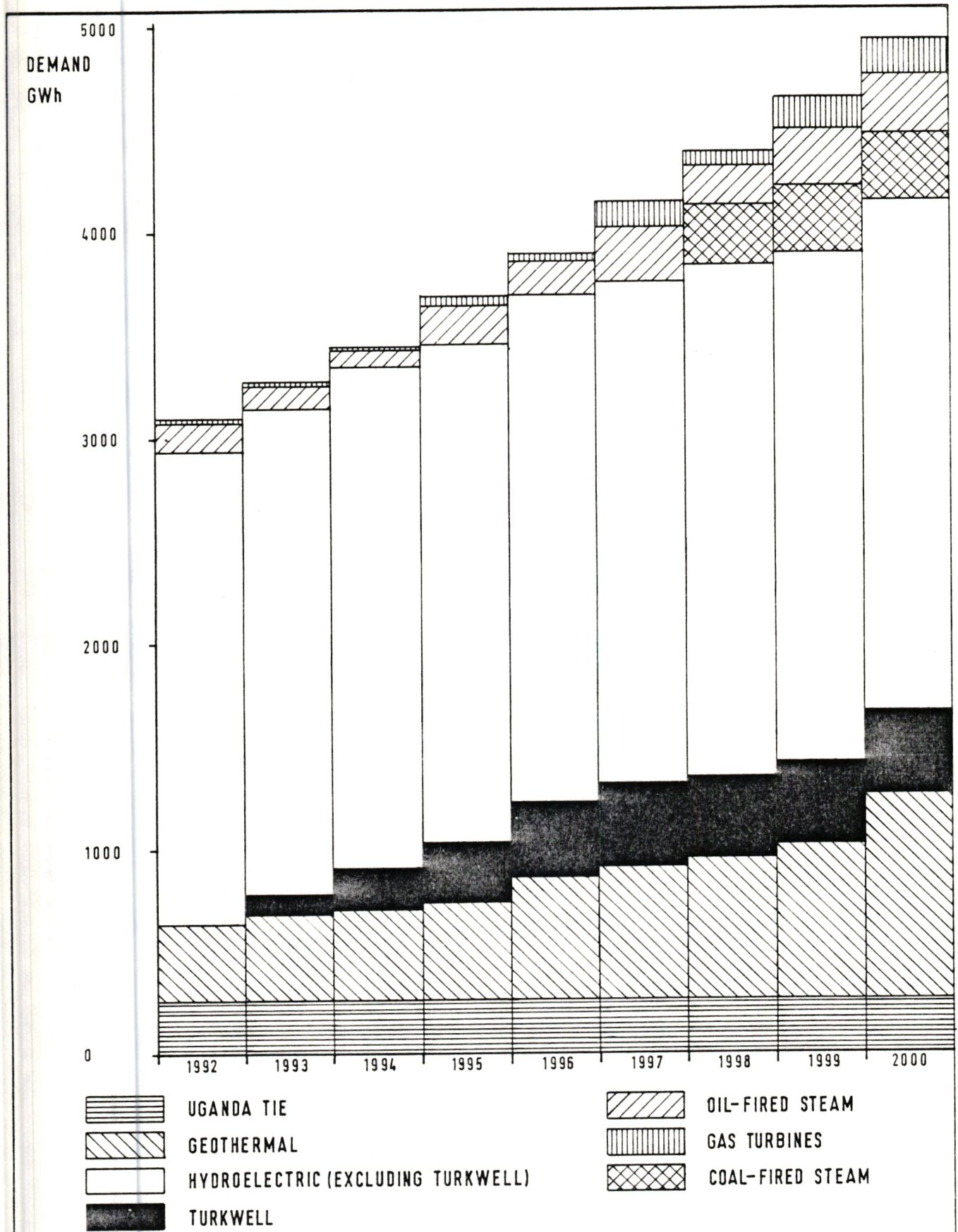
EXHIBIT 5



PREECE CARDEW & RIDER
CONSULTING ENGINEERS
Prudential House
North Street
Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY
TURKWELL (1993) GENERATION SEQUENCE, GROWTH OF
INSTALLED CAPACITY RELATIVE TO GROWTH
OF MAXIMUM DEMAND (MWSO) AND PLANNING MARGIN

