ix) Agri-Institution

Establishment of farmers' organization including those for operation and maintenance and the agricultural cooperatives.

For the implementation of the above-mentioned Project Components, necessary construction equipment should be procured, and the appropriate number of consulting engineers and experts should be recruited.

Preliminary Study in the Field Survey

20. Preliminary feasibility study on Agricultural Development Project with Widening of Pat Feeder Canal has been made in Pakistan during the field survey for around 10 weeks from the middle of February to the end of April, 1982. The preliminary study was made on two alternative of Case-1 (available water of 8,200 cusec) and Case-2 (available water of 6,700 cusec) based on the Agreement (S/W) concluded between the Ministry of Finance, Planning and Economic Affairs, the Government of Pakistan and the Japan International Cooperation Agency, the Government of Japan, on January 23, 1982.
The study on Case-1 was made based on the availability of water of 8,200 cusec throughout the year. Widening of Desert Pat Feeder and Pat Feeder Canals and distributaries, construction of minor canals and development of on-farm facilities were scheduled according to the peak water requirement estimated based on the proposed cropping pattern. Likewise, the study on Case-2 was made based on the availability of water of 6,700 cusec and the relevant civil works and development programme were planned by the capacity at the peak stage of the water requirement in the proposed cropping pattern.

Feasibility Study Made During the Home Office Work

21. Through various discussions and meetings on the preliminary study presented in the Interim Report, the feasibility study for the development of the Project was carried out as the home office work. In addition to the Case studies with Case-1 and Case-2 that were referred to in the former paragraph, Case-3 and Case-4 were taken up for a thorough study of the availability of water, especially in Rabi season. The Case-3 was discussed based on the available water of 8,200 cusec in Kharif (Summer) and dependable water in Rabi (Winter) while the Case-4 is studied based on the available water of 6,700 cusec in Kharif and dependable water in Rabi. The irrigation facilities for both Case-3 and -4 were designed in considering the peak water requirements appearing in Kharif.

Results of the Alternative Studies

22. The results of the aforementioned alternative studies show that the cropping intensity of the Case-1 in Kharif and Rabi is 60 per cent and 95 per cent, respectively, resulting in the total cropping intensity of 155 per cent, while in the Case-2, the cropping intensity in Kharif and Rabi is 50 per cent and 80 per cent, respectively, totaling 130 per cent. From an engineering point of view, it is obvious that the Case-1 development would be more beneficial than the Case-2. However, the development plans of both the Cases-1 and -2 have physical difficulty regarding the availability of water in Rabi season, because availability of water of 8,200 cusec and 6,700 cusec is considered throughout the year for the alternative study of Cases-1 and -2.

Although the Agreement of the Study for the Project (S/W) refers to the availability of water, the water balance study on the Indus River at Guddu Barrage is roughly carried out and the studies of Case-3 and Case-4 show that the cropping intensity in Kharif and Rabi will be able to propose at 60 per cent in the both seasons resulting in the total cropping intensity of 120 per cent for Case-3, and the cropping intensity in Kharif and Rabi is 50 per cent and 60 per cent, respectively, resulting in the total cropping intensity of 110 per cent for Case-4 in consideration of available water of Guddu Barrage for the Project.

The development scheme of the Case-3 and Case-4 are found technically sound and economically viable.

Staged Development Plan

23. As per conclusion of the meeting held between the Government of Pakistan and the JICA Mission on the Draft Final Report, the supplementary study on the Staged Development Plan is made assuming that the existing Rabi supplies and the Kharif cropping pattern are so adjusted that the peak water requirements occur in July and August.

As seen in the Supplementary Study attached in the Appendix, the cropping intensity of Kharif and Rabi is designed at 54 per cent and 23.7 per cent, respectively, resulting in the total cropping intensity of 77.7 per cent for the Staged Development Plan.

