6. PROPOSED DAMSITE AND RESERVOIR AREA

6.1 General Description of the Damsite and Reservoir Area

The proposed Beris damsite is located in the narrow valley of the Beris river, a left bank tributary of the Muda river, 1.6 km upstream of the confluence of the Muda river and the Beris river. The riverbed is at El. 50 m.

A paved road linking Alor Setar, Nami, Sik and Gurn (the Nami-Sik road) crosses the Muda river near Nami. An unsealed all-weather road branching off from the above-mentioned road near Nami follows the left bank of the Muda river and leads to Kg. Kuala Beris, which is located near the confluence of the Muda river and the Beris river. The right abutment of the proposed Beris dam is accessible from Kg. Kuala Beris by a jeepable road on the right bank of the Beris river.

The reservoir area extends into a hilly region to the southeast of the damsite with peaks ranging from El. 200 m to El. 450 m. Upstream area of the proposed reservoir is featured by mildly undulating terrain of low relief, through which runs the eastern part of the Nami-Sik road.

The damsite and reservoir area are situated in the geological province of Triassic Semanggol Formation, which consist of sandstones, shales, gritty sandstones and conglomerates. Instrusive granite is encountered at the upstream end of the reservoir area.

Sandstone and shale alternation covers much of the reservoir area. Lenses of the gritty sandstone and conglomerate are exposed in the vicinity of the damsite and on the right bank of the Charok Sungkai river, a right bank tributary. Mt. Dada Ayam (El. 447 m) on the right bank is composed of the same geological formations.

The geological structure of the reservoir area exhibits a north to south trend as presented in the general strike of the bedding planes, though considerable deviations are observed. The dip of the strata varies in gradient and direction. It is believed that the boundary between the upstream granite zone and the Semanggol Formation is a fault contact of northeasterly and east-west trends. Also, a probable fault runs northwesterly through the saddle damsite, 500 m to the north of the main damsite.

Although the slopes in the reservoir area appear to be covered with thick residual soil, these slopes are generally of mild inclination. It is improbable that any rapid large scale land slide would geopardize the safety of the dam and reservoir. There is no evidence of possible leakages through the bedrock in the reservoir rim, which is sufficiently thick.

6.2 Geological Exploration

Geological exploration for the Beris dam and reservoir area was carried out between December 1982 and March 1983, as a part of the pre-feasibility study for the proposed six dams under Part 1 Study. For the Beris dam, two alternative damsites were considered; the present main damsite was called Damsite No.2 and the other site located 750 m upstream of the present main damsite was named Damsite No.1. Both sites are located narrow vallies apparently suitable for concrete dams, but Damsite No.2, with the larger reservoir area will require a saddle dam. A probable fault passing through the Damsite No.1 and the saddle damsite was detected during core drilling of 200 m in total length. It was then judged that Damsite No.2 should be selected because treatment of the fault would be much easier for a lower saddle dam (Damsite No.2) than for a higher dam (Damsite No.1).

The geological exploration in Part 2 Study including core drilling and seismic exploration was conducted between

December 1983 and March 1984 to examine the foundation geology of Damsite No.2, the saddle damsite and some quarry sites. Out of 18 holes of 520 m in total length of drilling, 11 holes totalling 310 m in drilling length for the main damsite and an alternative quarry site were financed by the Government of Malaysia and the remaining 7 holes of 210 m of drilling and 2,100 m of seismic exploration were undertaken by JICA.

6.3 Geology of Damsite

The river channel, 20 m in width, adjoins mountain slopes of 30° on both banks. If frequently exposes bedrocks such as gritty sandstones and conglomerate, while the river deposits are shallow and at a steep slope of about 1/100. There are small scale talus deposits near the brooks which are located 50 m upstream and 250 m downstream of the proposed dam axis on the left bank. On the right bank, there are no brooks but gritty sandstones and conglomerate outcrops.

The Triassic Semanggol Formation of gritty sandstones and conglomerate, sandstones, alternations of shales and fine grained sandstones is overlain by alluvial deposits in the vicinity of the main damsite. Gritty sandstones and conglomerates are dominant at the main damsite and contain many fragments of slate and quartzite of less than 2 cm in diameter. They are highly resistant to weathering because their matrixes and fragments are hard and well cemented. Sandstones are also hard and resistant to weathering, derived from coarse grained quartzite. Shales occur in far remote area from the main damsite.

The bedding plane strikes at N45E and dips 20NW, approximately parallel to the left bank slope. Joints develop at intervals of 2 m to 3 m parallel to an perpendicular to the bedding plane. No sign of fault was observed.

Topsoil of extremely soft, unsaturated clay containing rock fragments and 1 m in depth covers the surface of slopes, tending thicker in higher parts of slopes. Riverbed and other areas of outcrops of sandstone and conglomerate lack this layer. Residual soils of very stiff clay containing many rock fragments are located under the topsoil to a thickness of 1 m to 2 m. The upper weathered zone of 1 m to 3 m in thickness comprises strongly weathered rocks accompanied by frequent cracks and joints. The lower weathered zone of apparently fresh but weathered rocks is about 1 m thick at the bottom of the valley but increaes in thickness to 10 m towards the upper portion of the slopes. The fresh rock zone of alternating sandstone, conglomerate and gritty sandstone has rather frequent joints but the gritty sandstones in the right bank are almost monolithic.

According to water pressure tests in the bore holes, these rocks are sufficiently water tight, generally showing Lugeon values of less than 10 except in surfacial sections. High Lugeon values of more than 100 were measured in a depth of more than 15 m near the toe of the proposed dam.

Judging from the results of this geological exploration, a concrete gravity dam should be built on the top of the lower weathered zone. The required average excavation depth will be 7 m in the left abutment, 5 m in the right abutment, and 4 m in the riverbed section respectively. If a fill type dam is selected, the foundation of the impervious core also should be at the top of the lower weathered zone, but the shell zone could be placed on the top of upper weathered zone. The permeability of the rocks is generally small but it is relatively high in fractured or heavily weathered rocks, which occur locally. Curtain grouting along the dam axis should provide reasonable water tightness.

6.4 Geology of Saddle Damsite

The proposed saddle damsite is located 700 m to the northwest of the main damsite. The lowest ground of the saddle is at El. 70 m. The topography of this site is gentle, and the overburden of topsoil and residual soil is 4 m to 10 m in depth.

The bedrock in the left abutment is mainly composed of sandstone and gritty sandstone with subordinate inter-bedded conglomerate, but that in the right abutment is alternations of shale and fine grained sandstone. Core samples were generally in poor condition. Particularly weak shales and sandstone were recovered in fragile condition in sections below 10 m in the middle of the proposed dam axis, very likely indicating the presence of a fault zone perpendicular to the axis. Another fault zone is suspected in the right abutment, where a low velocity zone was detected.

Topsoil and residual soil develop at a depth of 5 - 6 m in the left abutment and 3 - 4 m in the right abutment. Strongly weathered rocks involving stiff clay constitute the upper weathered zone of 1 - 5 m in thickness. The lower weathered zone of apparently fresh rocks but bearing latent cracks is 8 - 15 m thick in the left abutment, but 5 - 10 m thick in the right abutment. Fresh rocks underneath are rather intensively cracked.

Permeability is generally low; Lugeon units are lower than 15 in most test sections. The fault zone inferred in the middle of the dam axis and superficial weathered zone show rather low permeability, persumably because of the clayey material included. The rather high permeability detected in deep zones near both ends of the proposed saddle dam crest was attributed to open cracks in fresh hard rocks.

A rockfill dam is definitly more economical than a concrete gravity dam at the saddle damsite, because of the flat topography. The impervious core should be built on top of the lower weathered zone, which can be reached by excavation of 5 - 12 m in depth on the left abutment and 5 - 8 m in depth on the right abutment. Excavation for the foundation of the shell zone of the embankment is only 3 m on an average to top of the upper weathered zone.

The relatively highly pervious zone can be improved by conventional cement grouting. In order to seal possible seepage passages in the lower weathered zone, curtain grouting is recommended of about 20 m at close intervals. The inferred fault zone in the middle of the dam axis is assumed to be composed of several minor faults, considering that it was not revealed by the seismic exploration. These faults should be treated by slush grouting or if required with dental concrete with grouting. A similar treatment should be given to the inferred fault on the right abutment.

6.5 Construction Material

It is estimated that the as-built volume of required construction materials is 60,000 m^3 of concrete aggregate, 80,000 m^3 of rockfill, 20,000 m^3 of filter and transition and 25,000 m^3 of impervious core.

Soils and earth materials were investigated by test pitting, sampling and laboratory tests and rock materials were explored by core boring and seismic survey.

(1) Impervious Soils

Residual soils in the vicinity of the proposed Beris damsite originate from either sandstone or shale, and alluvial deposits rarely occur.

Two borrow pit sites for impervious soil materials are proposed on the right bank of the Beris river downstream of the proposed damsite, borrow pit site 1 (B1) is located 0.8 - 1.5 km to the west of the saddle damsite and borrow pit site 2

(B2) 0.3 - 1.1 km to the northwest of the saddle damsite. The depth of soil varies between 2 m and 5 m from the ground surface and the available volume was estimated to be 400,000 m^3 for B1 site and B2 site.

B1 site is an area of shale originated soils of inorganic clay of high plasticity or inorganic silt, which will have poor trafficability in the rainy season, be difficult in moisture control and will be weak in shear. These soils contain fine particles, suggesting liability to shrinkage cracks. These soils are not recommendable as impervious core material because they would need costly blending with coarse material.

The soils at B2 site are of sandstone origin. They are silty sands, clayey sands or sandy clays with low to medium plasticity. These soils are recommended as impervious core material because of better engineering properties than the shale originated soils. In order to sustain adequate trafficability, it is recommended to compact these soils in drier side of optimum moisture content. The cohesion is fairly high but the internal friction angle is rather small. An internal friction angle of 22° and cohesion of 5 t/m^2 are preliminarily recommended as design values.

(2) Sand and Gravel

Sand and gravel deposits are scarce in the vicinity of the proposed Beris damsite, but relatively large deposits were found at 3 places in the Beris river and at one location in the Muda river. The materials in the Beris river occur shallow deposits about 1 m thick, and in the low flow channel. They are generally well graded with a maximum size less than 10 mm. Sand and gravel in the Muda river are medium to coarse sands occuring in 2 m thick deposit in the river channel. They are well graded with a maximum size of 10 mm. The available volume, 10,000 m^3 each in the Beris river and the Muda river, is too small to meet all requirements.

(3) Rocks

Three quarry sites were investigated and are proposed.

Quarry site 1 is located on the upper half of the left abutment slope of the main damsite. The rock consists of conglomerates and sandstone which are intensively weathered to more than 40 m in depth.

The core samples taken from bore holes show that the rocks are very cracky and badly deteriorated by subsurface weathering. Consequently, it was judged that the rocks at the quarry site 1 (Q1) were not suitable for concrete aggregate materials.

Quarry site 2 (Q2) is located on the ridge of El. 130 m to 150 m between the main damsite and the saddle damsite. It is about 200 m distant from the saddle damsite and 500 m from the main damsite.

The rocks are mainly conglomerates, but a sandstone layer 5 m thick is located about 20 m below the ground surface. The thickness of topsoil is only 3 meters and hard fresh bedrock is encountered immediately beneath the topsoil. The quality and quantity of the bedrock at quarry site 2 (Q2) were judged to be satisfactory both for concrete aggregate materials in the main dam and its appurtenant structures, and for embankment materials in the saddle dam.

Quarry site 3 (Q3) is located on the left bank slope of the Beris river about 200 m downstream of quarry site 1 (Q1). The geology of the site consists of two bedrock zones, sandstones with thickness of 20 m from the ground surface and conglomerates developing beneath the sandstone zone. The thickness of topsoil is about 3 m.

The quality of sandstones is relatively hard and less cracky compared with that in quarry site 1 (Q1). The conglomerates are, however, cracky. The efficiency of excavation in quarry site 3 (Q3) will be poor, though the quality of rock is much better than that in quarry site 1 (Q1).

Consequently, the quarry site 2 (Q2) is the best quarry site for the construction of the Beris dam followed by the quarry site 3 (Q3). The available volume was estimated to be 400 x $10^3 m^3$ at quarry site 2 (Q2) and 200 x $10^3 m^3$ at quarry site 3 (Q3).

6.6 Land Use in the Proposed Reservoir Area

The proposed Beris reservoir area is covered by a forest reserve in its northwestern half and forest largely developed for rubber cultivation by smallholders in the southeastern half. The Nami - Sik road passes to the north-northeast across the southeastern part of the proposed reservoir area. There are three villages along the above-mentioned road. They are Kg. Batu Seketul (population: 500), Kg. Sg. Batang (pop. 1,600) and Kg. Terenas (pop. 500). Residential areas and mixed cultivation areas and paddy fields are located in and around the villages. Most public facilities are located in Kg. Sg. Batang. A low voltage power line is under construction for electricity supply to Kg. Sg. Batang. A map of present land use in the proposed reservoir area is shown in Plate 1.

The reservoir surface area was estimated to be 1,597 ha at the maximum water level of El. 87.7 m of the recommended plan. Present land use is classified into rubber plantations of 492 ha, paddy fields of 143 ha, residential and mixed cultivation areas of 261 ha, unalienated forest of 561 ha and alienated forest of 140 ha.

If the proposed reservoir is created, 336 houses out of 510 will be flooded; 54 out of 100 in Kg. Batu Seketul, 231 out of 280 in Kg. Sg. Batang and 51 out of 130 in Kg. Terenas, and the Nami-Sik road will be submerged over a length of 4.2 km.

6.7 Flood Analysis

According to hourly rainfall records at Jeniang for 1953/54 - 1982/83, a large storm rainfall never lasted more than 24 hours and most rainfalls occurred during the initial few hours of each storm. The highest 24-h rainfall was 184 mm in the above-mentioned period. Analysis shows that the 24-h probable rainfall is 100 mm for a return period of 2 years, 165 mm for a return period of 20 years, 206 mm for a return period of 100 years and 323 mm for a return period of 10,000 years.

Probable maximum precipitation (PMP) in the catchment area of the Beris dam was estimated by the method recommended by WMO (Ref. 3). A rain storm recorded at the Malacca Airport on June 6, 1979 was the largest that occurred in the west coast between 1979 and 1983. Its 24-h rainfall was 283 mm and dew point was 24°C. A dew point of a little less than 27°C was the highest one lasting for 24 hours recorded at the Alor Setar airport since 1972. PMP in the catchment area of the Beris dam was estimated to be 350 mm in terms of point rainfall, by maximizing and transposing the above-mentioned storm rainfall assuming a maximum dew point of 27°C in the catchment area.

An unithydrograph at the Beris dam site was derived from recorded floods at the Jeniang hydrological station by means of the dimensionless hydrograph method (Refs. 4 and 5). Hydrographs of probable floods and the probable maximum flood (PMF) were derived by applying the unithydrograph to the estimated probable rainfall and PMP, with certain assumptions on hydrograph, areal reduction factor of rainfall, rainfall loss and base flow. The resulting flood hydrographs show that discharges would increase to a peak in 8 hours after the beginning of storm rainfall in the catchment area, thereafter they would come back to the same order of magnitude as before the storm by 24 hours from the beginning of the storm rainfall. The estimated peak discharge was 194 m^3/s for a return period of 2 years, 364 m^3/s for a return period of 20 years, 481 m^3/s for a return period of 100 years, 817 m^3/s for a return period of 10,000 years, and 897 m^3/s for the PMF as shown in Table 14.

7. DESCRIPTION OF PROPOSED FACILITIES

The recommended design of the Beris dam and related facilities is shown in Plates 2 to 4.

7.1 Scale of the Project

The scale of the Beris dam project was determined on the basis of the profit maximization criteria, in which the net benefit of a project was maximized at the optimum scale of the project.

The construction cost of the Beris dam and related facilities was estimated for reservoir normal high water levels (HWL) of El. 77 m, El. 83 m, El. 85 m and El. 88 m, respectively, assuming that the main dam would be a concrete gravity dam and the saddle dam would be a rockfill dam.

The storage capacity which would be utilized for water regulation "the active storage capacity", lies between HWL and low water level (LWL). The top of the sediment deposit in the reservoir was estimated to be at El. 65.5 m, assuming that sediment would be deposited horizontally at a rate of 26.9 x 10^3m^3/y for 100 years. The elevation of LWL was determined at such a height above the top of the 100-year sediment deposit as required for the operation of an outlet for releasing water. The storage capacity below LWL is "the dead storage capacity". The active storage capacity is estimated, when HWL and LWL are fixed.

The net regulated outflow from the Beris dam was estimated to be 32 x 10^6m^3 for HWL of El. 77m, 52 x 10^6m^3 for HWL of El. 83 m, 66 x 10^6m^3 for HWL of 85 m and 68 x 10^6m^3 for HWL of 88 m, according to the operation rule described in Section 4.3, as an average annual volume for the years of hydrological record (1961 and 1983).

The unit benefit per net regulated outflow was assumed to be between M$0.59/m^3 and M$1.31/m^3.

The present value of benefits and costs were calculated for discount rates of 8% and 12%.

It is recommended that HWL be set at El. 85 m, because the net benefit would be maximum at this elevation as shown in Fig. 5.

At the recommended scale, the maximum water level (FWL) would be at El. 87.7 m, HWL El. 85 m and LWL El. 69 m. The reservoir surface area would be 16 km^2 at FWL, 13 km^2 at HWL and 2 km^2 at LWL. The gross storage capacity would be 153.4 x 10^{6}m^3 including a flood storage capacity of 42.1 x 10^{6}m^3, active storage capacity of 102.4 x 10^{6}m^3 and dead storage capacity of 8.9 x 10^{6}m^3.

7.2 Diversion Facilities

Foundation excavation and concreting of the main dam must be conducted in the dry. For this purpose the river would be diverted through a diversion tunnel and the dam foundation is kept dry by being protected from flooding by upstream and downstream cofferdams.

A diversion tunnel of 215 m in length and 1/54 in slope would be driven through the right abutment of the main dam. It would have a concrete lined horseshoe shaped cross section of 5.0 m in diameter. A gate slot would be provided at the inlet to the tunnel to install a fixed roller gate for closing the tunnel. Permanent closure would be made with a concrete plug sysem.

The upstream cofferdam would be a concrete gravity dam about 10 m in height with the crest at El. 62 m. The downstream cofferdam would be a rockfill dam about 3.5 m in height with the crest at El. 51.5 m.

The diversion tunnel would be capable of discharging 200 m^3/s, under free flow conditions, if the upstream water surface is at El. 61.8 m. This discharge capacity which approximately corresponds to the peak discharge of a 2-year flood follows normal practice in concrete dam construction. A larger flood may overtop the upstream cofferdam as well as the main dam at the stage when only the lower portion of the dam is completed.

The upstream water surface may rise, if a large flood takes place while the main dam is already high. No cofferdam would be required for the saddle dam, however, because even a 20-year flood would only raise the upstream water surface to El. 64 m, which would still be 5 m lower than the lowest ground surface at the saddle damsite.

7.3 Main Dam

The proposed main dam would be a concrete gravity dam of 41 m in the maximum height, 150 m in crest length and 55.2 x $10^3 m^3$ in volume.

The crest elevation of the dam would be El. 89 m, which allows for wave height above FWL. The cross section of the dam is based on a basic triangle of vertical upstream face and a downstream slope of 1:0.8. The effective width of the crest is 6 m.

Curtain grouting would be conducted at varying depth of 6 m to 36 m at the upstream toe of dam, in order to provide a water tight curtain in the foundation rock. Short hole grouting would be carried out over the dam foundation to consolidate the surface of the foundation. An inspection gallery would be provided near the upstream toe of the dam. Drain holes would be drilled for the reduction of uplift pressure.

A rockfill dam was designed for consideration as an alternative to the proposed concrete dam. In this design, two lines of diversion tunnels of 5.0 m in diameter would be driven through the right abutment and a chute spillway would be provided on the left abutment. A concrete dam is, however, recommended as against a rockfill dam, since there will be a cost saving of 25% in terms of the construction cost at 1983 constant prices.

7.4 Spillway

A spillway would be provided to release water which cannot be retained in the reservoir. It is proposed that the spillway be provided in the central section of the main dam. A non-gated ogee crest would be set at El. 85 m to coincide with HWL. The downstream slope of the dam would be utilized as the chuteway. A concrete lined stilling basin type energy dissipator 31 m in length is constructed downstream of the toe of the dam. The bottom of the apron and the base of the stilling basin would be El. 45.2 m with an abrupt rise to El. 49 m at the downstream end. The width of the spillway would be 20 m, being limited by the width of the valley. A bridge would be provided over the crest of the spillway.

Any failure of a dam impounding a large volume of water such as the proposed Beris dam may jeopardize human life as well as various properties. The discharge capacity of the spillway has been, therefore, so determined that the rise in the reservoir water surface does not endanger the dam even in the event of the PMF.