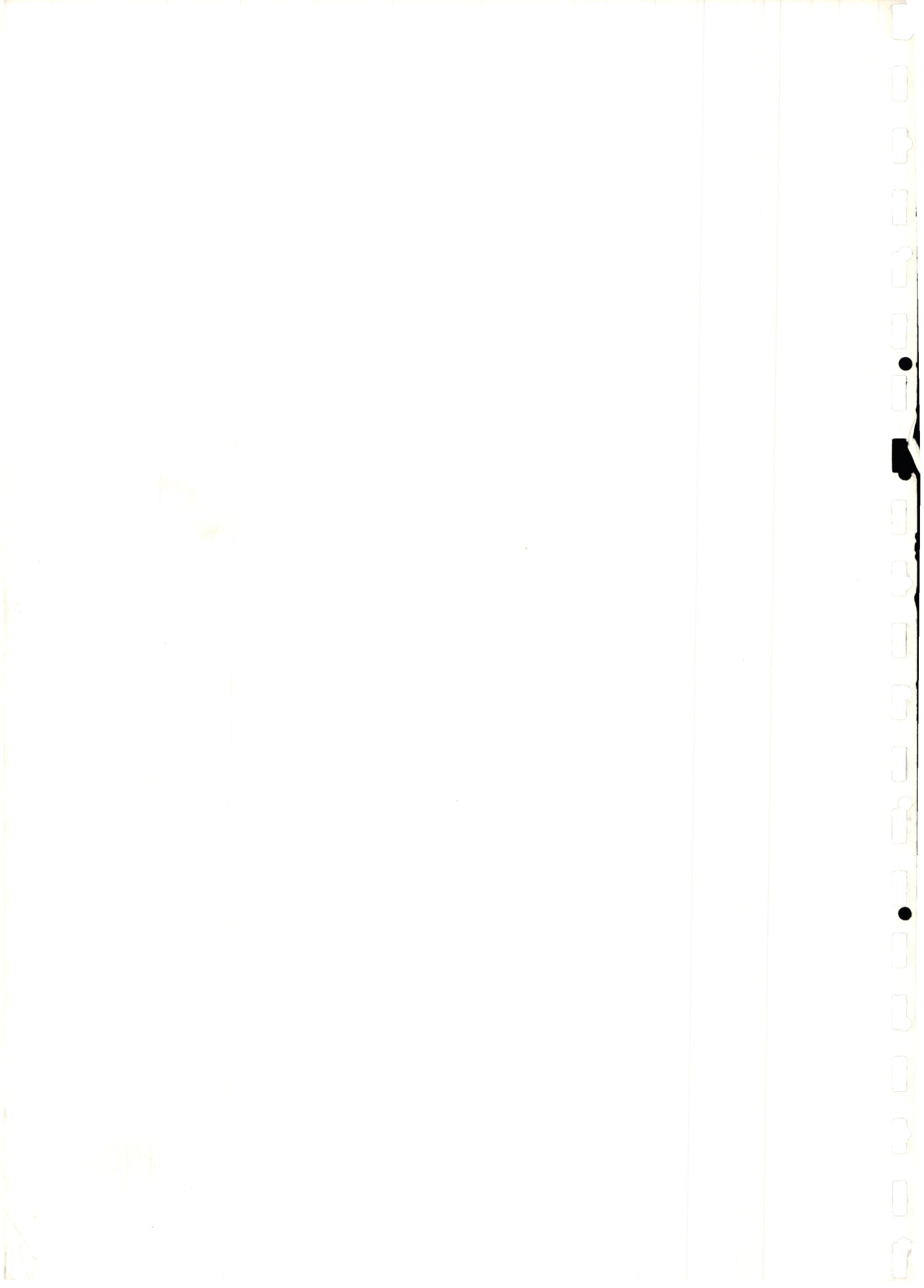
EXHIBIT 6



PREECE CARDEW & RIDER
CONSULTING ENGINEERS
Prudential House
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Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY
AVERAGE ANNUAL SOURCES OF GENERATION
FOR 1992- 2000 WITH TURKWELL INSTALLED IN 1993