Irrigation Plan

24. Reference crop evapotranspiration, ETo is estimated by using these methods; Blaney-Criddle method, Radiation method and Pan-evaporation method. As a result, the ETo estimated by Pan-evaporation method among them would be applied to the Project, because annual ETo and monthly peak ETo are higher than the others.

25. The estimation of the water requirements employed the canal losses by seepage, evaporation, operation, etc. for the Main Canal, Distributaries and Minor Canals at the rate of 15 per cent, 10 per cent and 10 percent, respectively, resulting in conveyance efficiency between the head regulator and the Outlet (at the head of the Water Courses) of 68.9 per cent.

On the other hand, for the field canal and application efficiency, the canal losses of the water courses and application losses at the on-farm are applied by 10 per cent and 20 per cent, respectively, resulting in the field canal and application efficiency of 72 per cent. On the basis of the above criteria, the Project efficiency was estimated at 49.6 per cent.

26. According to the calculation of the total water requirement on the 10-day basis, the peak demand is expected in the third decade of September in any cases except the Staged development plan.. The peak demand water allowance which is the water amount to be delivered to the farm by the outlet was calculated at 9.23 cusec, 7.54 cusec, 9.23 cusec and 7.54 cusec per 1,000 acres for Case-1, Case-2, Case-3, and Case-4, respectively. The annual total water requirements at the outlet including requirements of drinking water were estimated at 2.343 million acre-feet (MAF), 2.026 MAF, 2.033 MAF and 1.788 MAF for cases 1, 2, 3 and 4, respectively.

Drainage Plan

27. Since the Pat Feeder Canal crosses the Kachhi plain from east to west, the flood from the hilly land located at the northern Kachhi plain has attacked the Pat Feeder Canal. For the prevention of the flood damages, the following four methods can be considered.

i) To construct the cross drain and to introduce the flood into the Project Area,

ii) To construct the drain inlet and to introduce the flood into the Pat Feeder,

iii) To strengthen the right bank of Pat Feeder Canal to suit the flood and to introduce the flood toward the downstream, and

iv) To store the flood in the hilly side to spread it.

Taking into consideration the construction cost, construction period, construction method and so on, the above iii) is proposed for the prevention of the flood damages.

Proposed Facilities

28. The existing irrigation system of the Pat Feeder Canal Project is composed of the Desert Pat Feeder Canal, the Pat Feeder Canal and 13 Distributaries. The alignment of those Main Canals and Distributaries would be maintained, however, in order to secure effectiveness of water management and reduce of water losses in the Water Courses, Minor Canals should be constructed in off-taking from the Distributaries so as to decrease the length of the Main Course.

In general, an intensity of main and lateral/secondary canals in the irrigation system were discussed on their length of canals per unit irrigable area ranging from 10 ft to 20 ft in length per acre. In contrast, the existing Pat Feeder Canal System has a canal intensity of 2.9 ft per acre resulting from large size of a chak and long Main Water Course.

In order to carry out proper water management, size of a chak should be maintained at reasonable magnitude and Minor Canals of 4,080,000 ft in total length, equivalent to 6.7 ft per acre, is proposed.

29. Provision of the terminal on-farm facilities such as water courses, farm drains, and farm roads are essential works to execute the irrigated agriculture including farm mechanization, and in this work farmers' eagerness for agriculture will act as the prime mover. With their support, the rationalized land parcelling and land allocation will be materialized, which are the prerequisites to upgrading the agriculture. Thus, the modernized irrigation and drainage systems as well as new organization for farm management will be established at an early stage.

30. The Guddu Barrage was constructed across the Indus River at Guddu in 1963, incorporating a head regulator with a design discharge of 13,139 cusec (371.8 cu.m/sec) for diversion to the Desert Pat Feeder Canal on the right bank of the Indus in Sind and Baluchistan Provinces. Although the PC-1 in 1979 estimated the intake discharge to be 17,100 cusec (483.9 cu.m/sec) at normal pond level of 255.5 ft, it was calculated at 17,300 cusec (489.1 cu.m/sec) provided that a head loss of 0.8 ft is kept as constant by the survey team.