The proposed reservoir area of 13 km^2 covers mostly flat land, out of 116 km^2 of the catchment area. Flood outside the reservoir area will rush down steep slopes. When they enter the reservoir, they will propagate as surface waves which will be felt almost instantaneously at the damsite. Furthermore rainfall on the reservoir surface will tend to increase water level immediately. In consequence, the travel time of a flood after creation of the reservoir will be much shorter and if the reservoir effects are disregarded the peak discharge would be much larger than before. The peak discharge would be 900 m^3/s and rising phase would be 8 hours if PMF takes place under without-reservoir condition as described in Section 6.7. On the other hand the peak discharge would be 4,200 m^3/s and the rising phase 1 hour if PMF occurs under with-reservoir condition. These figures were calculated on the assumption that the reservoir water surface would remain at a fixed elevation all the time only for the purpose of design. In an actual reservoir, the flood would partly be retained in the reservoir causing a rise in the water level and partly run through a spillway.

A flood routing study has shown that PMF with a peak discharge of 4,200 m^3/s would raise reservoir water surface from El. 85 m to El. 86.9 m causing a maximum outflow of 111 m^3/s through the spillway, 5 hours after the beginning of flood. In determining the FWL of the reservoir and the discharge capacity of the spillway, a PMF occuring 24 hours after a 100-year flood is assumed according to a recommendation of the US Bureau of Reclamation. The peak discharge of 100-year flood was estimated to be 2,500 m^3/s under with-reservoir condition. In this case, the maximum reservoir water level was El. 87.7 m and the maximum outflow was 200 m^3/s. The clearance of the spillway bridge and dimensions of side walls and energy dissipator were determined for an outflow discharge of 200 m^3/s.

7.5 Outlet Works

Outlet works would be provided on the face of the main dam, in order to release water from the reservoir to the downstream river course at varying rates between 0.2 m^3/s and 15 m^3/s as required by downstream water users.

The outlet works would consist of two sets of facilities each capable of releasing 15 m^3/s, the maximum release rate of the system, even if the reservoir water surface was at LWL.

Each set of facilities would comprise an intake shaft with the bottom at El. 55 m on the upstream face of dam, a steel penstock of 1.5 m in diameter embedded in the dam body, a guard valve and a hollow jet valve of 1.5 m in diameter.

In the intake shaft, a fixed trash rack and an intake stop log gates would be provided. An intake stop log gate is commonly used for the closure of a penstock pipe by using a monorail crane installed on the dam crest.

A valve house would be constructed near the downstream toe of the dam on a backfilled area behind the side wall of the stilling basin. It would house the guard valves and control devices for all the valves. The hollow jet valves open to the stilling basin over the side wall. In order to release small discharges, a high pressure slide gate valve of 0.6 m in diameter would be installed at the end of a branch of the penstock in each of the outlet facilities.

7.6 Saddle Dam

The proposed saddle dam would be a zoned rockfill dam with a central earth core of 28 m maximum height, 160 m in crest length and 121.6 x $10^3 m^3$ in volume.

The crest elevation of the dam would be El. 90.5 m, which will allow 0.9 m of pervious fill above the core zone and 1.9 m of freeboard including wave run-up (0.9 m) above FWL of El. 87.7 m. The upstream slope would be 1:2.3, downstream slope 1:1.8, and crest width 8 m.

Curtain grouting and blanket grouting would be provided in the foundations of the core section. The faults inferred in the middle portion and right abutment would be treated by slush grouting or, if required with dental concrete and grouting.

7.7 Relocation Road

A new road of 11.9 km in length would be required along the eastern rim of the reservoir as a relocation of the Nami-Sik road. The road would be designed as an asphalt penetration macadam pavement of 5.5 m in effective width. A 300 m bridge would be constructed across a narrow portion of the reservoir. This would consists of a 6.5 m wide 20 m span precast PC girders.

7.8 Hydropower Development Study

A small scale hydropower development would be possible for the Beris dam project by utilizing potential of outflow discharge when the reservoir would be operated to meet the downstream water demand. The power station would be able to be operated approximately for 7 months a year and the annual energy output of the power station was estimated to be 4.05 GWh on average with an installed capacity of 3,000 kW. The net present value of incremental (B-C) in case of the power station being added was, however calculated to be negative at the interest rate of 8%. The hydropower development at the Beris dam is not economically justified.

8. CONSTRUCTION SCHEDULE AND COST

8.1 Construction Schedule

8.1.1 Time schedule

It is estimated that pre-construction activities including detailed design, pre-qualification of tenderers, tenders and contract negotiation will take 21 months, i.e., the construction work would commence at the beginning of June 1987 if the detailed design were started at the beginning of September 1985. Construction work should be completed in 31 months by the end of 1989, allowing 12 months for initial filling of the reservoir before commissioning of the Beris dam at the beginning of the 6MP period.

The construction schedule for the project is shown in Fig. 6.

8.1.2 Construction works

Major construction works of the project would consist of preparatory works, river diversion works, main dam works, saddle dam works and relocation road works.

Construction facilities required for the dam would include access roads, power and water supply systems, telecommunications, temporary buildings and heavy construction facilities such as a cable crane, concrete batching and rock crushing plants. The layout of these construction facilities is shown in Plate 2.

For the river diversion works, the quantity of tunnel excavation is estimated to be $7.3 \times 10^3 m^3$ and which should be completed in 2 months by a 2 shift system so as to divert the river water to the tunnel in January 1988 when the water stage of the river is low.

The foundation treatment of the main dam would be carried out by means of cement grouting. The total grouting length of 5.52 x 10^3 m would take 5 months.

The dam concrete of 55.2 x 10^3m^3 total volume would take 19 months. Temperature control will be necessary for mass concrete. If natural cooling is relied upon without any artificial cooling, the minimum lift interval will be 5 days.

The embankment of the saddle dam would be 121.6 x 10^3m^3 in total volume which includes 22.3 x 10^3m^3 for core, 18.6 x 10^3m^3 for filter and transition and 80.7 x 10^3m^3 for rock materials. The bedrock of the saddle dam would be treated by ordinary blanket and curtain grouting.

8.1.3 Construction equipment and materials

The principal items of construction equipment required for the construction works are listed in Table 15. The required construction materials were estimated as shown in Table 16.

8.2 Cost Esmiate

8.2.1 Assumptions

The following assumptions were employed for the estimate of construction cost:

(1) Costs estimated at end of 1983 price levels.

(2) Cost calculated in terms of the Malaysian Ringgit for both foreign and local currency portions.

(3) Exchange rates are: US$1.0 = MS$2.312 = ¥231.6.

(4) Price escalation rate assumed to be 5% per annum for both foreign and local currency portions.

8.2.2 Basic cost

The main construction cost were estimated on a unit price basis. Unit costs were computed from basic labour, material and equipment costs and production rate estimated in the construction planning, and were compared with recent tender rates in Malaysia.

Tables 17 and 18 show current daily labour wage rates and major material costs.

8.2.3 Construction cost

The construction cost is a sum of the direct construction cost, the indirect cost and the contingency. The direct cost is calculated by applying the unit construction costs to the work quantities derived from the proposed design. The indirect cost includes the land compensation costs, and government administration and engineering services cost. The contingency consists of physical contingency and price escalation allowance. The physical contingency is assumed to be 20% of the direct and indirect costs, while the price escalation is assumed to be 5% per annum for both foreign and local components.

Interest during the construction period was not included in this estimate.

The construction cost was estimated to be M$96,590,000 in total comprising M$20,450,000 for the foreign currency portion and M$76,140,000 for the local currency portion as shown in Tables 19 and 20.

An estimated disbursement schedule for the construction cost is given in Table 21 according to the construction schedule, in which an advance payment of M$5,000,000 for civil works was assumed.

8.2.4 Operation and maintenance cost

The annual operation and maintenance costs of the Beris dam were estimated at M$160,000 in total as shown in Table 22.

9. LAND ACQUISITION AND ENVIRONMENTAL STUDIES

9.1 Land Acquisition Cost

Land acquisition cost will consist of compensation costs, and relocation costs of public facilities. Compensation costs include payment for purchase of agricultural land, alienated forest to private personnel and relocation of families. Public facilities to be relocated will include a part of the Nami-Sik road, a low voltage power line, a mosque, a school, a surau, a cemetery, a hospital and other public buildings. Among these the relocation costs of the Nami-Sik road and low voltage power line have been excluded here from the land acquisition cost as they have been included in the direct construction cost.

The land acquisition costs were estimated on the present market prices and information provided by the Kedah Economic Development Authority (KEDA) and the State Valuation Department. The relocation cost of families are classified into three classes, based on the type of house; class A: wood and concrete, class B: wood, class C: bamboo. The estimated land acquisition cost is shown in Table 23.

9.2 Resettlement Plan

It should be noted that the resettlement plan in this Study was preliminary because a socio-economic study had not been conducted and a definitive resettlement plan should be prepared on the basis of the results of the detailed socio-economic survey which should be completed by the detailed design stage. In this study, it was assumed that new land would be developed to allow the same land uses as at present in the proposed flooded area.

In view of the importance of maintaining village communities, the following criteria were assumed: (1) the whole of

Sg. Batang village (280 households) would be resettled in the new area even though some houses in this village will not be affected by the reservoir; (2) all families of the submerged houses (54 households) in Batu Seketul village would be resettled in the new area; (3) the houses not affected would remain because they can be kept within the village community along with the relocated houses owing to close location; (4) submerged houses in Terenas village (51 households) would be absorbed into the community center zone of Terenas village which will be not affected by the Beris reservoir, and no resettlement plan was proposed for submerged houses in this village.

The proposed resettlement area for residential/mixed cultivation area and paddy field is located to the east of the Nami-Sik road about 3 km to the northeast of Kg. Batu Seketul. The present land use in the area of 400 ha comprises 100 ha of forest reserve and 300 ha of rubber farms. A mosque and other public facilities would be located in the proposed resettlement area. There are rubber farms along the proposed relocation road of the Nami-Sik road. There are prospects that 1,000 ha of potential land for rubber farms could be secured from the forest reserve adjacent the above-mentioned rubber farms and on the western side of the existing Nami-Sik road near the proposed resettlement area. It is proposed that 500 ha of these rubber farms be developed for resettlement. The resettlement cost was estimated as shown in Table 24.

9.3 Environmental Studies

Suspended solids will increase in the downstream river course and increased heavy traffic will be a problem during the construction period. There may be some interuption of river flow during initial filling of the reservoir. These adverse effects can be mitigated by installing a sedimentation pond, by controlling traffic and by providing a temporary bypass channel. After the completion of the Beris dam, flood discharges will be significantly reduced owing to large flood space in the reservoir, and the eutrophication and other adverse effects to wildlife are unlikely to occur.

10. ECONOMIC ANALYSIS

10.1 Assumptions

The proposed Beris dam will benefit all water users in the Kedah-Muda-Perai river system and no exclusive water users will be supplied by the dam. Benefits attributable to the proposed Beris dam were, therefore, estimated based on a unit value of the water output.

The output of the Beris dam will be allocated to beneficiaries as described in Section 3.4.

All benefits and costs were estimated on the basis of price levels at the end of 1983 for an evaluation period of 50 years starting from the beginning of 1984.

10.2 Economic Benefit

10.2.1 Irrigation benefit

The economic irrigation benefit is defined as an increment of the economic net production value of paddy attributable to newly developed water resources and to the improved water distribution system.

It is assumed that all water demand and available water remain at the level of 1983 under the without-project condition. On the other hand, under the with-project condition it is assumed that tertiary development in the MADA area and minor irrigation development will continue and that water demand will increase as projected.

Under the without-project condition, it is assumed that water supply to the MADA area will be limited on average to 70% of the total area for off-season cropping to avoid the delays of a fixed cropping schedule. In the rainfed paddy cultivation areas outside the MADA area, it is assumed that there will be no minor irrigation development.

Under the with-project condition, it is assumed that; new tertiary development project will be executed in the MADA area following the completion of ongoing Muda II project; the whole of the MADA area will be provided with tertiary system by 2000; the existing minor irrigation schemes diverting irrigation water from the main streams of the Kedah and Muda river and the MADA main canal will be fully irrigated throughout the year; minor irrigation projects will be developed where available water in tributaries can meet more than 50% of the water demand for the off-season cropping.

(1) Crop yeild

According to paddy statistics, the average paddy yeild was 3.3 ton/ha for the off-season cropping in 1982 and 4.3 ton/ha for the main season cropping in 1982/83 in the MADA area. It is 2.2 ton/ha in the rainfed areas and 3.2 ton/ha in the minor irrigation scheme areas in other paddy cultivation areas of the Region.

In the MADA area, paddy yield of the dry season crop has recently shown a sharp decline due to the outbreak of pests and diseases under continuous growth of the crop all the year round. With the introduction of one month fallow period in the fixed cropping schedule, the average paddy yield for the future under the without-project condition is assumed to be 4.0 ton/ha for one crop season. There is no incentive for farmers in other areas to increase paddy production under without-project condition.

If sufficient water is made available through new water resources development and timely distribution to farm plots by the improvement of tertiary canal systems, paddy yields can be maximized under a reasonable cropping pattern. Coupled with the optimum application of fertilizer and water, this cropping pattern enables agronomic control of pests and diseases and growth of longer varieties with higher yield.

It was assumed therefore that the paddy yield in the MADA area will be 5.0 ton/ha on average for one crop season when sufficient water is available and tertiary development has been provided. For the minor irrigation projects scheduled for development after 1984, the average paddy yield was assumed to be 4.5 ton/ha on average for one crop season when sufficient water is available and tertiary canal density is 45 m/ha.

On existing minor irrigation projects which depend on the discharge of tributaries for their irrigation water, it was assumed that the average crop yield would remain at the present level of 3.2 ton/ha for one crop season since no structural improvements are likely to have been made.

(2) Net production value

The economic farm gate price of paddy was estimated to be M$548/ton at 1983 constant prices as derived from the IBRD projected international price of rice F.O.B. Bangkok for the period of 1990 - 1995. A 10% discount in quality and an average milling rate of 65% were assumed in the above estimated price.

The net production value of paddy was estimated from the economic view point as the difference between the gross production value and production cost including family labour cost and government subsidized fertilizer cost. The net production values estimated at 1983 price level are as shown in Table 25.

(3) Crop intensity

The schedule of double cropping a year in the MADA area is always staggered due to the insufficient water supply and lack of timely water distribution system. The period of every two crops exceeds one year resulting in the presence of rice plants in the MADA area throughout the year. Such a situation causes cancellation of off-season cropping every 6 years as well as the occurrence of pests and diseases during the off-season. Consequently, the average crop intensity was assumed to be 170% in the MADA area under the without-project condition. The assumed crop intensity for minor irrigation schemes ranges from 100% to 200% depending on water availability in individual projects.

Under the with-project condition, the crop intensity in the whole MADA area was taken to be 200% on the assumption that minor topography will be solved by tertiary development. For minor irrigation projects to be developed after 1984, the cropping intensity was assumed to be 150% in a tributary basin and 200% in the main stream basin.

(4) Total net production value

It was estimated that the scheduled crop intensity would be made possible as soon as sufficient water becomes available but that paddy yield will be built up to a maximum 4 years after that. In part of the MADA area where tertiary development has already been conducted, the net production value in the final year of construction work was assumed to be M$1,180/ha. The estimated total net production value in 2003 onward under with- and without-project conditions is shown in Tables 26 and 27.

In estimating rice yield under insufficient irrigation, it is normally assumed that the crop area is reduced in proportion to water available, as the relationship between water applied to an area and rice yield on the area has not been quantified. The seasonal variation in water deficit can be adjusted significantly by applying a reasonable operation rule of reservoir. The above-mentioned assumption can, therefore, be justified in the Region. Consequently, it was assumed that the net production value in an area would be reduced in proportion to the water deficit.

10.2.2 Domestic and industrial water supply benefit

The benefit arising from the domestic and industrial water supply was estimated on the basis of the least costly alternative facilities method.

The Tawar-Muda dam was selected as the least-costly alternative to the proposed source facilities in the integrated river system. The unit value of water was calculated to be the annual equivalent of the potential cost of Tawar-Muda dam, divided by the potential net water output of the dam, assuming a discount rate of 8%. The water output of a dam is dependent on the frequency and volume of the water deficit. The potential net water output of Tawar-Muda dam was estimated to be 37 x $10^6 m^3$, if the dam was operated to cover the deficit in the Kedah river where water deficit occurs every year. On the other hand, the net water output would be only 16.8 x $10^6 m^3$ if it was operated for the Muda-Perai river where the water deficit occurs once in several years. The unit value of water calculated on the basis of the above-mentioned assumptions is;

For Kedah river	M$0.24/$m^3$
For Muda-Perai river	M$0.58/$m^3$

The domestic and industrial water supply benefit of a source project is computed to be the net water output allocated to the domestic and industrial water supply multiplied by the above-mentioned unit value of water.

10.2.3 Recreation benefit

Although the reservoir to be created by the construction of the Beris dam will produce recreational benefits, these are not included here for sake of simplicity.

10.3 Economic Cost

10.3.1 Economic cost of source facilities

The financial cost of the Beris dam project was converted to the economic cost by means of the national economic conversion factors prepared by EPU as listed in Table 28. The resultant economic cost is shown in Table 29. The financial land acquisition cost comprises the compensation cost for land and investiment costs for houses and public facilities. In the economic analysis, the compensation cost for land is excluded from the compensation cost but agricultural production forgone due to flooding the land is counted as annual cost.

The cost of Tawar-Muda dam estimated in Part 1 Study was revised by using the unit costs applied to the Beris dam project in Part 2 Study. The costs of the other source facilities are the same as those estimated in Part 1 Study.

The estimated economic investment cost and annual cost, including O&M cost and production forgone, are shown in Table 30 for the Jeniang system, the proposed Beris dam and the potential dams. The cost of the Jeniang system was taken from Ref. 2, and the cost of the Reman dam from Ref.6.

10.3.2 Economic cost of irrigation facilities

The financial investment cost of irrigation facilities was estimated to be M$9,000/ha for the tertiary development for MADA area and M$11,500/ha for pump/gravity schemes.

10.4 Economic Internal Rate of Return

The net water output of the Beris dam was allocated to the water users who cause water deficit as described in Chapter 5. Table 31 shows the matrix of the net water output of the Beris dam for the three Alternatives. Rows of the matrix indicate the water output allocated to water users who should bear the cost of the Beris dam corresponding to the water amount. Columns of the matrix show the water output which would be sent to the affected areas, i.e. MADA and main minor irrigation schemes in the Kedah river and main minor irrigation schemes in the Muda river.

For the calculation of the economic internal rate of return of the Beris dam, it was assumed that the Beris dam project could claim benefits arising from the affected area.

The economic benefit to an irrigation project faced with water deficit supply was estimated to be the net benefit, or the incremental net production value less the cost of irrigation facilities assigned in proportion to the water deficit supplied by the water allocated to the total water demand of the irrigation project.

The economic internal rate of return (EIRR) of the Beris dam was calculated to be 14.8% for both Alternative 1 (Muda priority) and Alternative 2 (even distribution) and 14.6% for Alternative 3 (Kedah priority). This is satisfactory for any of the Alternatives. Thus the project is justifiable from the economic point of view.

The estimated present values of benefit by purpose and cost assuming a discount rate of 8% and value of EIRR are summarized in Table 32 for the three Alternatives.

The results of the economic analysis suggest that Alternative 1 (Muda priority) is economically the best among the three Alternatives in terms of EIRR and net benefit (B-C), but the difference between Alternatives 1 and 2 would be insignificant.

On the other hand, the target risk of safe supply would be attained for both the Kedah and Muda-Perai river systems in Alternative 2. From the view point of equality of the Region as described in Section 5.6, it is recommended in this Study that Alternative 2 should be adopted as the operation rule of the Jeniang system.

10.5 Sensitivity Analysis

The calculation of EIRR in the previous section was based on the most probable value of key factors. Sensitivity tests were carried out to evaluate the extent of changes in EIRR if key factors changed within a reasonable range.

The key factors and the percentage changes examined were:

(1)	Investment costs	10% increase
(2)	Benefits	20% decrease
(3)	Delay in commisioning project	one year
(4)	Combination of (1), (2) and (3)	

Table 33 shows the resulting EIRR and the sensitivity indicator (SI), where SI is defined as the percentage change of EIRR due to the percentage change in the factor tested.

10.6 Subsequent Project to the Beris Dam

As described in Chapter 5, the water deficit expected in the integrated river system from 1990 onward cannot be removed even if the Beris dam is implemented following the ongoing Jeniang system. Thus, other source facilities are necessary in addition to the Beris dam project.

The economic feasibility of the Reman dam, Khlong Thepha dam, Tawar-Muda dam and Merbok storage was individually examined, assuming that each could be implemented subsequent to the Beris dam. The Reman dam shows a high economic feasibility but none of the others could be justified, which suggests that they might only be implemented after 2000.