EXHIBIT 7



DESCRIPTION		Line No.	1984	1985	1986
REPORTS & FUNDING		1			
	KENYA GENERATION STUDY (CEC)	2	Draft Final		
	DESIGN STUDY	3		Draft Final	
	EXPLORATORY WORKS (PROVISIONAL)	4			
	DONOR NEGOTIATIONS	5			
PRELIMINARY CONTRACTS - DOCUMENTS & TENDERING		6			
	INVESTIGATIONS	7			
	ACCESS ROAD WORKS	8			
	CAMP FACILITIES	9			
		10			
		11			
MAIN CIVIL WORKS - DOCUMENTS & TENDERING		12			
	MOBILISATION	13			
DAM - DIVERSION TUNNEL		14			
	COFFERDAMS	15			
	EXCAVATION OF MAIN ARCH FOUNDATIONS	16			
	GROUT CURTAIN	17			
	FOUNDATION PREPARATION & GROUTING	18			
	CONCRETE TO MAIN ARCH & AFTERBAY DAMS	19			
	DIVERSION TUNNEL PLUG	20			
	ACCESS ROAD TUNNEL	21			
UNDERGROUND - INTAKE		22			
	HEADRACE	23			
	PENSTOCK	24			
	UPSTREAM SURGE TANK	25			
	VALVE CHAMBER	26			
	POWERHOUSE ACCESS TUNNEL	27			
	MACHINE HALL	28			
	DRAFT TUBE ENCASEMENT	29			
	SERVICES SHAFT	30			
	TAILRACE OUTLET	31			
	TAILRACE TUNNEL	32			
	DOWNSTREAM SURGE CHAMBER	33			
	SWITCHYARD	34			
		35			
MECHANICAL & ELECTRICAL WORKS - DOCUMENTS & TENDERING		36			
	GATES & VALVES - LOW LEVEL OUTLET	37			
	INTAKE	38			
	PENSTOCK	39			
	DRAFT TUBE	40			
		41			
		42			
TURBINES & GENERATORS		43			
		44			
POWERHOUSE ELECTRICS		45			
		46			
SWITCHYARD EQUIPMENT		47			
		48			
OVERHEAD TRANSMISSION LINES		49			
		50			
COMMISSION		51			
		52			
KEY DATES		53			
		54			
		55			
		56			

Abbreviations

P = Prequalification of Tenderers
 I = Tender Documents Issued
 T = Receive Tenders
 A = Award Contract

Exc = Excavate
 Line = Install Steel Liners & Grout
 Conc = Concrete

Design Study
 Issue Prelim Tenders
 Award Prelim Contracts
 Issue Main Tenders
 Open Main Tenders
 Award Main C