In order to pass design discharge of 17,300 cusec (489.1 cu.m/sec) for the Case-1 & and -3 into the Desert Pat Feeder Canal, a head loss of 0.05 ft at the Head Regulator of Guddu Barrage should be increased by total 0.85 ft. It is negligibly small increase in the head loss; however, the necessary head at the head of the Desert Pat Feeder Canal should be kept by lowering a water level of 0.05 ft from the original water level.

31. The existing Desert Pat Feeder Canal with 7.0 miles (11.3 km) in length, 15.5 ft (4.72 m) in water depth and 240 ft (73.2 m) in bed width has a capacity of 13,748 cusec (389.1 cu.m/sec) and diverted at the end of the canal into the Desert Canal and the Pat Feeder Canal covering irrigable area in Baluchistan and Sind Provinces.

Widening of the Desert Pat Feeder Canal will be made in such manner that the right bank of the canal will be expanded to a canal bed width of 285 ft (86.87 m) with a water depth of 15.5 ft (4.72 m) and hydraulic gradient of 1:15,000, the same ratio as PC-1.

The right bank of the Desert Pat Feeder Canal should be expanded because Begari Sind Feeder Canal is running in parallel with the Desert Pat Feeder Canal at the left bank which obstructs the canal from its expansion at this side.

32. Widening of the existing Pat Feeder Canal for the portion between R.D 0 and R.D 586 will be made and the canal will be extended up to R.D 624. The Pat Feeder Canal has a total length of 118.20 miles (190.20 km) with a designed discharge of 11,000 to 1,960 cusec (311.2 to 55.47 cu.m/sec) in Case-1 and Case-3 and 9,500 to 1,602 cusec (268.9 to 45.3 cu.m/sec) in Case-2 and Case-4.

To reduce the seepage of the canal at the portion of high embankment with sandy soil, brick lining is proposed with a total length of 42,000 ft (12.8 km) from R.D 185 to R.D 190, from R.D 224 to R.D 235, and from R.D 292 to R.D 318.

In considering the existing canal structures such as Head Regulator, Cross Regulator and Offtake, the proposed full supply level is designed to keep a differential of one tenth of one foot compared with the present one.

Canal structures are composed of Head Regulator, Cross Regulator, Plain Fall, Cross Drainage and Offtake, and most of these structures will be expanded to meet the requirements for the widening programme. In depend on the arrangement of the existing structures, some of the canal structures will be newly constructed. Design of the canal structures is made based on the locally prevailing criteria with indigenous materials, which should be examined from the engineering and economical point of view.

33. The traffic system in the Project Area, which is the road networks and road bridges, is very poor. At the center of the Project Area, the national road, Quetta - Sibi - Jhatpat - Karachi, is running through North to South and the other national road, Jacobabad - Guddu Barrage, is one of the trunk road in the Area. The service roads along the Main Canal and Distributaries together with the above-mentioned two national roads are only traffic system available in the Project Area and the national roads are the metalled roads and others are slippery clayey roads. For about a week after raining, the said clayey road are not available for traffic.

The completion of the Project will greatly increase the traffic in its volume with rapid increase in the volume of farm inputs and outputs to be transported. In addition to the two national roads, the service road along the Main Canal will be improved with metalled road with 20 ft width of asphalt pavement in a distance of 73.3 miles (118 km) at RD 238 to RD 625.

The service roads along the Distributaries, 217 miles (349.2 km) in length, and the connecting road between the end of each Distributary and the national road, 35 miles (56.3 km) in length, would be provided by gravel pavement with 10-ft width, and utilized as trunk road of the Project Area supplementarily to the service roads along the Main Canal and National Road.