If the Reman dam is implemented following the Beris dam, the water deficit remaining in the Kedah-Muda-Perai river system is expected to be 72 - 86 x $10^6 m^3$, which is about 4% of the total water demand in the river system.

Further removal of water deficit by developing one of the other pontential dams cannot be justified from the economic point of view. It is, therefore, recommended that the water deficit after implementation of the Reman dam should be dealt with by means of water rationing.

11. FINANCIAL ANALYSIS

11.1 Financial Cost Allocation

The cost of the Beris dam was allocated to purposes which were the causes of water deficit to be met by the Beris dam project. The separable costs-remaining benefits method was applied as a cost allocation rule since it is the common practice for water resources development project as discussed in Part 1 Study.

The capital and O&M costs were allocated in terms of their present value at a discount rate of 8%. The results of the calculation are shown in Tables 34 to 36 for Alternatives 1, 2 and 3, respectively. For all the purposes, the benefit is smaller than the corresponsing alternative cost. The sum of the separable costs is 67 to 77% of the total construction cost, indicating the allocation to be highly use-oriented.

The construction cost was allocated to the agencies concerned for reference as shown in Table 37, assuming the following relationship:

MADA	:	MADA main in the Kedah river
Kedah DID	:	all minor irrigation schemes including MADA fringe area, and river maintenance flow in the Kedah river and part of minor irrigation schemes in the Muda river
Kedah PWD	:	D&I private and public in the Kedah river and part of D&I in the Muda river
P.Pinang DID	:	part of minor irrigation schemes in the Muda river
PWA	:	part of D&I private and public in the Muda river

11.2 Financial Farm Budget

In order to assess the capacity to pay by benefited farmers, a farm budget analysis was made for a typical farmer operating an average farm size under with- and without-project conditions as shown in Table 38.

The annual net reserve or capacity to pay in the future under with-project condition would increase markedly as compared with the condition without project implementation. The increase in net reserve would also offer to the farmer's incentives for further development and a substantial capacity to pay would be greatly in excess of irrigation fee.

11.3 Financial Statement

(1) Financial analysis for Federal Government

The financial statement for the Beris dam project was prepared from the assumed viewpoint of the Federal Government adopting Alternative 2.

The cost of the Beris dam was allocated to the MADA irrigation project, minor irrigation projects for the State of Kedah and domestic and industrial water supply for the States of Kedah and Pulau Pinang.

It was assumed that the cost allocated for these pusposes would be financed under the following conditions:

The foreign currency portion of the investment costs of the Beris dam would be financed by an international financing agency. The repayment conditions were assumed to be at an annual interest rate of 4% and a term of 25 years including a 7-year grace period.

The investment costs allocated to MADA irrigation project would be financed by the Federal Government.

The investment costs allocated to the minor irrigation projects would be first paid by the State DIDs and then be reimbursed by the Federal Government.

The investment costs allocated to urban water supply projects would be financed by a federal loan, while the rural water supply projects would be financed by a Federal grant.

The operation and maintenance cost would be born by the purpose's own funds.

Table 39 shows the financial cash flow from the viewpoint of the Federal Government. The annual peak of the fund requirement of the Federal Government is estimated to be M$34.45 x 10^6 at 1983 price levels, and which occurs in 1987.

(2) Cash flow by purpose

From the viewpoint of MADA, it is assumed that the investment cost would be covered by Federal funds and that the O&M costs of the Beris dam would be allocated to MADA and be born by MADA's own fund as shown in Table 40.

The analysis for the State DIDs is shown in Tables 41 and 42 for the minor irrigation projects. It is assumed that the State DIDs will be reimbursed from the Federal Government one year later.

From the viewpoint of PWA for domestic and industrial water supply, a cash flow table is shown in Table 43. Becuase of repayments of the loan to the Federal Government, a peak deficit of M$0.42 x 10^6 occurs in 1990.

Table 44 shows the cash flow for PWD of the State of Kedah. Since the proportion of rural area in the State of Kedah is 65%, the repayment amount is relatively small.

(3) Unit water cost

The unit water cost for irrigation project was calculated on the assumption that the irrigation projects would bear only the operation and maintenance costs of source and direct facilities. The cost per unit water volume was estimated to be M$0.024/$m^3$ in 2000 for MADA and M$0.025/$m^3$ for the minor irrigation projects. Since the increase in income from paddy production was estimated to be M$0.049/$m^3$ to M$0.059/$m^3$, the farmers benefited by the project seem to be able to bear the O&M cost as a water charge.

For domestic and industrial water supply, the unit water cost was estimated by including investment and O&M costs. The resultant unit water cost of the Beris dam for domestic and industrial water supply was M$0.26/$m^3$ for PWA and M$0.24/$m^3$ for PWD. These costs are comparable with present water rates for domestic use. Being mixed with the costs of existing facilities, these costs will push up the water rates in a long run.

12. SUPPLEMENTAL STUDY

12.1 Water Demand and Supply Balance

As discussed in the previous sections, the existing water deficit in the integrated river system in 2000 would not be able to be fully removed even if all the possible source facilities would be implemented by 2000. As a supplemental study, herein studied was the water demand and supply balance for the water demand under the condition that new minor irrigation projects in the Region would not be implemented after 1983.

If no minor irrigation project would be implemented after 1983, the water demand will be reduced by 10×10^6 m^3 in 1990 and 40×10^6 m^3 in 2000 for the Kedah river system compared with the condition that the new minor irrigation projects would be implemented as scheduled. For the Muda-Perai river system, the reduction in water demand was estimated to be 74×10^6 m^3 for 1990 and 117×10^6 m^3 for 2000.

Figure 7 shows the relationship among river runoff, water demand and water deficit for the supplemental case. The resultant water deficit was estimated to be 354×10^6 m^3 for 1990 and 384×10^6 m^3 for 2000 for the Kedah river system and 7×10^6 m^3 for 1990 and 12×10^6 m^3 for 2000 for the Muda--Perai river system assuming the existing dams and the ongoing Ahning and Mengkuang dams were in operation. The reduction of water deficit from those with new minor irrigation projects will be 4×10^6 m^3 for 1990 and 15×10^6 m^3 for 2000 for the Kedah river system, and 5×10^6 m^3 for 1990 and 11×10^6 m^3 for 2000 for the Muda-Perai river system. The proportion of the reduction to the total water deficit in the integrated river system will be 2% for 1990 and 7% for 2000.

Table 45 shows the average annual water deficit by cause and by affected area for the above demand condition.

12.2 Risk of Safe Supply and Remaining Water Deficit

As for the operation rule of the Jeniang weir, the ceiling discharge for Alternative 2 should be revised to be 10 m^3/s due to change in water deficit in the Muda main stream for the purpose of attaining the target risk of safe supply in the Muda river system. For Alternative 1, the Beris dam would be able to meet all the water deficit in the Muda main stream for 2000 under the 23-year hydrological condition and it will not be necessary to release water from Muda dam to the Muda river. Table 46 shows the risk of safe supply in the Muda main stream and Table 47 shows the average crop area in the MADA area if the frequency of water deficit year is 5/23, the proportion of average annual water deficit to the annual demand is 1% and the maximum proportion of monthly water deficit is less than 50% to the water demand of the planted area in the same month. By the reduction of the water demand, the possible off-season crop area of the MADA area will be improved by about 3% of the total MADA area.

Table 48 shows the net water output allocation of the Beris dam for the revised water demand in comparison with that for the previous water demand. The allocated water outputs to the minor irrigation both in tributaries and main streams would be decreased according to the demand reduction and reversely that to MADA would be increased to the same extent. The incremental water output to MADA would be 12 - 22 x 10^6 m^3 in 2000 and the proportion of the output to MADA to the total output of the Beris dam would be increased from 32 - 62% to 64 - 80%.

Table 49 shows the net water outputs and remaining water deficit in the integrated river system.

12.3 EIRR and Cost Allocation

The economic internal rates of return of the Beris dam for the revised water demand were calculated to be 15.3% for Alternative 1, 15.3% for Alternative 2 and 14.9% for Alternative 3 as shown in Table 50. They are slightly higher than those for the previous water demand.

The allocations of the cost to water users are shown in Table 51 for the three Alternatives.

13. LEGAL AND INSTITUTIONAL ARRANGEMENT

13.1 Federal-States Agreements

The Federal Government, in cooperation with the State Governments, is going to establish a legal system for the efficient implementation of water resources policies and plans and for the promotion of uniformity among water-related laws enforced by the States, taking into account recommendations made by NWRS in 1982.

As interim measures until the above-mentioned legal system is established, it was recommended in the Final Report of Part 1 Study to make agreements between the Federal Government, the State Governments of Perlis, Kedah and Pulau Pinang, and MADA, in order to promote coordinated actions for the regional water resources development and management, i.e., (1) the Master Agreement providing principles, (2) the Regional Water Resources Master Plan setting a target for water use and source development, and (3) the Agreements on Procedures and Methods. An outline of these agreements is described hereunder.

13.1.1 Master agreement

The framework of the Master Agreement was proposed in Part 1 Study as follows:

(1) a Regional Master Plan shall be formulated and authorized by the Federal Government and the Governments of the three States,

(2) the allocation of water in the Region to each State shall be agreed upon by the three States,

(3) all source facilities in the Region shall be integratedly operated according to rules approved by the three States,

(4) the costs for the development and operation and maintenance shall be equitably allocated among the Federal and the State Governments, and
(5) Federal Government shall show an arbitration proposal at the request by any of the three States.

Herein the following matters are additionally proposed:

(6) the priority to take water,
(7) an implementation and management body, and
(8) the establishment of a Federal-States Committee.

13.1.2 Regional water resources master plan

It was proposed in Part 1 Study that the Regional Water Resources Master Plan should include the following matters:

(1) the target envisaged by each State for the development of domestic and industrial water supply, irrigation and river maintenance flow,
(2) the target water demand which each State intends to meet, and
(3) the outline of source development projects to be implemented in the Region in immediate future.

13.1.3 Agreements on procedures and methods

This agreement should stipulate the procedures and methods including:

(1) the method of integrated operation of source facilities,
(2) the method of Jeniang system operation,
(3) the method of cost allocation or amount to be allocated to each agency,
(4) the monitoring of intakes,
(5) the procedure of reduction in off-season crop area in the MADA area, and
(6) the method to save water in the case of drought.

13.2 Federal-States Committee

As an interim measure until the institutional system recommended by NWRS is implemented, it is recommended that a Federal-States Committee should be established with the objectives to establish principles and to coordinate actions in case of extraordinary drought.

The member of the Committee should be representatives of Federal EPU, as chairman, the Governments of the three States and MADA.

The function of the Committee should be as follows:

(1) approval of the Federal-States Agreements,
(2) decision and arrangement of actions in case of an extraordinary drought, and
(3) decision on important matters related to regional water resources development and management.

13.3 Executing Agency

A number of agencies are concerned on both the supply and demand sides of water resources in the Region.

It is desirable to entrust the construction, operation and maintenance of source facilities and monitoring of water uses to a single agency.

In the absence of a specialized agency, Federal DID is in the nearest position of the executing agency, having been undertaking a wide range of water resources development and management. It is, however, more desirable to establish a federal statutory body, which is neutral with respect to water resources use. It is recommended that the National Water Resources Development and Management Corporation (NWRDMC) should be established on the basis of the recommendation by NWRS.

The board of directors of NWRDMC shall consist of several directors and its chairman shall be appointed by the Prime Minister. The board shall approve the annual operation schedule, annual budget and other important matters.

The Corporation shall have the head office, regional control centers and site offices.

The development expenditure of source facilities shall be transferred from the agencies which are responsible for the implementation of the facilities. Operation cost shall be charged to the agencies in accordance with the recurrent cost shearing, which shall be approved by the Prime Minister.

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6. FEASIBILITY STUDY OF REMAN RESERVOIR PROJECT, DRAFT FINAL REPORT, Nov. 1983

TABLES

Table 1 LIST OF DIRECT PARTICIPANTS IN THE STUDY

Colombo Plan Expert	Study Team	Counterpart Officer
E. Sazawa (MOC)	Team Leader I. Kuno (NK)	Chief Counterpart Sieh Kok Chi (DID)
	Deputy Team Leader N. Hirose (NK)	
	Member	
	M. Mizutani (NK)	
	Y. Murakami (NK)	
	T. Suzumura (NK)	
	M. Kawashima (NK)	
	S. Ninomiya (NK)	
	M. Akagawa (NK)	
	K. Yanagisawa (NK)	
	Y. Matsumoto (NK)	
	S. Sato (NK)	
	T. Ichikawa (NK)	
	T. Hirano (NK)	
	I. Araki (NK)	
	S. Ezoe (NK)	
	T. Naitoh (NK)	
	S. Nakao (NK)	
	H. Suzuki (OHBA)	
	H. Nakajima (OHBA)	
	T. Harada (OHBA)	

Special Abbreviations

MOC : Ministry of Construction

NK : Nippon Koei Co., Ltd.

OHBA : Ohba Co., Ltd.

Table 2 LIST OF MEMBERS OF COMMITTEES ESTABLISHED TO SUPPORT THE STUDY

Advisory Committee

Chairman

Y. Itobayashi (WRDPC)

Member

M. Tamura	(MOC)
T. Fujisawa	(MOC)
Y. Saitoh	(MOC)
K. Fukunari	(MOC)
M. Takemura	(MOC)
S. Yokotsuka	(MOC)
A. Kotaki	(MOFA)

Coordinator

R. Ono (JICA)

Steering Committee

Chairman

Ali Abul Hassan bin Sulaiman (EPU)

Member

Members of Technical Committee

Representatives of Federal Departments and State Governments

Secretary

Rosmah bt. Hj. Jentra (EPU)

Technical Committee

Chairman

Cheong Chup Lim (DID)

Member

Chan Boon Teik	(PWD)
Rosmah bt. Hj. Jentra	(EPU)
Jamilah bt. Talib	(EPU)
Th'ng Yong Huat	(NEB)
Peter Ho Yueh Chuen	(DOE)
Chiah Bee Peng	(AGC)
Colombo Plan Expert	

Secretary

Sieh Kok Chi (DID)

Japanese Agencies Concerned

Embassy of Japan in Kuala Lumpur

JICA (Tokyo)

JICA (Kuala Lumpur)

Special abbreviations

MOFA	:	Ministry of Foreign Affairs
MOC	:	Ministry of Construction
WRDPC	:	Water Resources Development Public Corporation
DOE	:	Division of Environment
AGC	:	Attorney General's Chambers

Table 3 PROJECTED POPULATION BY STATE

	Area (10^3 km^2)	Population (10^3)				
		1980	1983	1985	1990	2000
Perlis	0.80	145	156	161	173	194
Kedah	9.43	1,116	1,161	1,189	1,264	1,412
Pulau Pinang	1.03	955	1,003	1,034	1,106	1,433
Other States	318.82	11,526	12,491	13,164	14,866	18,220
Malaysia	330.08	13,745	14,811	15,548	17,409	21,259

Table 4 PROJECTED GDP AT 1970 CONSTANT PRICE

Unit: M$$10^6$

	1980	1983	1985	1990	2000
Perlis	193	226	249	363	781
Kedah	1,248	1,439	1,556	2,269	4,882
Pulau Pinang	2,073	2,561	2,936	4,048	7,698
Other States	21,896	26,584	30,513	43,932	83,895
Malaysia	25,410	30,810	35,254	50,612	97,256

Table 5 PROJECTED DOMESTIC AND INDUSTRIAL WATER DEMAND WITHIN THE REGION

Unit: 10^6 m^3/y

	1983			1990			2000		
	D	I	Total	D	I	Total	D	I	Total
Perlis	7	2	9	9	4	13	15	15	30
Kedah	41	13	54	62	23	85	99	100	199
Pulau Pinang	58	80	138	81	107	188	142	188	330
Total	106	95	201	152	134	285	256	304	560

Remarks; Source demand

D: Domestic water demand
I: Industrial water demand

Table 6 PROJECTED IRRIGATION WATER DEMAND WITHIN THE REGION

Unit: 10^6 m^3/y

	1983	1990	2000
MADA	1,309	1,278	1,243
Fringe	23	21	21
Minor	493	549	695
Total	1,825	1,848	1,959

Table 7 ANNUAL WATER DEMAND

Unit: 10^6 m^3

Basin	1983 D&I	1983 Irrigation	1990 D&I	1990 Irrigation	2000 D&I	2000 Irrigation
Kedah River						
Tributaries						
(1) Upstream of Pelubang	0	2	0	9	0	20
(2) Temin	1	26	1	28	2	41
(3) Downstream of Pelubang	1	2	1	2	1	3
Sub-total	2	30	2	39	3	64
Main						
(4) MADA (Main)	9	1,309	16	1,278	44	1,243
(Fringe)	0	23	0	21	0	21
(5) Others	24	0	39	1	93	6
Sub-total	33	1,332	55	1,300	137	1,270
Total	35	1,362	57	1,339	140	1,334
Muda-Perai River						
Tributaries						
(6) Muda River	10	30	10	66	15	100
(7) Perai & others	2	7	3	6	10	11
Sub-total	12	37	13	72	25	111
Main						
(8) Muda River	10	223	21	239	59	240
(9) Perai River	81	135	107	119	186	119
(10) Pinang Island	60	0	84	0	147	0
Sub-total	151	358	212	358	392	359
Total	163	395	225	430	417	470
Grand Total	198	1,757	282	1,769	557	1,804

Table 8 AVERAGE ANNUAL WATER DEFICIT BY CAUSE BY AFFECTED AREA

Unit: 10^6 m^3

Cause of Water Deficit	Affected Area by Water Deficit: Kedah River System: MADA main	Main minor	D&I	Total	Muda-Perai River System: Main minor: Kedah	P.Pinang	D&I	Total
1983 Kedah System								
MADA main	383.3	6.7	0	390				
Main minor	6.9	0.1	0	7				
Tributary minor	6.9	0.1	0	7				
D&I	4.9	0.1	0	5				
Total	402.0	7.0	0	409				
Muda-Perai System								
. Kedah: Main minor					0.2	0.8	0	1
Tributary minor					0.2	0.8	0	1
D&I					0	0	0	0
. P.Pinang: Main minor					0.9	3.1	0	4
D&I					0.2	0.8	0	1
Total					1.5	5.5	0	7
1990 Kedah System								
MADA main	338.2	5.8	0	344				
Main minor	6.9	0.1	0	7				
Tributary minor	6.9	0.1	0	7				
D&I	0	0	0	0(+46)				
Total	352.0	6.0	0	358(404)				
Muda-Perai System								
. Kedah: Main minor					1.0	2.0	0	3
Tributary minor					1.4	2.6	0	4
D&I					0.7	1.3	0	2
. P.Pinang: Main minor					1.0	2.0	0	3
D&I					0	0	0	0 (+5)
Total					4.1	7.9	0	12 (17)
2000 Kedah System								
MADA main	332.8	7.2	0	340				
Main minor	8.8	0.2	0	9				
Tributary minor	19.6	0.4	0	20				
D&I	15.7	0.3	0	16(+45)				
Maintenance flow	13.7	0.3	0	14				
Total	390.6	8.4	0	399(444)				
Muda-Perai System								
. Kedah: Main minor					1.0	2.0	0	3
Tributary minor					3.5	6.5	0	10
D&I					0.7	1.3	0	2
. P. Pinang: Main minor					1.0	2.0	0	3
D&I					1.7	3.3	0	5(+12)
Total					8.0	15.0	0	23 (35)

Remark; Figures between parentheses in row of D&I indicate supply from Ahning or Mengkuang dam, those in row of total indicate deficit if Ahning and Mengkuang dams are not operated.