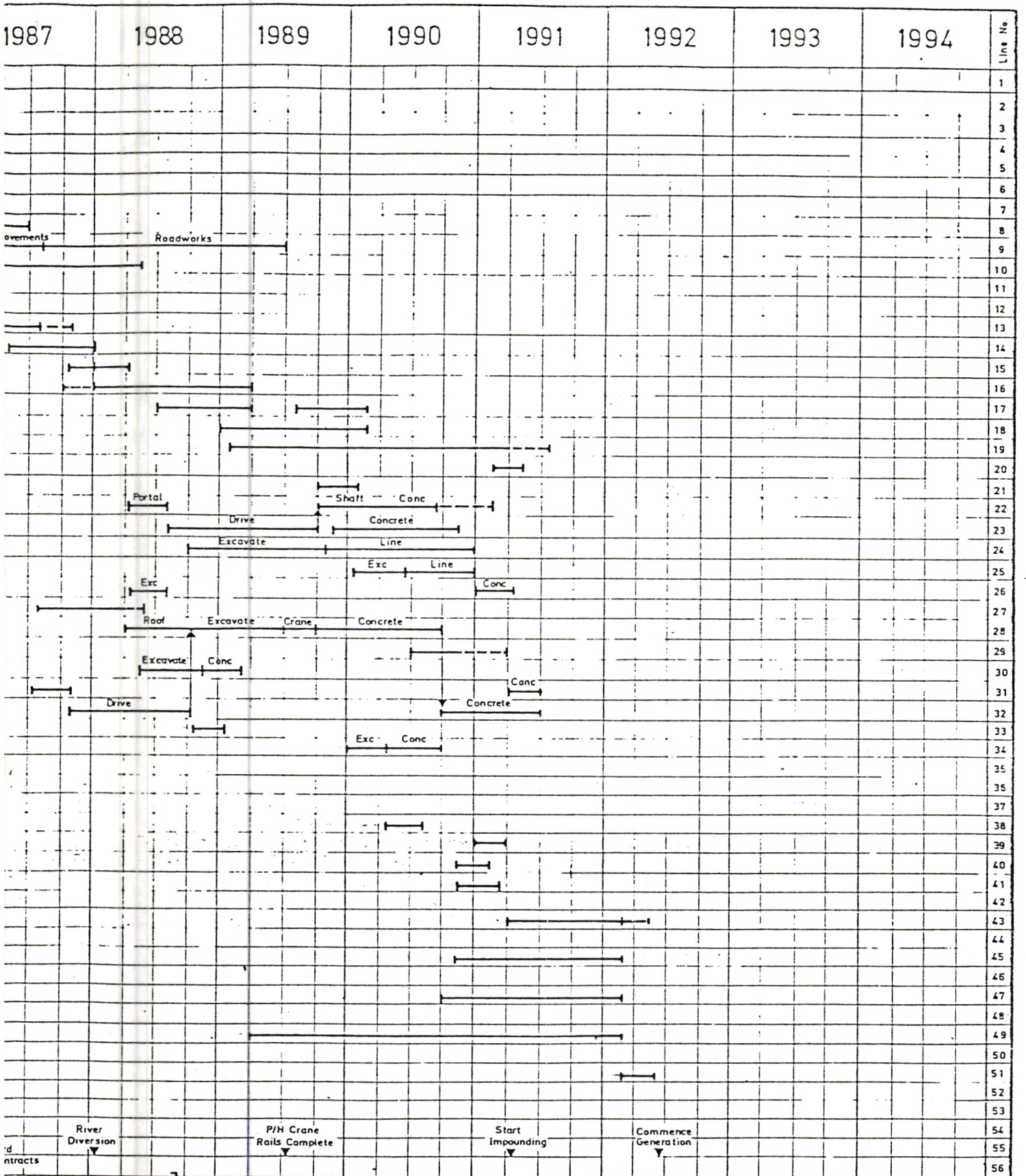
DESCRIPTION	Line No	1984	1985	1986
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PRELIMINARY CONTRACTS - DOCUMENTS & TENDERING	7			
INVESTIGATIONS	8			
ACCESS ROAD WORKS	9			
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MAIN CIVIL WORKS - DOCUMENTS & TENDERING	12			
MOBILISATION	13			
DAM - DIVERSION TUNNEL	14			
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TAILRACE TUNNEL	32			
DOWNSTREAM SURGE CHAMBER	33			
SWITCHYARD	34			
MECHANICAL &	35			
ELECTRICAL WORKS-DOCUMENTS & TENDERING	37			
GATES & VALVES - LOW LEVEL OUTLET	38			
INTAKE	39			