34. The proposed on-farm facilities are the main, internal and link water courses, farm drain and small structures such as nakka, division box, etc. All water courses will be constructed with earth.

In order to give a shape to the concept of the proposed on-farm facilities, the model design of irrigation and drainage canals as well as land parcelling was carried out for one sample area. Furthermore, the required costs for in on-farm development were estimated on the basis of this sample area, and their results were applied to designing the on-farm development works in the whole Project Area. The construction, operation and maintenance of the on-farm facilities are required to be undertaken by the land owners in basing on this model.

Proposed Agricultural Development

35. As for agricultural development, according to the farmers' intention, the government's policy and crop selection criteria, the following crops have been selected for future cropping:

In Kharif (summer), sorghum, paddy, sesamum and pulses (mungbean, mash etc.) have been included, while for Rabi (Winter), wheat, rapes and mustard, pulses (gram, lentil, etc.) and fodders (berseem) have been selected. Besides these crops, sugarcane, respective Kharif and Rabi vegetables and orchards like citrus, mango, and guava are also proposed to be raised at five per cent of command area as a whale. As a result, cropping intensity for Case-1 (8,200 cusec) is 60 per cent in Kharif and 95 per cent in Rabi, totally 155 per cent, while for Case-2 (6,700 cusec) they are 50 per cent, 80 per cent and 130 per cent, respectively. As for the recommendable development, the Case-3 (8,700 cusec) is proposed with cropping intensity of 60 per cent both for Kharif and Rabi while the Case-4 (6,700 cusec) is 50 per cent in Kharif and 60 per cent in Rabi, totally 110 per cent.

36. The agricultural development is a complex business. A great deal of money, efforts and time will be consumed by seizing on one or the other single problem as panacea for all the ills of agriculture. A harmonious combination of all inter-related factors such as experiments, research, extension, production credit, storage and marketing with full support from the public as well as the private sectors is a must for speedy development of the agriculture.

The link between the experiments or research and productive practices of farmers is not so tight. The results of a study or research are very hard to apply in the field by farmers themselves. It is natural that, experiments and research should be continued by respective expert of the field concerned for further development of agronomical science. For linkage of the above two, researchers and farmers, there is a need to establish the Trial Farm (Applied Research) as closely to the farmers fields as possible. Experiments in the Applied Research such as selection test of crops to be introduced into the Project Area, comparative yield study with several applications of irrigation, fertilizer trials and chemical spray, practice of new farming techniques and so on, should be carried out on the Trial Farm (Applied Research).

Pilot Project

37. The Pilot Project includes the following programmes as agricultural supporting services to secure successful farm production in "After Project" of the Agricultural Development Project with Widening of Pat Feeder Canal.

a) A Trial Farm (Applied Research Farm) will be provided in the Pilot Project and various applied researches will be conducted under proper water management and selection of suitable variety of crops.

b) The modern mechanized farming will be demonstrated and the extension services will be rendered regarding the mechanized farming techniques.

c) The modern irrigation facilities will be constructed in the Pilot Project and study on design criteria for such facilities for the future reference and practice on operation and maintenance of the facilities will be carried out.

d) Intensified extension services and training of farmers will be given regarding the improved techniques of irrigated agriculture.

Implementation Schedule

38. The study on construction schedule was carefully made taking into account the work volume and the total amount of the Project cost, and as the result, the construction period of three years for Stage-I and Stage-II, each starting from September 1985 and September 1987, has been scheduled, sparing other periods for detailed design and tendering and the Pilot Project.

Consulting Services

39. The consultants' engineering services are proposed for effective execution of the final detailed design, design and supervision of the Pilot Project, and Supervision of the Stage-1 and -II of the Project, the proposed consultants man-months for which are 242, 98, 267, and 258 man-months, respectively, including foreign and local consultants.