Table 9 ALLOCATION OF OUTPUT OF JENIANG AND BERIS TO CAUSE OF WATER DEFICIT

	Alternative 1 (Muda Priority)			Alternative 2 (Even)			Alternative 3 (Kedah Priority)		
	Jeniang	Beris	Deficit	Jeniang	Beris	Deficit	Jeniang	Beris	Deficit
1990									
Kedah River System									
MADA	178	45	121	178	46	120	178	54	112
Main minor	4	1	2	4	1	2	4	1	2
Tributary minor	-	7	0	-	7	0	-	7	0
D & I	0	0	0	0	0	0	0	0	0
Maintenance flow	0	0	0	0	0	0	0	0	0
Sub-total	182	53	123	182	54	122	182	62	114
Kedah									
Main minor	-	3	0	-	2.5	0.5	-	0	3
Tributary minor	-	4	0	-	4	0	-	0	4
D & I	-	2	0	-	2	0	-	0	2
Pulau Pinang									
Main minor	-	3	0	-	2.5	0.5	-	0	3
D & I	-	0	0	-	0	0	-	0	0
Sub-total	-	12	0	-	11	1	-	0	12
Total	182	65	123	182	65	123	182	62	126
2000									
Kedah River System									
MADA	166	21	153	166	23	151	168	41	131
Main minor	4	0	5	4	1	4	4	1	4
Tributary minor	-	20	0	-	20	0	-	20	0
D & I	8	1	7	8	1	7	8	2	6
Maintenance flow	7	1	6	7	1	6	7	2	5
Sub-total	185	43	171	185	46	168	187	66	146
Muda River System									
Kedah									
Main minor	-	3	0	-	1.5	1.5	-	0	3
Tributary minor	-	10	0	-	10	0	-	0	10
D & I	-	2	0	-	2	0	-	0	2
Pulau Pinang									
Main minor	-	3	0	-	1.5	1.5	-	0	3
D & I	-	5	0	-	5	0	-	0	5
Sub-total	-	23	0	-	20	3	-	0	23
Total	185	66	171	185	66	171	187	66	169

Table 10 NET WATER OUTPUT AND REMAINING DEFICIT

Unit: 10^6 m^3/y

	1990		2000	
	Kedah	Muda	Kedah	Muda
Alternative 1				
Target Deficit	358	12	399	23
Jeniang	182		185	
Beris	53	12	43	23
Reman	89		97	
K. Thepha	28		30	
Remaining Deficit	6	0	42	0
Alternative 2				
Target Deficit	358	12	399	23
Jeniang	182		185	
Beris	54	11	46	20
Reman	89		97	
K. Thepha	28		30	
Remaining Deficit	5	1	41	3
Alternative 3				
Target Deficit	358	12	399	23
Jeniang	182		187	
Beris	62		66	
Reman	83		83	
K. Thepha	26		26	
Remaining Deficit	5	12	37	23
Merbok		12		23
Remaining Deficit	5	0	37	0

Remark; Average figures under 1961 - 1983 hydrlogical condition

Table 11 ASSUMED FEATURE OF SOURCE FACILITIES

	Pedu-Muda	Ahning	Jeniang	Beris
Inflow (10^6 m^3)	827/1	64	630/6	109
Active storage Capacity (10^6 m^3)	1,209/2	200	27/7	102
HWL (EL. m)	97.6/3	113		85
LWL (EL. m)	67.8/4	72		69
Outlet discharge Capacity (m^3/s)	171 - 117/5	5	40	15

Remarks; /1 & /2: Pedu + Muda
/3 & /4: Pedu
/5: Pedu only but Muda's is 20 m^3/s
/6: Including Beris inflow
/7: Naok storage

Table 12 WATER DEFICIT IN MINOR IRRIGATION SCHEMES IN THE MUDA MAIN STREAM

	No Project	Alaternatives 1	2	3
1983				
Frequency	8/23			
Average annual deficit / Demand	3%			
Monthly maximum deficit / Demand	65%			
1990				
Frequency	14/23	1/23	7/23	14/23
Average annual deficit / Demand	4%	nil	0.3%	4%
Monthly maximum deficit / Demand	65%	nil	10%	65%
2000				
Frequency	16/23	1/23	8/23	17/23
Average annual deficit / Demand	8%	nil	1%	8%
Monthly maximum deficit / Demand	90%	nil	30%	90%

Table 13 AVERAGE OFF-SEASON CROP AREA IN THE MADA AREA

Source Facilities	Average Crop Area 1983 (%)	(ha)	1990 (%)	(ha)	2000 (%)	(ha)
Alternative 1						
Pedu + Muda	54	51,000				
+ Ahning			60	57,000	56	53,000
+ Jeniang			80	76,000	72	69,000
+ Beris			88	84,000	80	76,000
+ Reman			97	92,000	90	86,000
+ K. Thepha			100	95,000	93	89,000
Alternative 2						
+ Ahning			60	57,000	56	53,000
+ Jeniang			80	76,000	73	70,000
+ Beris			88	84,000	81	77,000
+ Reman			97	92,000	90	86,000
+ K. Thepha			100	95,000	93	89,000
Alternative 3						
+ Ahning			60	57,000	56	53,000
+ Jeniang			82	78,000	77	73,000
+ Beris			88	84,000	84	80,000
+ Reman			97	92,000	92	88,000
+ K. Thepha			100	95,000	93	89,000
+ Merbok			100	95,000	96	91,000

Remarks; Frequency of deficit year : 5/23
Average proportion of annual deficit to demand : 1%
Maximum proportion of monthly deficit to demand: 50%

Table 14 DESIGN FLOOD DISCHARGE AT BERIS DAMSITE

Return Period (years)	Peak Discharge (m^3/s)
2	190
10	310
20	360
50	430
100	480
200	530
1,000	650
10,000	820
PMF	900

Remark; The peak discharges include the base flow component.

Table 15 MAJOR CONSTRUCTION PLANT AND EQUIPMENT

Unit: nos.

No.	Equipment	Capacity	Required Number
1.	Bulldozer with ripper	21 ton	2
2.	Bulldozer	15 ton	3
3.	Bulldozer	11 ton	2
4.	Dozer Shovel	1.4 m^3	3
5.	Wheel Loader	2.1 m^3	2
6.	Dump Truck	15 ton	6
7.	Dump Truck	8 ton	5
8.	Truck Crane	15 ton	1
9.	Truck Crane	20 ton	1
10.	Agitator Car	3.2 m^3	2
11.	Vibrator Roller	7 ton	1
12.	Tamping Roller	4 ton	1
13.	Macadam Roller	8 ton	1
14.	Tire Roller	8 ton	1
15.	Asphalt Distributor	1,000 l	1
16.	Back Hoe	0.7 m^3	1
17.	Motor Grader	3.8 m	1
18.	Crawler Drill	10 m^3/min	2
19.	Boring Machine	5.5 kW	6
20.	Grout Mixer	600 l x 2	2
21.	Grout Mixer	200 l x 2	6
22.	Grout Pump	7.5 kW	6
23.	Leg Hammer	2.7 m^3/min	10
24.	Two-Boom Drill Jumbo (Hydraulic)	10 kgm x 2	2
25.	Rocker Shovel	0.4 m^3	1
26.	Air Compressor	10 m^3/min	3
27.	Air Compressor	5 m^3/min	4
28.	Generator	300 kVA	2
29.	Generator	75 kVA	5
30.	Cable Crane	4.5 ton	1
31.	Crushing Plant	100 ton/h	1
32.	Portable Crushing Plant	30 ton/h	1
33.	Concrete Mixing Plant	0.75 m^3 x 2	1
34.	Portable Concrete Mixing Plant	10 m^3/h	1
35.	Water Tank Lorry	6 m^3	2

Table 16 MATERIALS FOR CONSTRUCTION

No.		Unit	Quantity
1.	Diesel oil	l	1,200,000
2.	Lubricant	l	19,000
3.	Gasoline	l	200,000
4.	Grease	kg	1,800
5.	Dynamite	kg	51,000
6.	Cement	ton	17,500
7.	Reinforcement bar	ton	900
8.	H-shaped steel	ton	40
9.	ANFO	kg	57,000
10.	Electric power	kWh	2,300,000
11.	Retarder	kg	44,000
12.	Diamond bit	carat	2,250
13.	Cross bit	nos.	1,200
14.	Detonator	nos.	70,000
15.	Timber	ton	700

Table 17 LABOUR WAGE

Unit: M$/d

No.	Category	Wage
1.	Foreman	60
2.	Operator	50
3.	Assistant Operator	30
4.	Driver	16
5.	Mechanic	40
6.	Electrician	40
7.	Concrete Worker	25
8.	Reinforcement Worker	35
9.	Carpenter	35
10.	Power Operator	50
11.	Driller	40
12.	Boring Worker	35
13.	Grout Worker	30
14.	Common Labour	20

Table 18 UNIT PRICE OF MATERIALS*

Unit: M$

No.	Material	Unit	Price
1.	Diesel oil	lit	0.604
2.	Lubricant	lit	2.45
3.	Gasoline	lit	1.08
4.	Grease	kg	3.88
5.	Dynamite	kg	12.36
6.	Cement	kg	0.180
7.	Retarder	kg	2.70
8.	Reinforcement Bars	ton	847
9.	Timber (Plank Square Log)	ton	398
10.	H-shaped Steel, H125 x 125	kg	1.23
11.	Boring Rods	nos.	108

Remark; *: Including inland transportation cost from the port of Pulau Pinang to the site.

Table 19 DETAILED CONSTRUCTION COST ESTIMATES (1/2)

Description	Unit	Quantity	Foreign Currency Unit Cost (M$)	Foreign Currency Amount (M$10³)	Local Currency Unit Cost (M$)	Local Currency Amount (M$10³)	Total Unit Cost (M$)	Total Amount (M$10³)
1. River Diversion Work								
Excavation, common	m³	200	1.5	0.3	3.5	0.7	5	1
Excavation, weathered rock	m3	200	3	0.6	6	1.2	9	1.8
Excavation, rock	m³	600	3.3	2	16.7	10	20	12
Excavation, tunnel	m³	7,300	15	110	75	548	90	657
Conctete in open	m³	320	25	8	215	69	240	77
Concrete in tunnel	m³	2,100	75	158	195	410	270	567
Backfill grouting	m	220	15	3	155	34	170	37
Curtain and consolidation grouting	m	470	25	12	225	106	250	118
Diversion gate	ton	35	11,900	417	1,100	39	13,000	455
Care of river	L.S.			6		24		30
Miscellaneous	L.S.			73.1		118.1		194.2
Sub-total				790		1,360		2,150
2. Main Dam*								
Excavation, common	m³	7,100	1.5	11	3.5	25	5	36
Excavation, weathered rock	m³	13,300	3	40	6	80	9	120
Excavation, rock	m³	10,100	3.3	33	16.7	169	20	202
Concrete in dam	m³	56,400	25	1,410	105	5,922	130	7,332
Curtain and consolidation grouting	m	5,520	25	138	225	1,242	250	1,380
Measuring apparatus	L.S.			80		20		100
Miscellaneous	L.S.			88		742		830
Sub-total				1,800		8,200		10,000
3. Stilling Basin								
Excavation, common	m³	300	1.5	0.5	3.5	1	5	1.5
Excavation, weathered rock	m³	1,400	3	4	6	8	9	13
Excavation, rock	m³	5,500	3.5	19	16.5	91	20	110
Concrete in open	m³	2,700	20	54	170	459	190	513
Miscellaneous	L.S.			12.5		61		72.5
Sub-total				90		620		710
4. River Outlet								
Concrete in open	m³	400	25	10	215	86	240	96
Trash rack	ton	7	8,200	57	800	6	9,000	63
Emergency gate	ton	15	13,800	207	1,200	18	15,000	225
Steel pipe shell	ton	36	7,300	263	700	25	8,000	288
Release valve**	set	2	276,000	552	24,000	48	300,000	600
Miscellaneous	L.S.			111		17		128
Sub-total				1,200		200		1,400

Remarks; (1) At 1983 price level.
(2) *: Including secondary cofferdam of 1.2×10^3 m³.
(3) **: Consisting of one hollow jet valve (ø1500), one high pressure slide valve (ø600) and guard valve (ø1500) for one set.

Table 20 DETAILED CONSTRUCTION COST ESTIMATES (2/2)

Description	Unit	Quantity	Foreign Currency Unit Cost (M$)	Foreign Currency Amount (M$10^3)	Local Currency Unit Cost (M$)	Local Currency Amount (M$10^3)	Total Unit Cost (M$)	Total Amount (M$10^3)
5. Saddle Dam								
Excavation, common	m^3	27,800	1.5	42	3.5	97	5	139
Excavation, weathered rock	m^3	12,600	3	38	6	76	9	113
Excavation, rock	m^3	500	3.5	2	16.5	8	20	10
Embankment, core	m^3	22,300	3.5	78	6.5	145	10	223
Embankment, filter	m^3	18,600	15	279	22	409	37	688
Embankment, rock	m^3	80,700	5	404	12	968	17	1,372
Curtain grouting	m	4,250	25	106	225	956	250	1,063
Blanket grouting	m	1,500	20	30	120	180	140	210
Slush grouting	m	1,070	20	21	120	128	140	150
Measuring apparatus	L.S.			60		20		80
Miscellaneous	L.S.			40		238		322
Sub-total				1,100		3,270		4,370
6. Relocation Road								
Road	km	11.9	78,000	928	312,000	3,713	390,000	4,641
Bridges (1 No.)	m	300	1,200	360	4,600	1,380	5,800	1,740
Power line	km	12.2	7,500	92	7,500	92	15,000	183
Miscellaneous	L.S.			140		525		666
Sub-total				1,520		5,710		7,230
7. Preparatory Works	L.S.			1,000		3,040		4,040
8. Compensation	L.S.					25,700		25,700
9. Engineering and Government Administration (*Design and Supervision*)	L.S.			5,900		2,500		8,400
Sub-total 1 to 9				13,400		50,600		64,000
10. Contingencies								
Physical contingencies	L.S.			2,680		10,120		12,800
Price escalation	L.S.			4,370		15,420		19,790
Grand Total				20,450		76,140		96,590

Table 21 DISBURSEMENT SCHEDULE OF BERIS DAM PROJECT

Unit: $M\$10^3$

		Total Amount	1st year (1985)	2nd year (1986)	3rd year (1987)	4th year (1988)	5th year (1989)
1. River Diversion Works	F.C.	790			290	330	170
	L.C.	1,360			490	570	300
	Sub-total	2,150			780	900	470
2. Main Dam	F.C.	1,800				950	850
	L.C.	8,200				4,300	3,900
	Sub-total	10,000				5,250	4,750
3. Stilling Basin	F.C.	90				90	
	L.C.	620				620	
	Sub-total	710				710	
4. River Outlet	F.C.	1,200			120	960	120
	L.C.	200					200
	Sub-total	1,400			120	960	320
5. Saddle Dam	F.C.	1,100				340	760
	L.C.	3,270				1,030	2,240
	Sub-total	4,370				1,370	3,000
6. Relocation Road	F.C.	1,520				450	1,070
	L.C.	5,710				1,690	4,020
	Sub-total	7,230				2,140	5,090
7. Preparatory Works	F.C.	1,000			820	90	90
	L.C.	3,040			2,480	280	280
	Sub-total	4,040			3,300	370	370
8. Advance Payment	F.C.	-			5,000	-2,000	-3,000
	L.C.	-					
	Sub-total	-					
9. Compensation	F.C.	-					
	L.C.	25,700			25,700		
	Sub-total	25,700			25,700		
10. Engineering Services and Government Administration (Design and Supervision)	F.C.	5,900	700	1,200	700	1,400	1,900
	L.C.	2,500	300	500	300	600	800
	Sub-total	8,400	1,000	1,700	1,000	2,000	2,700
11. Contingencies Physical Contingencies	F.C.	2,680	140	240	390	920	990
	L.C.	10,120	60	100	5,790	1,820	2,350
	Sub-total	12,800	200	340	6,180	2,740	3,340
Price Escalation	F.C.	4,370	90	230	500	1,530	2,020
	L.C.	15,420	30	90	7,490	3,020	4,790
	Sub-total	19,790	120	320	7,990	4,550	6,810
Total	F.C.	20,450	930	1,670	7,820	5,060	4,970
	L.C.	76,140	390	690	42,250	13,930	18,880
Grand Total		96,590	1,320	2,360	50,070	18,990	23,850

Remarks; (1) At 1983 price level
(2) F.C. : Foreign currency portion
(3) L.C. : Local currency portion

Table 22 ANNUAL OPERATION AND MAINTENANCE COST

Unit: M$$10^3$

		Amount
1. Operating Personnel		
Chief Technician	(1 person)	25
General Clerk	(1 person)	10
Mechanical Technician	(1 person)	15
Electrical Technician	(1 person)	15
Caretaker	(3 persons)	20
Sub-total		85
2. Administration and Maintenance		
Civil works		
- Total construction cost* of main dam, stilling basin, civil works of river outlet, saddle dam and preparatory works x 0.2% = 23,070 x 0.002		46
Mechanical works		
- Total construction cost* of hydromechanical works of river outlet x 1% = 1,554 x 0.01		16
Sub-total		62
3. Miscellaneous		13
Total		160

Remarks; (1) *: Including physical contingency (20%)

(2) At 1983 price level

Table 23 ESTIMATE OF LAND ACQUISITION COST

	Quantity	Unit Price ($M\$10^3$)	Amount ($M\$10^6$)
1. Compensation on Land			
1.1 Rubber	492 ha	20	9.84
1.2 Paddy	143 ha	25	3.57
1.3 Residential/mixed cultivation area	261 ha	25	6.53
1.4 Alienated forest	140 ha	10	1.40
Total	1,216 ha		21.34
2. Removal of Families			
2.1 Kg. Batu Seketul			
Class A	7 nos.	20	0.14
Class B	33 nos.	12	0.40
Class C	14 nos.	5	0.07
Sub-total	54 nos.		0.61
2.2 Kg. Sg. Batang			
Class A	11 nos.	20	0.22
Class B	172 nos.	12	2.06
Class C	48 nos.	5	0.24
Sub-total	231 nos.		2.52
2.3 Kg. Terenas			
Class A	-	20	-
Class B	40 nos.	12	0.48
Class C	11 nos.	5	0.06
Sub-total	51 nos.		0.54
Total	336 nos.		3.67
3. Public Facilities			
3.1 Mosque	1 no.	120	0.12
3.2 School	1 no.	290	0.29
3.3 Place of worship (Surau)	2 nos.	30	0.06
3.4 Storehouse, public house, RISDA hospital	4 nos.	40	0.16
3.5 Small public house	1 no.	10	0.01
3.6 Cemetery	1 no.	50	0.05
Total	10 nos.		0.69
Grand Total			25.70

Table 24 ESTIMATED RESETTLEMENT COST

	Description	Unit	Quantity	Unit Price (M$10^3)	Amount (M$10^3)
1.	Land Acquisition Cost				
1.1	Rubber Farm	ha	300	20	6,000
2.	Development Cost				
2.1	Resettlement Area	ha	400	12	4,800
2.2	Rubber Field in Forest Reserve	ha	500	6	3,000
	Sub-total				13,800
3.	House	nos.	334	12	4,010
4.	Public Facilities				
4.1	Mosque	nos.	1	120	120
4.2	School	nos.	1	290	290
4.3	Place of Worship (Surau)	nos.	2	30	60
4.4	Storehouse	nos.	2	40	80
4.5	Public House	nos.	1	40	40
4.6	RISDA Hospital	nos.	1	40	40
4.7	Small Public House	nos.	1	10	10
4.8	Cemetery	nos.	1	50	50
	Sub-total				690
	Total				18,500

Table 25 ESTIMATED AVERAGE PADDY YIELD AND ECONOMIC NET PRODUCTION VALUE

Scheme	Yield (ton/ha)	Gross Production Value (M$/ha)	Production Cost (M$/ha)	Net Production Value (M$/ha)
1. With Insufficient Irrigation Water Supply				
1.1 MADA				
- Without tertiary development	4.0	2,192	892	1,300
1.2 Rainfed	2.2	1,206	796	410
1.3 Existing minor irrigation	3.2	1,754	844	910
2. With Sufficient Irrigation Water Supply				
2.1 MADA				
- With tertiary development	5.0	2,740	938	1,802
- Without tertiary development	4.0	2,192	892	1,300
2.2 Minor irrigation				
- New projects	4.5	2,466	916	1,550

Remark; Economic production value is projected to 1995 onward at 1983 constant price.

Table 26 FLOW OF NET PRODUCTION VALUE WITH AND WITHOUT PROJECT CONDITION FOR THE KEDAH RIVER BASIN

Unit: M$$10^6$

Year	MADA			Main Minor			Tributary Minor		
	W/O	W/P	I/B	W/O	W/P	I/B	W/O	W/P	I/B
1982	210.34	210.34	-	6.02	6.02	-	2.70	2.70	-
1983	210.34	210.34	-	6.02	6.02	-	2.70	2.70	-
1984	210.34	210.34	-	6.02	6.02	-	2.70	2.70	-
1985	210.34	210.34	-	6.02	6.02	-	2.70	2.82	0.12
1986	210.34	210.34	-	6.02	6.02	-	2.70	3.14	0.44
1987	210.34	210.34	-	6.02	6.02	-	2.70	3.19	0.49
1988	210.34	210.34	-	6.02	6.02	-	2.70	3.24	0.54
1989	210.34	210.34	-	6.02	6.02	-	2.70	3.45	0.75
1990	210.34	252.40	42.06	6.02	8.80	2.78	2.70	3.70	1.01
1991	210.34	271.57	61.23	6.02	8.86	2.84	2.70	4.51	1.81
1992	210.34	276.96	66.62	6.02	8.91	2.89	2.70	4.62	1.92
1993	210.34	281.75	71.41	6.02	8.95	2.93	2.70	4.72	2.02
1994	210.34	287.14	76.80	6.02	8.95	2.93	2.70	5.05	2.35
1995	210.34	292.53	82.19	6.02	9.05	3.03	2.70	5.24	2.54
1996	210.34	297.48	87.14	6.02	9.25	3.23	2.70	5.52	2.82
1997	210.34	303.03	92.69	6.02	9.29	3.27	2.70	5.60	2.90
1998	210.34	308.92	98.58	6.02	9.38	3.36	2.70	5.65	2.95
1999	210.34	317.79	107.65	6.02	9.48	3.46	2.70	5.84	3.14
2000	210.34	324.65	114.31	6.02	9.63	3.61	2.70	6.31	3.61
2001	210.34	328.49	118.14	6.02	9.67	3.65	2.70	6.37	3.67
2002	210.34	330.79	120.45	6.02	9.72	3.70	2.70	6.43	3.73
2003	210.34	331.56	121.22	6.02	9.73	3.71	2.70	6.47	3.77
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2032	210.34	331.56	121.22	6.02	9.73	3.71	2.70	6.47	3.77

Remarks; (1) At 1983 constant price.