PENSTOCK	40			
DRAFT TUBE	41			
TURBINES & GENERATORS	42			
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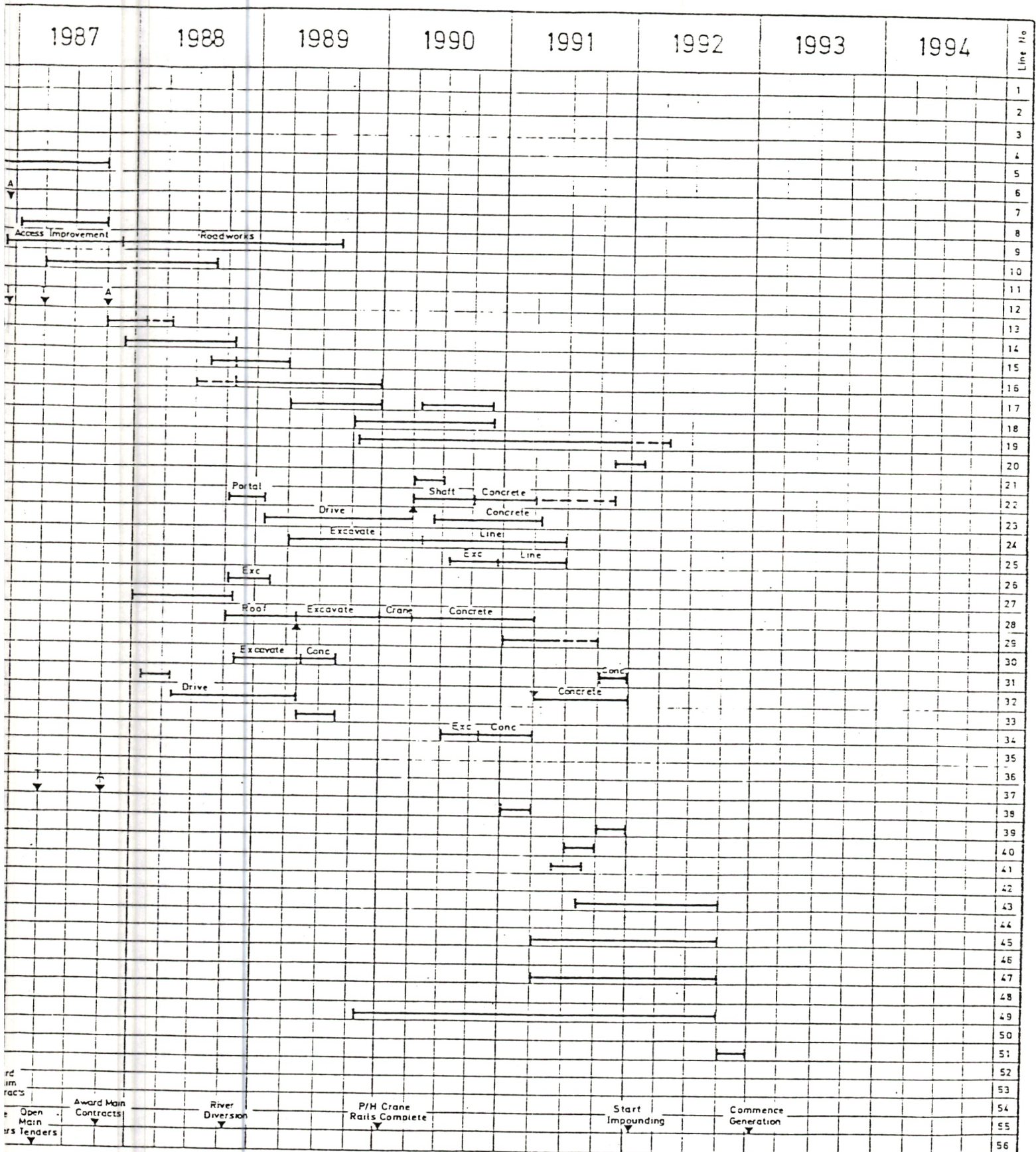
Design Study
 Issue Prelim Tender Docs
 Award Pre Contract
 Issue Main Tender



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TURKWELL GORGE GENERATION STUDY
ACCELERATED IMPLEMENTATION
PROGRAMME
TURKWELL BROUGHT INTO SERVICE MAY/JUNE 1992

EXHIBIT 9



PREECE CARDEW & RIDER
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 Brighton BN1 1RW

TURKWELL GORGE GENERATION STUDY
 IMPLEMENTATION PROGRAMME
 TURKWELL BROUGHT INTO SERVICE JAN 1993

EXHIBIT 8