(2) W/O : Without-project, W/P : With-project

I/B : Incremental benefit

Table 27 FLOW OF NET PRODUCTION VALUE WITH AND WITHOUT PROJECT CONDITION FOR THE MUDA RIVER BASIN

Unit: M$$10^6$

Year	Main Minor			Tributary Minor		
	W/O	W/P	I/B	W/O	W/P	I/B
1982	30.79	30.79	-	4.20	4.20	-
1983	30.79	30.79	-	4.20	4.20	-
1984	30.79	30.79	-	3.70	3.70	-
1985	30.64	37.69	7.05	3.66	4.48	0.82
1986	31.38	41.61	10.23	3.66	5.30	1.64
1987	30.44	44.21	13.77	3.66	5.47	1.81
1988	30.44	46.86	16.42	3.66	5.65	1.99
1989	29.60	46.11	16.51	3.66	6.90	3.24
1990	29.54	45.80	16.26	3.66	8.29	4.63
1991	29.54	49.74	20.20	3.66	8.58	4.92
1992	29.54	49.81	20.27	3.66	8.85	5.19
1993	29.54	49.85	20.31	3.66	8.99	5.33
1994	29.54	49.86	20.32	3.66	9.54	5.88
1995	29.54	49.92	20.38	3.66	10.12	6.46
1996	29.54	50.02	20.48	3.66	10.90	7.24
1997	29.54	50.04	20.50	3.66	11.10	7.44
1998	29.54	50.06	20.52	3.66	11.23	7.54
1999	29.54	50.19	20.65	3.66	12.31	8.65
2000	29.54	50.37	20.83	3.66	12.77	9.11
2001	29.54	50.51	20.97	3.66	12.98	9.32
2002	29.54	50.55	21.01	3.66	13.18	9.52
2003	29.54	50.57	21.03	3.66	13.28	9.62
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
2032	29.54	50.57	21.03	3.66	13.28	9.62

Remarks; (1) At 1983 constant price.

(2) W/O : Without-project, W/P : With-project
I/B : Incremental benefit

Table 28 NATIONAL ECONOMIC CONVERSION FACTORS

Category	Factor
Opportunity Cost of Capital	0.10
General Conversion Factor	0.89
Rubber	1.22
Agricultural inputs	0.86
Port handling	0.72
Transport services	0.66
Construction services	0.77
Construction materials	0.88
Transport equipment	0.76
Power and fuel	0.97
Public services	0.89

Source: National Parameters for Project Appraisal in Malaysia Vol. I to Vol. V; The Opportunity Cost of Labour (in Peninsular Malaysia) Vol. III; Conversion Factors for Tradeable and Non-tradeable Goods and Services, Economic Planning Unit, Prime Minister's Department.

Table 29 ECONOMIC COST OF BERIS DAM

	Financial Cost (M$10³)	Conversion Factor	Economic Cost (M$10³)
1. Investment Cost			
River Diversion	2,150	0.88	1,890
Main Dam			
Excavation and concrete	8,480	0.88	7,460
Grouting	1,520	0.77	1,170
Sub-total	10,000		8,630
Stilling Basin	710	0.88	620
River Outlet			
Concrete	105	0.88	90
Mechanical works	1,295	0.88	1,140
Sub-total	1,400		1,230
Saddle Dam			
Excavation and embankment	2,802	0.88	2,470
Grouting	1,568	0.77	1,210
Sub-total	4,370		3,680
Relocation Road	7,230	0.89	6,430
Preparatory Works	4,040	0.88	3,560
Compensation/1	4,360	0.89	3,880
Engineering Services and Government Administration (Design and Supervision)	8,400	0.77	6,470
Contingency/2	8,530		7,280
Total	51,190		43,670
2. Annual Operation and Maintenance (O & M) Cost			
Personnel Expenses	95	0.77	73
Administration and Maintenance	65	0.88	57
Total	160		130

Remarks; /1 : Excluding compensation cost on land

/2 : Excluding price escalation

Table 30 ECONOMIC INVESTMENT COST AND ANNUAL COST OF JENIANG SYSTEM, PROPOSED DAMS AND POTENTIAL DAMS

	Investment Cost ($M\$10^6$)	Annual Cost ($M\$10^6/y$)
Jeniang system	60.13	0.66
Beris dam	43.67	0.93
Tawar-Muda dam	78.68	0.89
Khlong Thepha dam	72.00	1.40
Reman dam	65.10	4.75
Merbok scheme (High)	99.77	1.40
(Low)	79.82	1.12

Remarks; (1) Values at the optimum scale

(2) In 1983 constant price

(3) Annual cost consists of O & M cost and production forgone

Table 31 NET WATER OUTPUT OF BERIS DAM

Unit: 10^6 m^3

Cause of Water Deficit	Net Water Output in Affected Area								
	Alternative 1			Alternative 2			Alternative 3		
	MADA	Main minor	Total	MADA	Main minor	Total	MADA	Main minor	Total
1990									
Kedah System									
MADA	44.3	0.8	45.1	45.3	0.8	46.1	53.0	0.9	53.9
Main minor	0.9	0.0	0.9	0.9	0.0	0.9	1.1	0.0	1.1
Tributary minor	6.9	0.1	7.0	6.9	0.1	7.0	6.9	0.1	7.0
D & I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	52.1	0.9	53.0	53.1	0.9	54.0	61.0	1.0	62.0
Muda-Perai									
Kedah									
Main minor		3.0	3.0		2.5	2.5			
Tributary minor		4.0	4.0		4.0	4.0			
D & I		2.0	2.0		2.0	2.0			
Pulau Pinang									
Main minor		3.0	3.0		2.5	2.5			
D & I		0.0	0.0		0.0	0.0			
Sub-total		12.0	12.0		11.0	11.0			0.0
Total			65.0			65.0			62.0
2000									
Kedah System									
MADA	20.2	0.4	20.6	22.8	0.5	23.3	40.4	0.9	41.3
Main minor	0.6	0.0	0.6	0.6	0.0	0.6	1.1	0.0	1.1
Tributary minor	19.6	0.4	20.0	19.6	0.4	20.0	19.6	0.4	20.0
D & I	1.0	0.0	1.0	1.1	0.0	1.1	1.9	0.0	1.9
Maintenance flow	0.8	0.0	0.8	1.0	0.0	1.0	1.7	0.0	1.7
Sub-total	42.2	0.8	43.0	45.1	0.9	46.0	64.7	1.3	66.0
Muda-Perai System									
Kedah									
Main minor		3.0	3.0		1.5	1.5			
Tributary minor		10.0	10.0		10.0	10.0			
D & I		2.0	2.0		2.0	2.0			
Pulau Pinang									
Main minor		3.0	3.0		1.5	1.5			
D & I		3.0	5.0		5.0	5.0			
Sub-total		23.0	23.0		20.0	20.0			0.0
Total			66.0			66.0			66.0

Table 32 RESULTS OF ECONOMIC EVALUATION OF BERIS DAM

Unit: M$$10^6$

	Alternative 1	Alternative 2	Alternative 3
Present Value of Benefit (r = 8%)			
Kedah river system			
MADA	31.21	34.52	56.68
Main minor	0.84	0.84	1.48
Tributary minor	24.35	24.35	24.35
D & I	1.16	1.30	2.22
Maintenance flow	0.93	1.16	1.99
Sub-total	58.48	62.16	86.72
Muda-Perai river system			
Kedah State			
Main minor	3.62	2.15	
Tributary minor	10.04	10.04	
D & I	2.42	2.42	
Pulau Pinang State			
Main minor	3.62	2.15	
D & I	4.36	4.36	
Sub-total	24.06	21.13	0
Total	82.54	83.29	86.72
Present Value of Cost (r = 8%)	37.32	37.32	37.32
Net Benefit	45.22	45.97	49.4
EIRR (%)	14.8	14.8	14.6

Table 33 SENSITIVITY ANALYSIS

	Change in (%)	EIRR (%) Alternative 1	2	3	Sensitivity Indicator Alternative 1	2	3
Base Case	-	14.8	14.8	14.6	-	-	-
(1) Investment costs and O & M costs	+10	13.8	13.9	13.8	0.68	0.61	0.55
(2) Benefits	-25	12.1	12.1	12.1	0.73	0.73	0.68
(3) Delay in Construction	one year	14.1	14.1	14.2	-	-	-
(4) Combination of (1), (2) and (3)		11.0	11.0	11.2	-	-	-

Table 34 JOINT COST ALLOCATION OF BERIS DAM, ALTERNATIVE 1, MUDA PRIORITY

Unit: M$$10^6$

	Kedah River System					Muda-Perai River System					
	MADA main	Main minor	Tributary minor	D & I	River maintenance flow	Main minor Kedah	Main minor P. Pinang	Tributary minor	D & I Kedah	D & I P. Pinang	Total
1. Benefit	31.21	0.84	24.35	1.16	0.93	3.62	3.62	10.04	2.42	4.36	82.55
2. Alternative Cost	40.37	29.11	39.95	29.32	29.12	30.45	30.45	34.39	29.95	31.58	324.69
3. Justifiable Expenditure	31.21	0.84	24.35	1.16	0.93	3.62	3.62	10.04	2.42	4.36	82.55
4. Separable Cost											
Construction	14.59	0.77	14.17	1.05	0.91	2.87	2.87	8.34	2.03	4.62	52.22
Capitalized O & M	0.13	0	0.07	0	0	0.01	0.01	0.04	0.01	0.02	0.31
Total	14.72	0.77	14.24	1.05	0.91	2.88	2.88	8.38	2.04	4.64	52.53
Total Allocated Cost											
Construction	23.05	0.80	19.36	1.10	0.92	3.25	3.25	9.19	2.22	4.62	67.76
Capitalized O & M	0.62	0.01	0.37	0.01	0	0.04	0.04	0.09	0.02	0.02	1.22
Total	23.67	0.81	19.73	1.11	0.92	3.28	3.28	9.28	2.25	4.64	68.98
(Proportion in %)	34.31	1.17	28.60	1.61	1.34	4.76	4.76	13.46	3.26	6.73	100.00

Table 35 JOINT COST ALLOCATION OF BERIS DAM, ALTERNATIVE 2, EVEN DISTRIBUTION

Unit: M$$10^6$

	Kedah River System					Muda-Perai River System					
	MADA main	Main minor	Tributary minor	D & I	River maintenance flow	Main minor Kedah	Main minor P. Pinang	Tributary minor	D & I Kedah	D & I P. Pinang	Total
1. Benefit	34.52	0.84	24.35	1.30	1.16	2.15	2.15	10.04	2.42	4.36	83.29
2. Alternative Cost	41.79	29.11	39.95	29.46	29.32	29.53	29.53	34.39	29.95	31.58	324.62
3. Justifiable Expenditure	34.52	0.84	24.35	1.30	1.16	2.15	2.15	10.04	2.42	4.36	83.29
4. Separable Cost											
Construction	16.13	0.77	14.17	1.12	1.05	1.47	1.47	8.34	2.03	4.62	51.17
Capitalized O & M	0.08	0	0.07	0.01	0	0.01	0.01	0.04	0.01	0.02	0.25
Total	16.21	0.77	14.24	1.13	1.05	1.48	1.48	8.38	2.04	4.64	51.42
Total Allocated Cost											
Construction	25.58	0.80	19.39	1.21	1.10	1.82	1.82	9.20	2.23	4.62	67.76
Capitalized O & M	0.63	0.01	0.37	0.01	0.01	0.03	0.03	0.09	0.02	0.02	1.22
Total	26.21	0.81	19.76	1.22	1.11	1.84	1.84	9.29	2.25	4.64	68.98
(Proportion in %)	37.99	1.17	28.65	1.77	1.61	2.67	2.67	13.46	3.26	6.73	100.00

Table 36 JOINT COST ALLOCATION OF BERIS DAM, ALTERNATIVE 3, KEDAH PRIORITY

Unit: M$$10^6$

	Kedah River System					Muda-Perai River System					
	MADA main	Main minor	Tributary minor	D & I	River maintenance flow	Main minor Kedah	Main minor P. Pinang	Tributary minor	D & I Kedah	D & I P. Pinang	Total
1. Benefit	56.68	1.48	24.35	2.22	1.99	0	0	0	0	0	86.72
2. Alternative Cost	52.00	29.46	39.95	29.88	29.81	0	0	0	0	0	181.11
3. Justificable Expenditure	52.00	1.48	24.35	2.22	1.99	0	0	0	0	0	86.72
4. Separable Cost											
Construction	26.37	1.12	14.17	1.82	1.75	0	0	0	0	0	45.23
Capitalized O & M	0.12	0.01	0.07	0.01	0.01	0	0	0	0	0	0.21
Total	26.49	1.13	14.24	1.83	1.76	0	0	0	0	0	45.44
Total Allocated Cost											
Construction	42.07	1.34	20.39	2.06	1.89	0	0	0	0	0	67.76
Capitalized O & M	0.82	0.02	0.35	0.02	0.01	0	0	0	0	0	1.22
Total	42.90	1.35	20.74	2.08	1.91	0	0	0	0	0	68.98
(Proportion in %)	62.19	1.96	30.07	3.02	2.77	0	0	0	0	0	100.00

Table 37 CONSTRUCTION COST ALLOCATION TO AGENCIES CONCERNED

Unit: M$$10^6$

		Kedah		P. Pinang	
	MADA	DID	PWD	DID	PWA
Alternative 1	33.14	47.65	4.70	4.60	6.50
Alternative 2	36.69	45.94	4.86	2.58	6.50
Alternative 3	60.07	33.61	2.91	0	0

Table 38 TYPICAL FARM BUDGET OF AVERAGE FARM HOUSEHOLD FOR ONE CROP SEASON

Unit: M$/ha

	Without-project		With-project	
	MADA	Rainfed	MADA	Minor
(1) Paddy Expenditure				
Material inputs/1	46.77	36.55	50.17	46.77
Hired machinary	407.53	318.55	437.18	407.53
Hired labour	423.57	331.09	454.38	423.57
Transportation	56.88	42.55	61.02	54.44
Taxes and others	96.14	96.14	96.14	96.14
(Cost for land owner)	(1,030.89)	(824.88)	(1,098.89)	(1,028.45)
Land rent	285.00	285.00	285.00	285.00
Total	1,315.89	1,109.88	1,383.89	1,313.45
(2) Paddy Income				
Paddy sales	1,576.80	604.80	1,971.00	1,773.90
Labour income	19.13	170.70	19.13	19.13
Other income	19.76	49.38	19.76	19.76
Gross cash income	(1,615.69)	(824.88)	(2,009.89)	(1,812.79)
Value of unsold paddy	583.20	583.20	729.00	656.10
Total	2,198.89	1,408.08	2,738.89	2,468.89
(3) Net Income				
Net cash income from paddy	584.80	0	911.00	784.34
Net income from paddy	883.00	298.20	1,355.00	1,155.44
(4) Increase in cash income from paddy cultivation	-	-	326.20	784.34

Remark; /1 : Cash subsidy of M$457.88/ha deducted.

Table 39 CASH FLOW TABLE FOR FEDERAL GOVERNMENT

Unit: M$$10^6$

Year	Outflow: Beris Dam Cost Foreign	Outflow: Beris Dam Cost Local	Outflow: Beris Dam Cost Total	Outflow: Repayment for Foreign Loan	Inflow: Foreign Loan	Inflow: Repayment from PWA	Inflow: Repayment from PWD	Surplus Balance
1985	0.84	0.36	1.20	0.04	0.88	0.01	0	-0.35
1986	1.44	0.60	2.04	0.10	1.54	0.02	0	-0.58
1987	7.32	34.76	42.08	0.40	7.72	0.25	0.06	-34.45
1988	3.53	10.91	14.44	0.55	4.08	0.30	0.08	-10.53
1989	2.95	14.09	17.04	0.67	3.62	0.42	0.11	-13.56
1990				0.67		0.42	0.11	-0.14
1991				0.67		0.42	0.11	-0.14
1992				1.27		0.42	0.11	-0.74
.				.		.	.	.
.				.		.	.	.
.				.		.	.	.
2009				1.27		0.42	0.11	-0.74
2010						0.42	0.11	+0.53
2011						0.41	0.10	+0.51
2012						0.17	0.04	+0.21
2013						0.09	0.02	+0.11

Table 40 CASH FLOW TABLE FOR MADA

Unit: M$$10^6$

Year	Outflow: Beris Dam Cost Const.	Outflow: Beris Dam Cost O & M	Inflow: Federal Fund	Surplus Balance
1985	0.45		0.45	0
1986	0.78		0.78	0
1987	15.99		15.99	0
1988	5.48		5.48	0
1989	6.48		6.48	0
1990		0.06		-0.06
.		.		.
.		.		.
.		.		.
2015		0.06		-0.06

Table 41 CASH FLOW TABLE FOR KEDAH DID

Unit: M$$10^6$

Year	Outflow Beris Dam Cost Const.	 O & M	Inflow Reimbursement from Federal	Surplus Balance
1985	0.57		0	-0.57
1986	0.97		0.57	-0.40
1987	20.02		0.97	-19.05
1988	6.87		20.02	+13.15
1989	8.11		6.87	-1.24
1990		0.08	8.11	+8.03
1991		0.08		-0.08
.		.		.
.		.		.
.		.		.
2015		0.08		-0.08

Table 42 CASH FLOW TABLE FOR PULAU PINANG DID

Unit: M$$10^6$

Year	Outflow Beris Dam Cost Const.	 O & M	Inflow Reimbursement from Federal	Surplus Balance
1985	0.03		0	-0.03
1986	0.06		0.03	-0.03
1987	1.12		0.06	-1.06
1988	0.39		1.12	+0.73
1989	0.45		0.39	-0.06
1990		0	0.45	+0.45
1991		0		0
.		.		.
.		.		.
.		.		.
2015		0		0

Table 43 CASH FLOW TABLE FOR PWA

Unit: M$$10^6$

Year	Outlfow: Beris Dam Cost: Const.	Outlfow: Beris Dam Cost: O & M	Outlfow: Repayment to Federal	Inflow: Loan from Federal	Surplus Balance
1985	0.08		0.01	0.08	-0.01
1986	0.14		0.02	0.14	-0.02
1987	2.83		0.25	2.83	-0.24
1988	0.97		0.30	0.97	-0.32
1989	1.15		0.42	1.15	-0.41
1990		0	0.42		-0.42
.		.	.		.
.		.	.		.
.		.	.		.
2009		0	0.42		-0.42
2010		0	0.42		-0.42
2011		0	0.41		-0.41
2012		0	0.17		-0.17
2013		0	0.09		-0.09

Table 44 CASH FLOW TABLE FOR PWD, KEDAH

Unit: M$$10^6$

Year	Outflow: Beris Dam Cost: Const.	Outflow: Beris Dam Cost: O & M	Outflow: Repayment to Federal	Inflow: Loan from Federal	Inflow: Grant from Federal	Surplus Balance
1985	0.06		0	0.02	0.04	0
1986	0.10		0	0.03	0.07	0
1987	2.11		0.06	0.74	1.37	-0.06
1988	0.72		0.08	0.25	0.47	-0.08
1989	0.86		0.11	0.30	0.56	-0.11
1990		0.01	0.11			-0.12
.		.	.			.
.		.	.			.
.		.	.			.
2010		0.01	0.11			-0.12
2011		0.01	0.10			-0.11
2012		0.01	0.04			-0.05
2013		0.01	0.02			-0.03

Table 45 AVERAGE ANNUAL WATER DEFICIT BY CAUSE BY AFFECTED AREA FOR SUPPLEMENTAL STUDY

Unit: 10^6 m^3

	Cause of Water Deficit	Affected Area by Water Deficit: Kedah River System: MADA main	Main minor	D&I	Total	Muda-Perai River System: Main minor: Kedah	P.Pinang	D&I	Total
1983	Kedah System								
	MADA main	383.3	6.7	0	390				
	Main minor	6.9	0.1	0	7				
	Tributary minor	6.9	0.1	0	7				
	D&I	4.9	0.1	0	5				
	Total	402.0	7.0	0	409				
	Muda-Perai System								
	. Kedah: Main minor					0.2	0.8	0	1
	Tributary minor					0.2	0.8	0	1
	D&I					0	0	0	0
	. P.Pinang: Main minor					0.9	3.1	0	4
	D&I					0.2	0.8	0	1
	Total					1.5	5.5	0	7
1990	Kedah System								
	MADA main	334.5	5.5	0	340				
	Main minor	6.9	0.1	0	7				
	Tributary minor	6.9	0.1	0	7				
	D&I	0	0	0	0(+46)				
	Total	348.3	5.7	0	354(400)				
	Muda-Perai System								
	. Kedah: Main minor					0.2	0.8	0	1
	Tributary minor					0.2	0.8	0	1
	D&I					0.5	1.5	0	2
	. P.Pinang: Main minor					0.7	2.3	0	3
	D&I					0	0	0	0 (+4)
	Total					1.6	5.4	0	7 (11)
2000	Kedah System								
	MADA main	334.4	5.6	0	340				
	Main minor	6.9	0.1	0	7				
	Tributary minor	6.9	0.1	0	7				
	D&I	15.7	0.3	0	16(+45)				
	Maintenance flow	13.8	0.2	0	14				
	Total	377.7	6.3	0	384(429)				
	Muda-Perai System								
	. Kedah: Main minor					0.2	0.8	0	1
	Tributary minor					0.2	0.8	0	1
	D&I					0.5	1.5	0	2
	. P.Pinang: Main minor					0.7	2.3	0	3
	D&I					1.2	3.8	0	5 (+9)
	Total					2.8	9.2	0	12 (21)

Remark; Figures between parentheses in row of D&I indicate supply from Ahning or Mengkuang dam, those in row of total indicate deficit if Ahning and Mengkuang dams are not operated.

Table 46 WATER DEFICIT IN MINOR IRRIGATION SCHEMES IN THE MUDA MAIN STREAM FOR SUPPLEMENTAL STUDY

	No Project	Alternatives 1	2	3
1983				
Frequency	8/23			
Average annual deficit / Demand	3%			
Monthly maximum deficit / Demand	65%			
1990				
Frequency	10/23	1/23	6/23	10/23
Average annual deficit / Demand	3%	nil	0.4%	2%
Monthly maximum deficit / Demand	60%	nil	15%	50%
2000				
Frequency	11/23	1/23	7/23	11/23
Average annual deficit / Demand	5%	nil	1%	4%
Monthly maximum deficit / Demand	90%	nil	30%	75%

Table 47 AVERAGE OFF-SEASON CROP AREA IN THE MADA AREA FOR SUPPLEMENTAL STUDY

	Average Crop Area					
	1983		1990		2000	
	(%)	(ha)	(%)	(ha)	(%)	(ha)
Alternative 1						
Pedu + Muda	54	51,000				
+ Ahning			61	58,000	60	57,000
+ Jeniang			81	77,000	77	73,000
+ Beris			89	85,000	85	81,000
+ Reman			98	93,000	94	89,000
+ K. Thepha			100	95,000	96	91,000
Alternative 2						
+ Ahning			61	58,000	60	57,000
+ Jeniang			81	77,000	77	73,000
+ Beris			89	85,000	86	82,000
+ Reman			98	93,000	94	89,000
+ K. Thepha			100	95,000	99	91,000
Alternative 3						
+ Ahning			61	58,000	60	57,000
+ Jeniang			83	79,000	80	76,000
+ Beris			89	85,000	90	84,000
+ Reman			98	93,000	94	89,000
+ K. Thepha			100	95,000	96	91,000
+ Merbok			100	95,000	99	94,000

Remarks; *Frequency of deficit year* : 5/23
Average proportion of annual deficit to demand : 1%
Maximum proportion of monthly deficit to demand: 50%

Table 48 NET WATER OUTPUT OF BERIS DAM FOR SUPPLEMENTAL STUDY

Unit: 10^6 m^3

	Alternative 1		Alternative 2		Alternative 3	
	Orignal*	Revised**	Original*	Revised**	Original*	Revised**
1990						
Kedah System						
MADA	45.1	50.0	46.1	51.0	53.9	53.9
Main minor	0.9	1.0	0.9	1.0	1.1	1.1
Tributary minor	7.0	7.0	7.0	7.0	7.0	7.0
D & I	0	0	0	0	0	0
Sub-total	53.0	58.0	54.0	59.0	62.0	62.0
Muda-Perai						
Kedah						
Main minor	3.0	1.0	2.5	0.8		
Tributary minor	4.0	1.0	4.0	1.0		
D & I	2.0	2.0	2.0	2.0		
Pulau Pinang						
Main minor	3.0	3.0	2.5	2.2		
D & I	0	0	0	0		
Sub-total	12.0	7.0	11.0	6.0	0	0
Total	65.0	65.0	65.0	65.0	62.0	62.0
2000						
Kedah System						
MADA	20.6	42.4	23.3	45.1	41.3	53.2
Main minor	0.6	0.9	0.6	0.9	1.1	1.1
Tributary minor	20.0	7.0	20.0	7.0	20.0	7.0
D & I	1.0	2.0	1.0	2.1	1.9	2.5
Maintenance flow	0.8	1.7	1.0	1.9	1.7	2.2
Sub-total	43.0	54.0	46.0	57.0	66.0	66.0
Muda-Perai System						
Kedah						
Main minor	3.0	1.0	1.5	0.2		
Tributary minor	10.0	1.0	10.0	1.0		
D & I	2.0	2.0	2.0	2.0		
Pulau Pinang						
Main minor	3.0	3.0	1.5	0.8		
D & I	5.0	5.0	5.0	5.0		
Sub-total	23.0	12.0	20.0	9.0	0	0
Total	66.0	66.0	66.0	66.0	66.0	66.0

Remarks; * : Estimate for the previous demand condition.
** : Estimate for the revised demand conditon in the supplemental study.

Table 49 NET WATER OUTPUT AND REMAINING DEFICIT FOR SUPPLEMENTAL STUDY

Unit: 10^6 m^3

	1990		2000	
	Kedah	Muda	Kedah	Muda
Alternative 1				
Target Deficit	354	7	384	12
Jeniang	182		185	
Beris	58	7	54	12
Reman	83		83	
K. Thepha	26		26	
Remaining Deficit	5	0	36	0
Alternative 2				
Target Deficit	354	7	384	12
Jeniang	182		185	
Beris	59	6	57	9
Reman	83		83	
K. Thepha	26		26	
Remaining Deficit	4	1	33	3
Alternative 3				
Target Deficit	354	7	384	12
Jeniang	182		187	
Beris	62		66	
Reman	83		83	
K. Thepha	26		26	
Remaining Deficit	1	7	22	12
Merbok		7		12
Remaining Deficit	1	0	22	0

Table 50 RESULTS OF ECONOMIC EVALUATION OF BERIS DAM FOR SUPPLEMENTAL STUDY

Unit: M$$10^6$

	Alternatives		
	1	2	3
Present Value of Benefit (r = 8%)			
Kedah river system			
MADA	59.33	62.75	73.00
Main minor	1.23	1.23	1.52
Tributary minor	9.58	9.58	9.58
D & I	2.41	2.55	3.01
Maintenance flow	2.04	2.27	2.64
Sub-total	74.59	78.37	89.75
Muda-Perai river system			
Kedah			
Main minor	1.40	0.51	
Tributary minor	1.40	1.40	
D & I	2.80	2.80	
P. Pinang			
Main minor	4.20	1.68	
D & I	5.07	5.07	
Sub-total	14.87	11.46	0
Total	89.96	89.83	89.75
Present Value of Cost (r = 8%)	37.32	37.32	37.32
Net Benefit	52.14	52.51	52.43
EIRR (%)	15.3	15.3	14.9

Remark; r : Discount rate

Table 51 CONSTRUCTION COST ALLOCATION TO AGENCIES CONCERNED FOR SUPPLEMENTAL STUDY

Unit: M$$10^6$

	MADA	Kedah		Pulau Pinang	
		DID	PWD	DID	PWA
Alternative 1	58.72	19.26	6.64	5.12	6.85
Alternative 2	62.44	18.46	6.86	1.95	6.85
Alternative 3	74.58	17.96	4.05	0	0

FIGURES

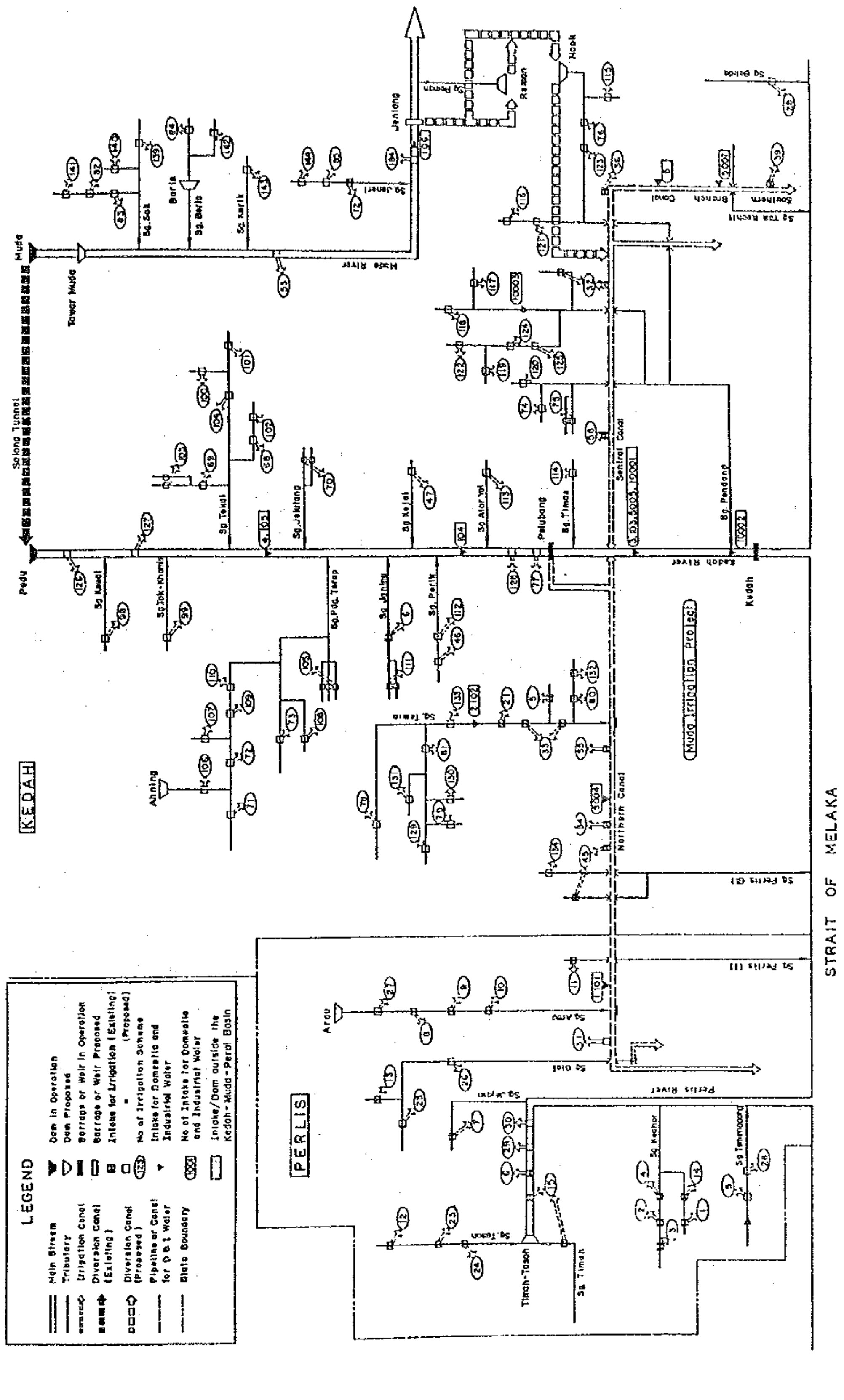

Fig. 1 Water Demand and Supply System Diagram (1/2)

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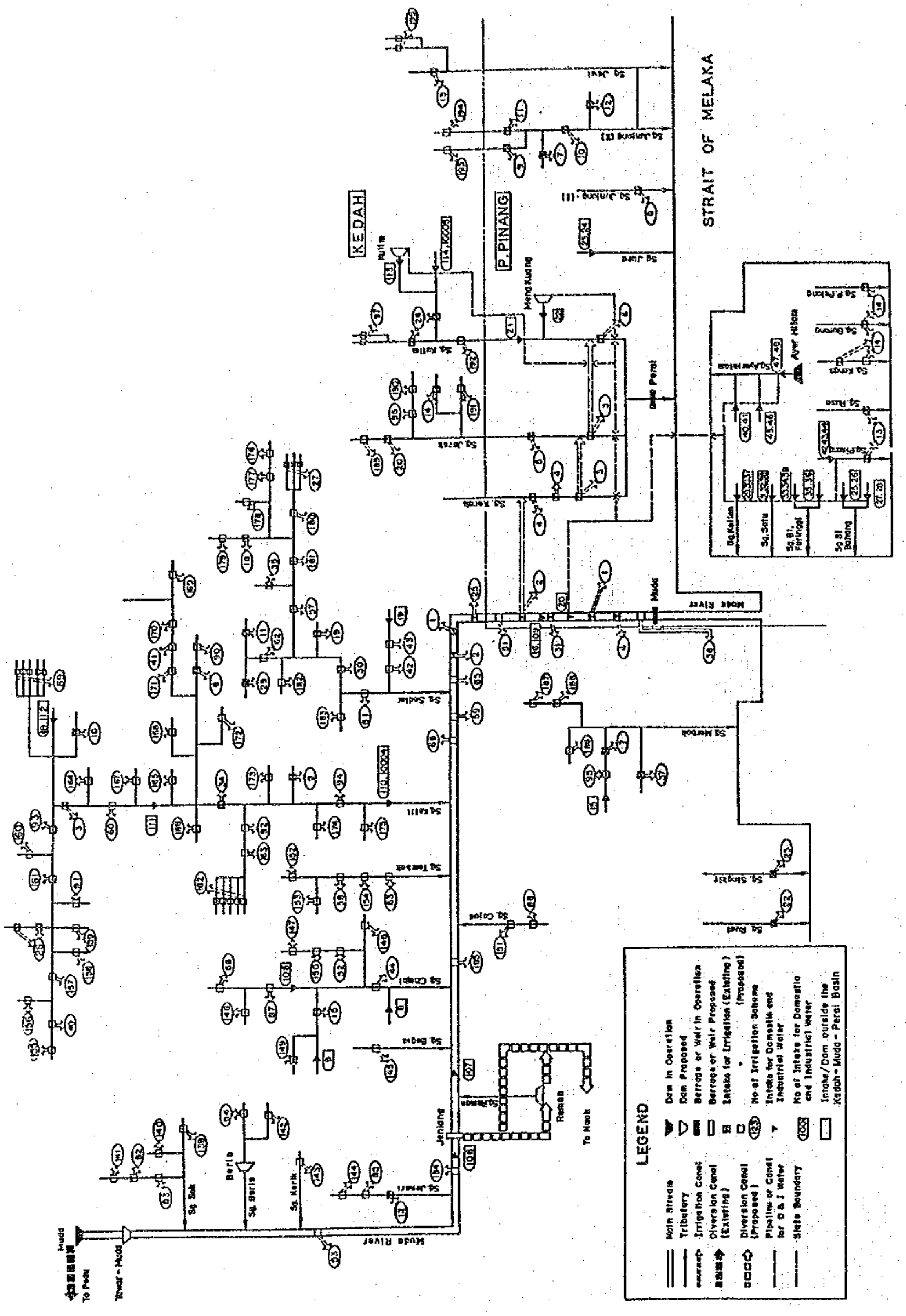

Fig. 2 Water Demand and Supply System Diagram (2/2)

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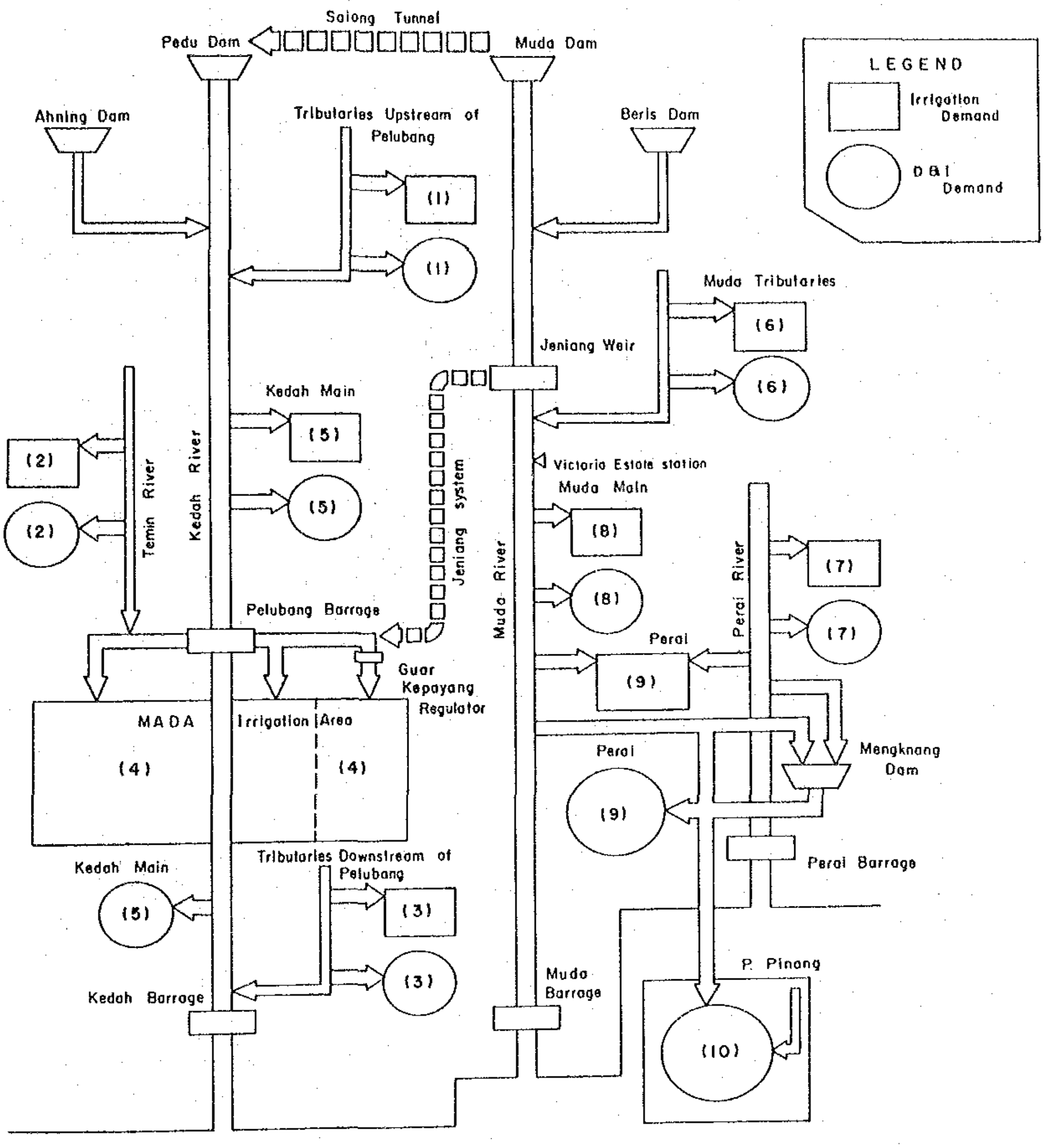

Remarks : Figures between paretheses show item numbers in Table 7.

Fig.3 Simplified Water Demand and Supply System Diagram

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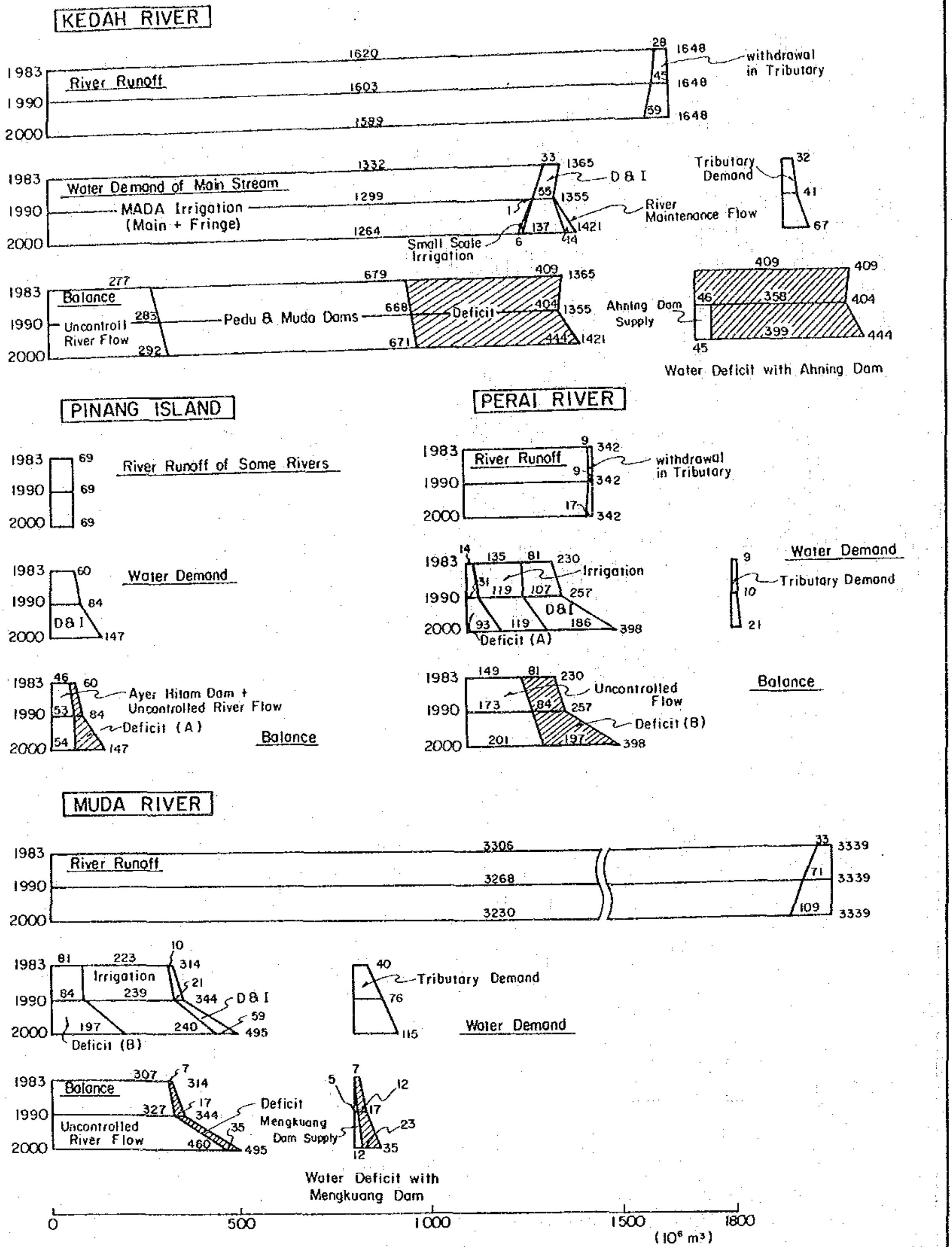

Fig. 4 Water Demand and Supply Balance with Existing and Ongoing Source Facilities

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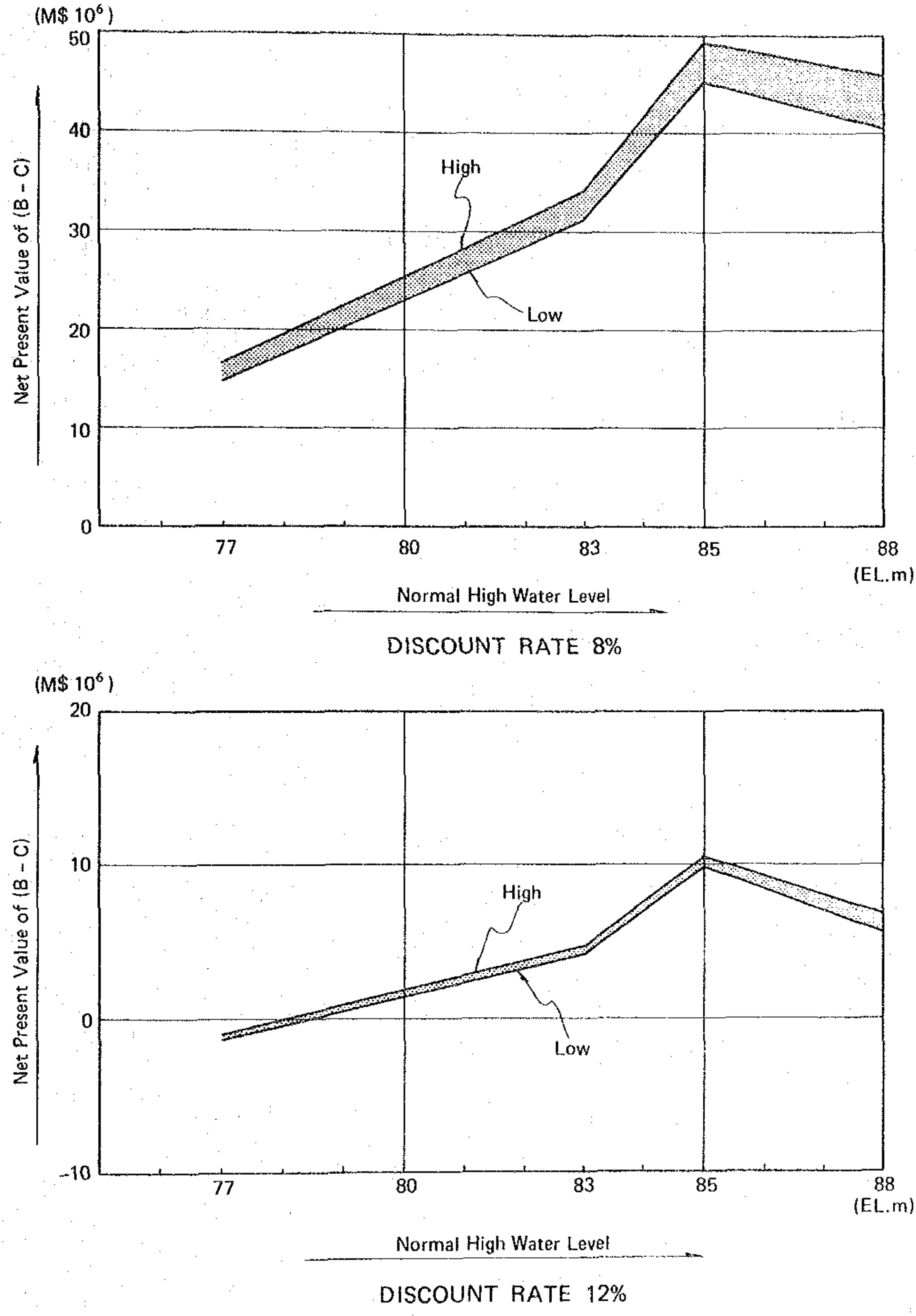

Remarks; 1) High is drawn based on the highest estimate of unit water present value.
2) Low is drawn based on the lowest estimate of unit water present value.

Fig. 5 Relation Between Project Scale and Net Present Value of (B - C)

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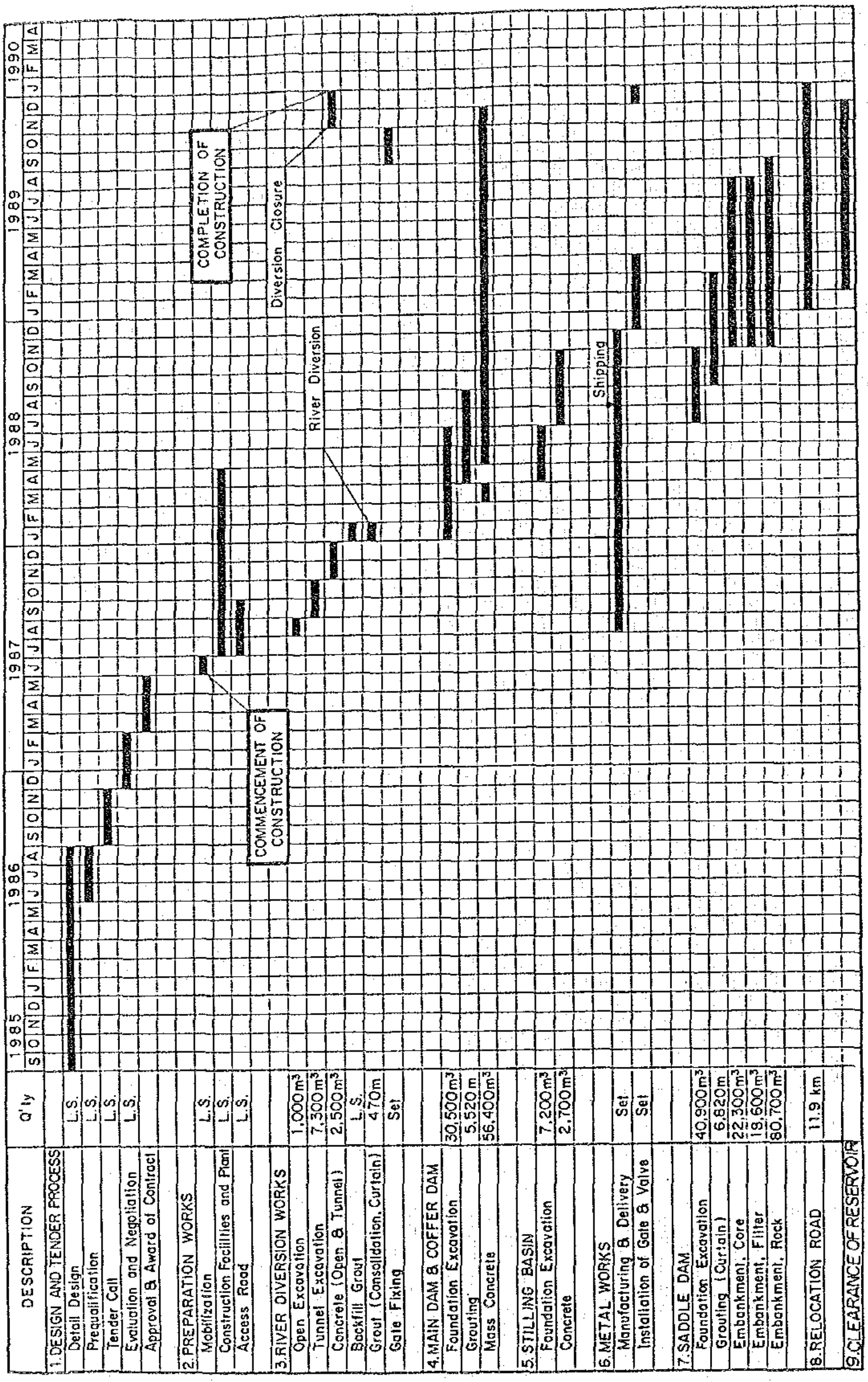

Fig. 6 Construction Time Schedule of The Project

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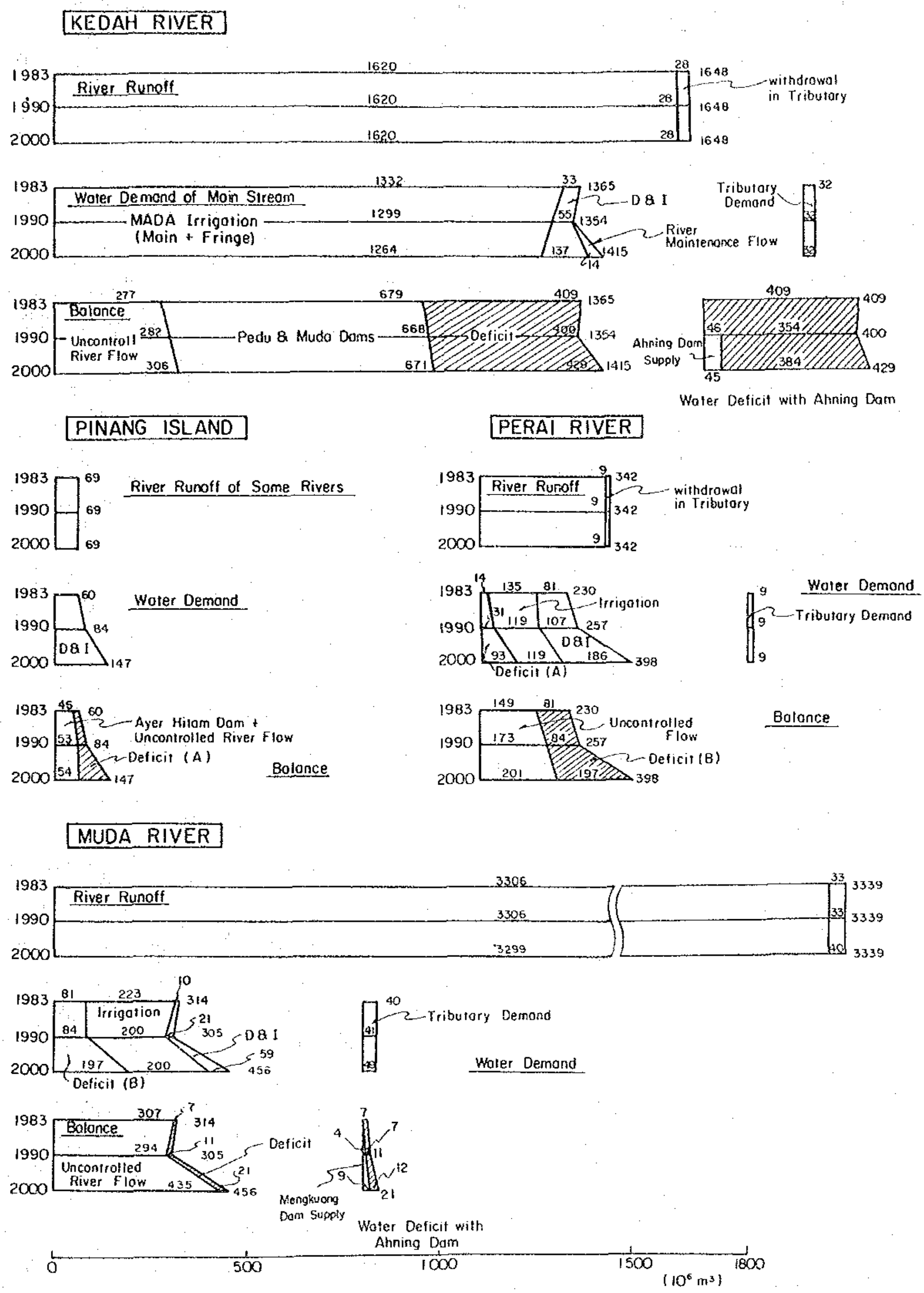

Fig. 7 Water Demand and Supply Balance with Existing and Ongoing Source Facilities for Supplemental Study

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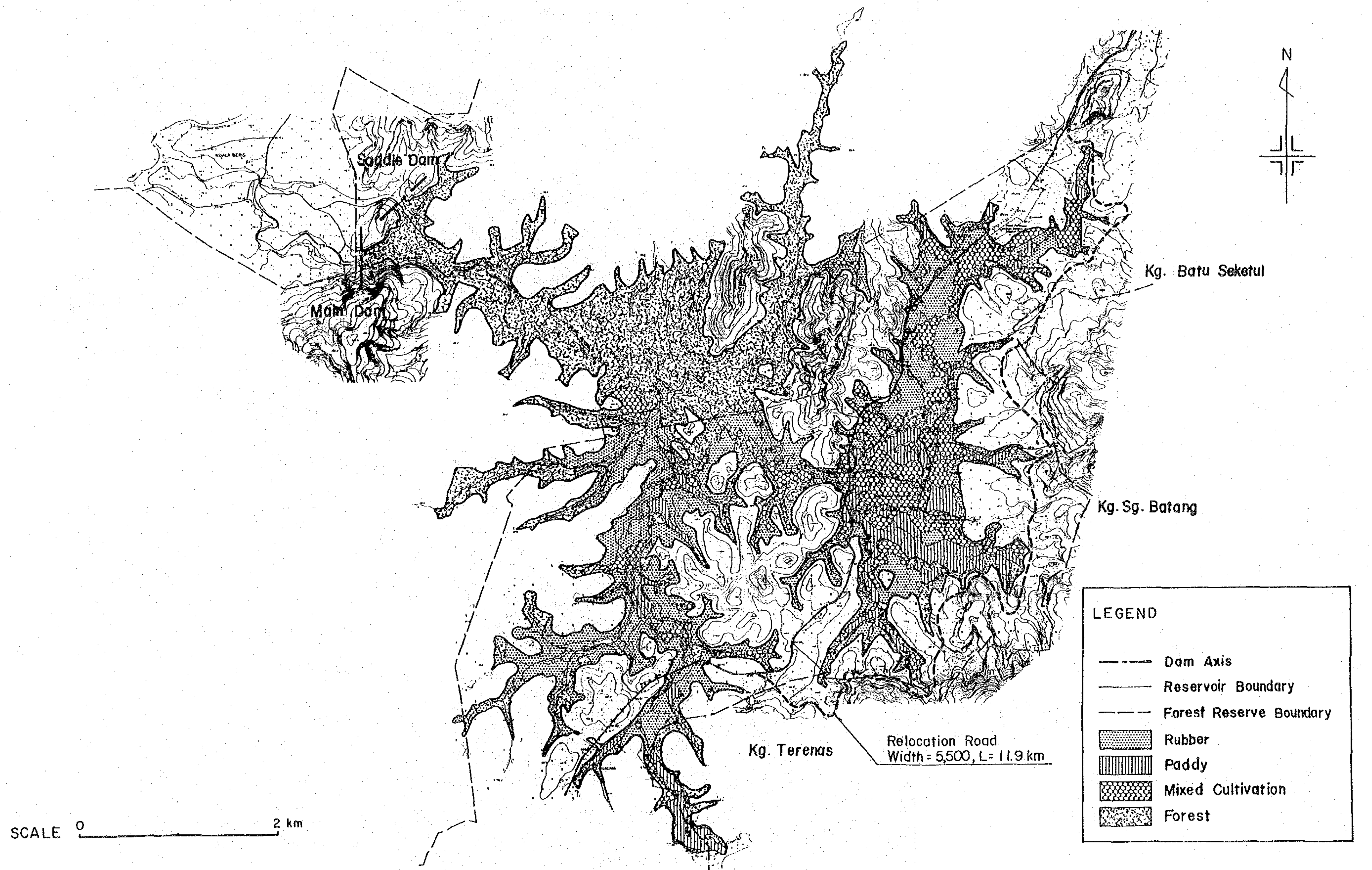
PLATES

PLATE NO. 1



Present Land Use in Proposed Reservoir Area

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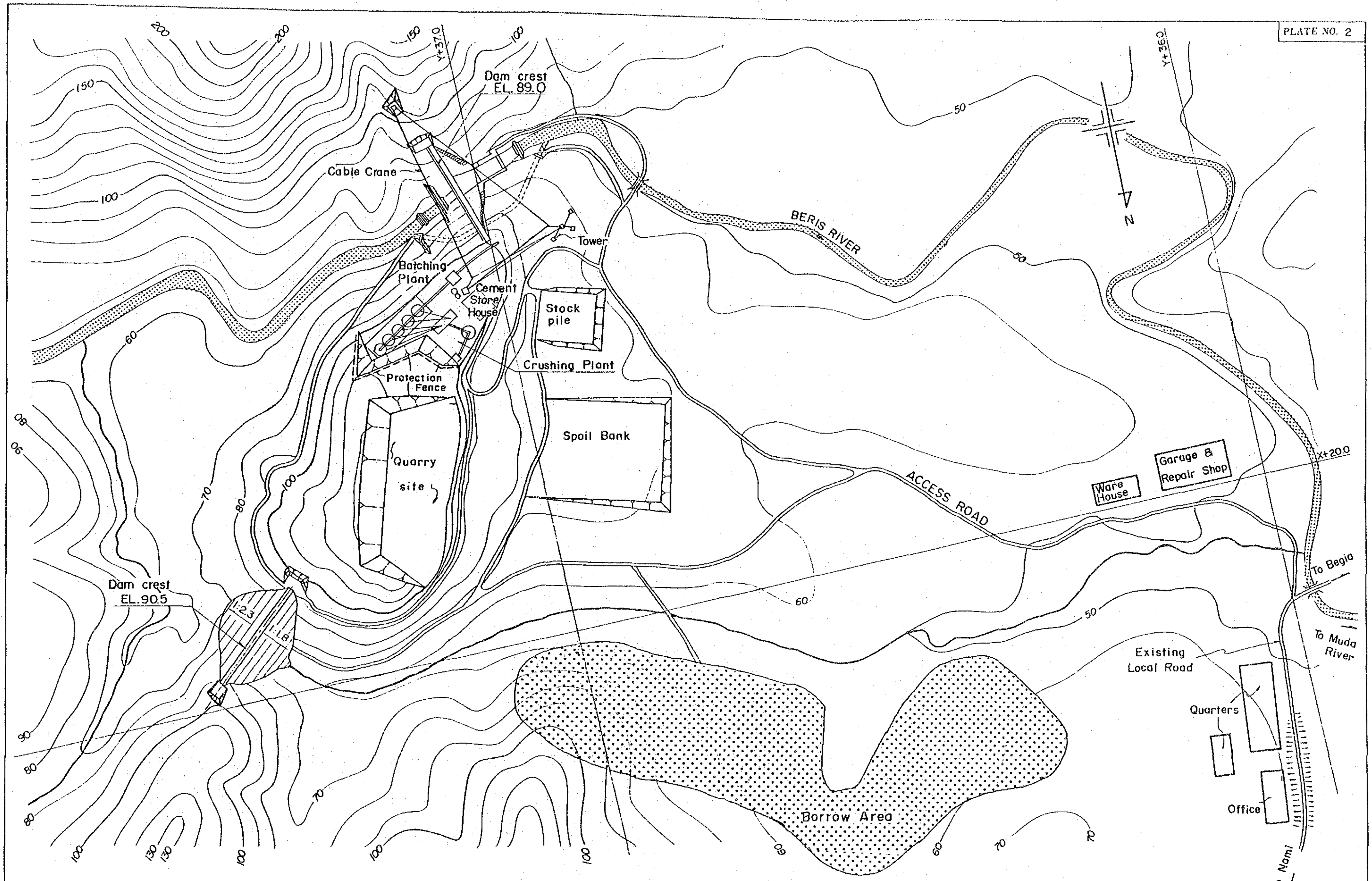
PLATE NO. 2



General Plan of Damsite

SCALE 0 — 500m

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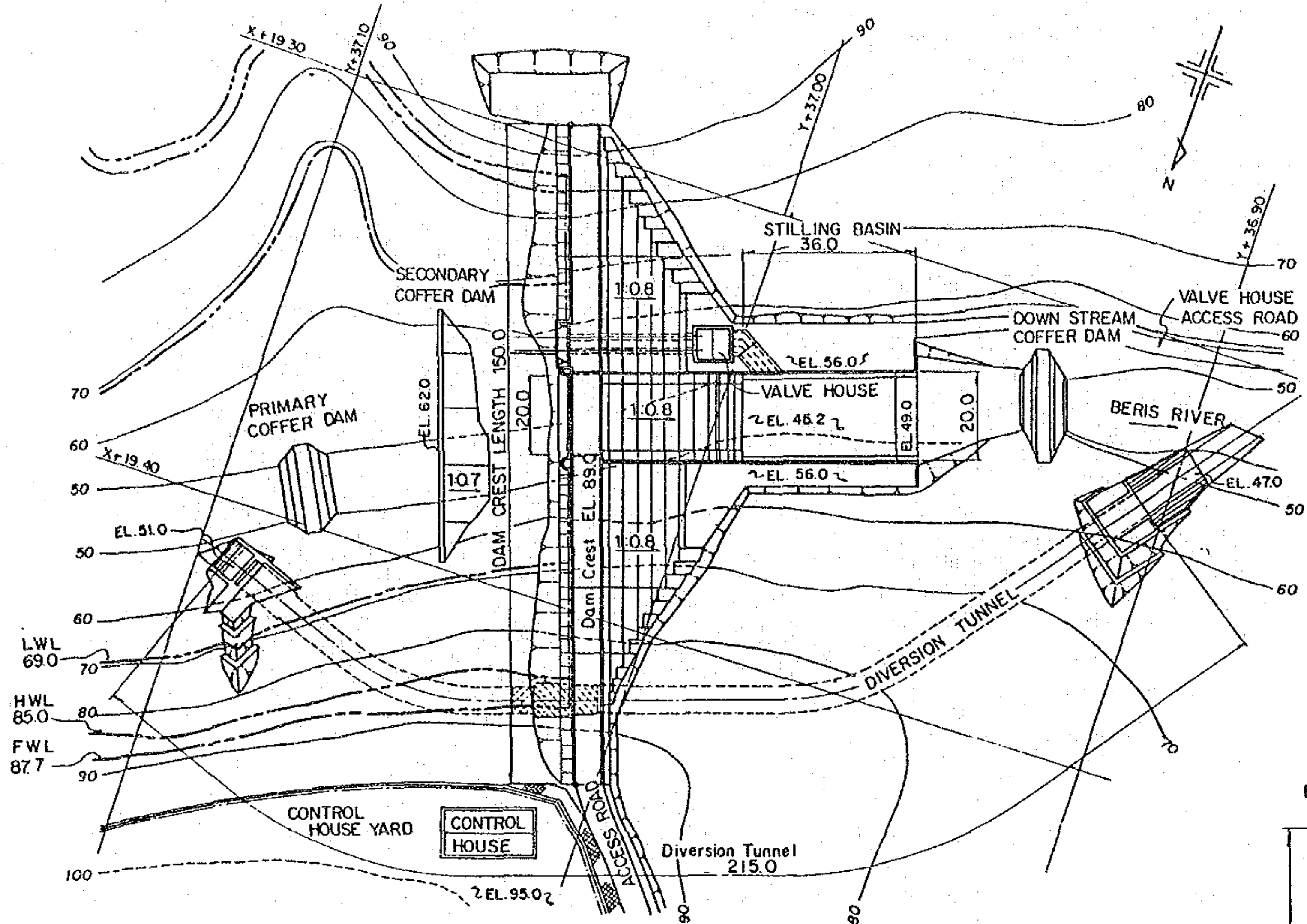
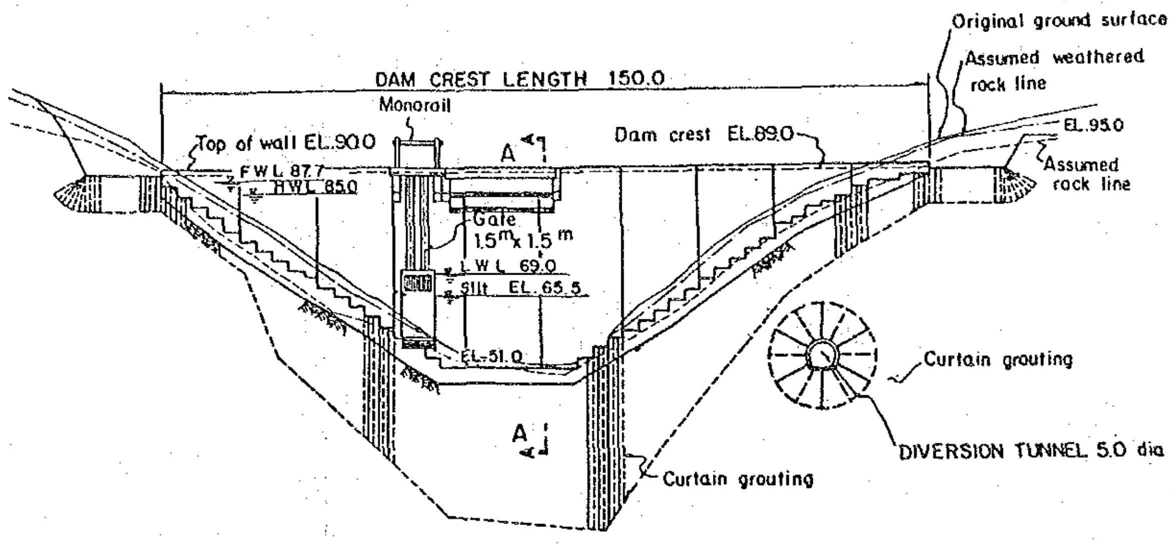
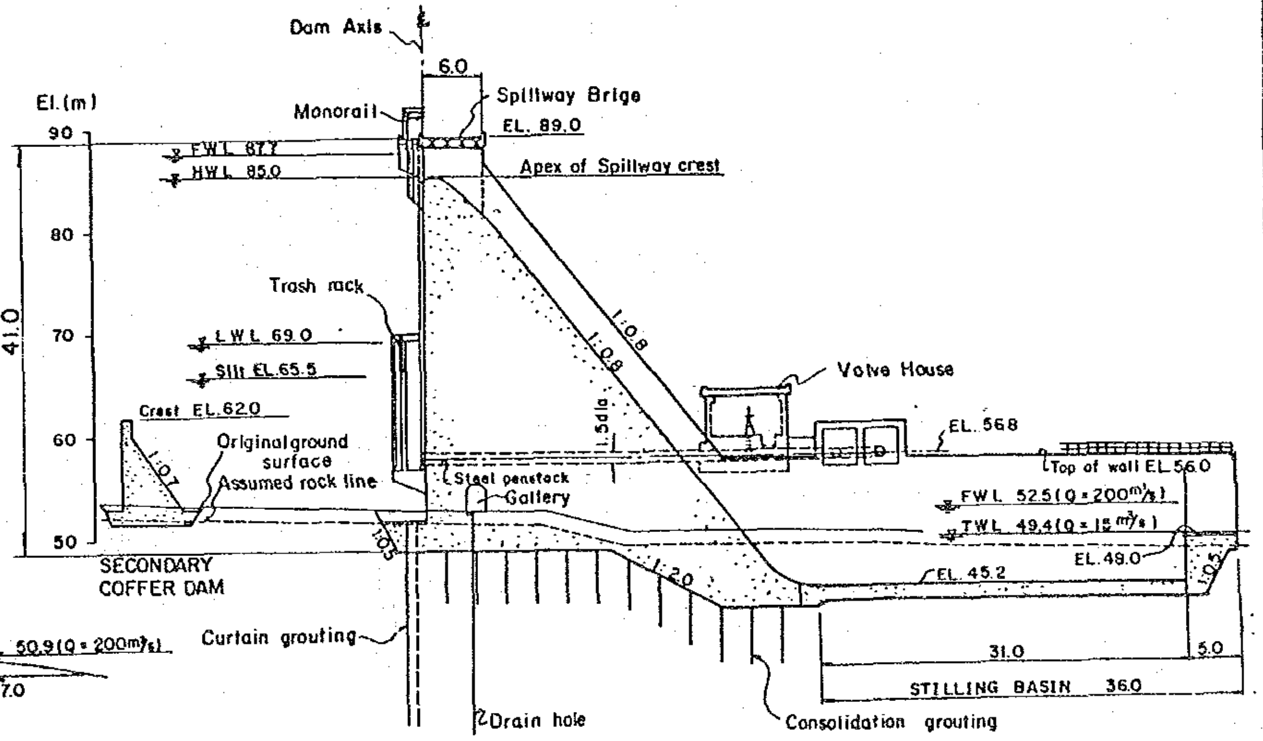
PLATE NO. 3



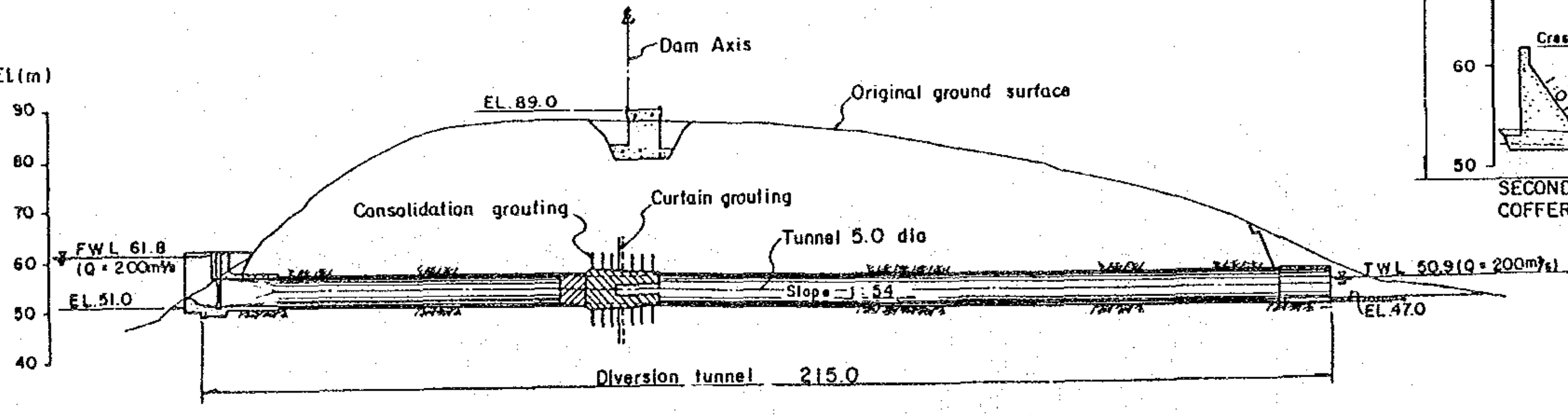
PLAN SCALE A



ELEVATION (UPSTREAM SIDE) SCALE A



SECTION A-A SCALE B



PROFILE OF DIVERSION TUNNEL SCALE A

SCALE A 0 — 100m

SCALE B 0 — 50m

Main Dam

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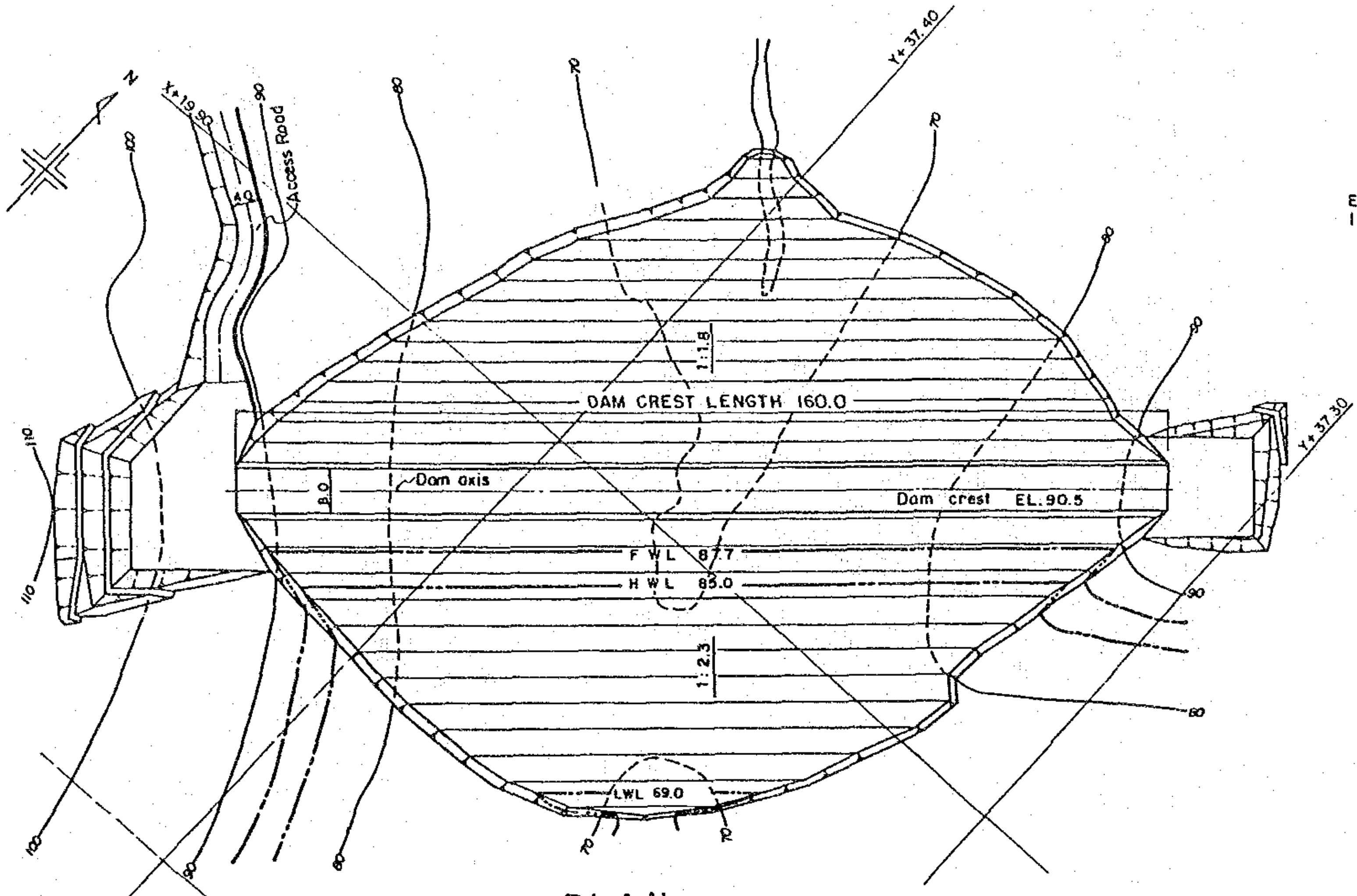
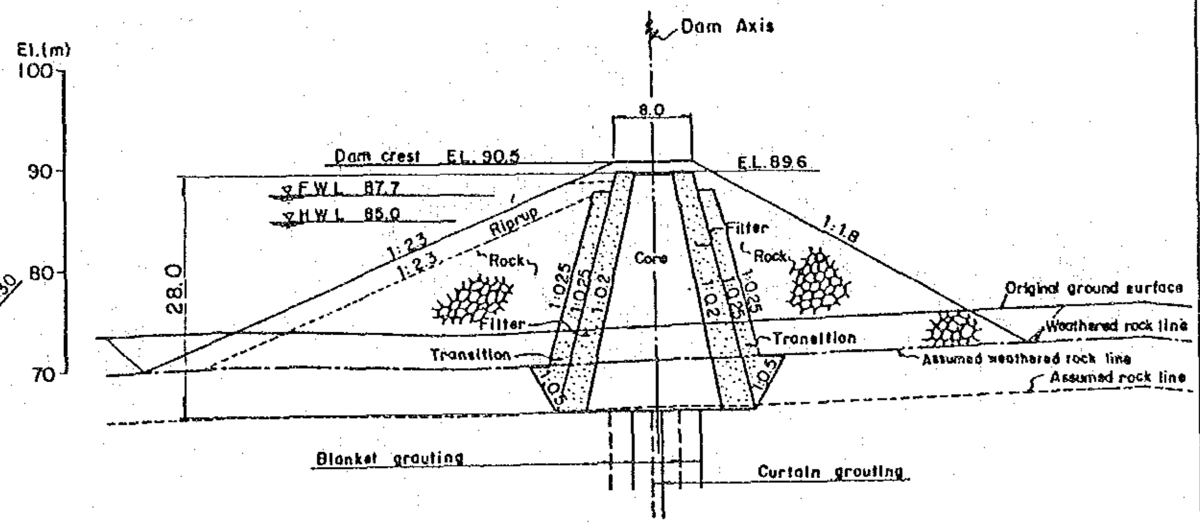
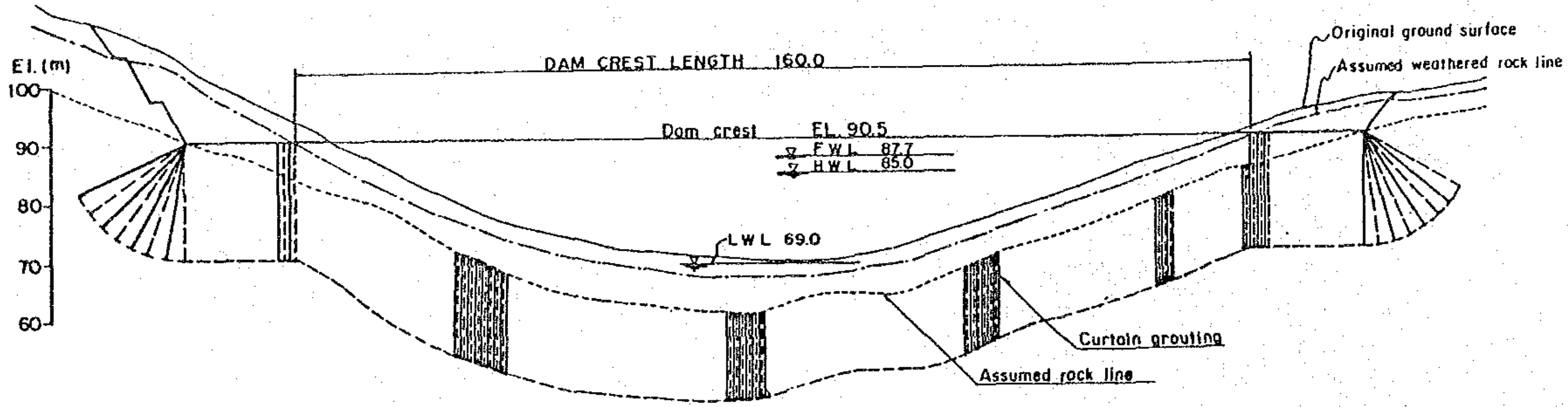
PLATE NO. 4



PLAN SCALE A



SECTION SCALE B



PROFILE SCALE A

SCALE A 0 — 80m

SCALE B 0 — 50m

Saddle Dam

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