Project Cost

40. The total investment cost including the cost for price escalation during the implementation period was estimated at Rupees 2,165 million (US$196.82 million) for Case-1 and Case-3 (Discharge 8,200 cusec) and at Rupees 1,892 million (US$172 million) for Case-2 and Case-4 (Discharge 6,700 cusec) while the investment cost for the Stage Development Plan was estimated at Rupees 1,389 million (US$126.28 million). Those costs are not included the interest on capital investment during construction.

The summary of the investment cost of the Project is illustrated as follows:

Description	Case-1 & 3 (8,200 cusec) Rs. '000	Case-1 & 3 (8,200 cusec) US$ '000	Case-2 & 4 (6,700 cusec) Rs. '000	Case-2 & 4 (6,700 cusec) US$ '000	Staged Development Plan (6,700 cusec) Rs. '000	Staged Development Plan (6,700 cusec) US$ '000
A. Pilot Project						
1. Project Cost	85,299	7,750	85,299	7,750	-	-
2. Contingency	12,701	1,160	12,701	1,160	-	-
3. Price Escalation	15,000	1,360	15,000	1,360	-	-
Total (1 to 3)	113,000	10,270	113,000	10,270	-	-
4. Interest at 8% ann.	10,000	910	10,000	910	-	-
Total (1, 2 and 4)	108,000	9,820	108,000	9,820	-	-
B. Stage-I						
1. Project Cost	617,223	56,110	469,847	42,720	438,731	39,890
2. Contingency	79,777	7,250	63,153	5,740	57,969	5,270
3. Price Escalation	237,000	21,550	187,000	17,000	169,300	15,390
Total (1 to 3)	934,000	84,920	720,000	65,460	666,000	60,550
4. Interest at 8% ann.	139,000	12,640	109,000	9,910	99,800	9,070
Total (1, 2 and 4)	836,000	76,000	642,000	58,370	596,500	54,230
C. Stage-II						
1. Project Cost	585,010	53,180	553,134	50,280	382,075	34,730
2. Contingency	86,990	7,910	82,866	7,530	57,025	5,190
3. Price Escalation	446,000	40,550	423,000	38,460	283,900	25,810
Total (1 to 3)	1,118,000	101,640	1,059,000	96,210	723,000	65,730
4. Interest at 8% ann.	169,000	15,370	160,000	14,550	112,700	10,250
Total (1, 2 and 4)	841,000	76,460	796,000	72,360	551,800	50,170
Grand Total						
1. Project Cost	1,287,532	117,040	1,108,280	100,750	820,806	74,620
2. Contingency	179,468	16,320	158,720	14,430	114,994	10,460
3. Price Escalation	698,000	63,460	625,000	56,820	453,200	41,200
Total (1 to 3)	2,165,000	196,810	1,892,000	172,000	1,389,000	126,280
4. Interest at 8% ann.	318,000	28,920	279,000	25,370	212,500	19,320
Total (1, 2 and 4)	1,785,000	162,280	1,546,000	140,550	1,148,300	104,400

Note : (1) Total (1 to 3) is not included the interest while total (1, 2 and 4) is included the interest but price escalation.
(2) Exchange rate : 1US$ = Rupees 11.00

Project Implementation and Operation

41. Since the major works included in the Project are excavation of the Desert Pat Feeder Canal, the Pat Feeder Canal, Distributaries and Minor Canals with considerable amount of earth moving volume, the Contract basis implementation of the Project is recommended to be made under the supervision of the Government Agency with assistance of the Consultants.

The Project Steering Committee should be organized by the representatives of the Governmental agencies concerned with the Project for smooth project execution. The Committee will make a good coordination among the related Departments and Authorities concerned and requests them to extend their assistances and advices directly or indirectly to the Project and also the committee will give advices to the Project from the administrative point of view.

Although the Federal Government should appoint a governmental agency as an executing agency for the implementation of the Project, the WAPDA is recommended as an agency for the purpose under the supervision of the Irrigation and Power Department of Baluchistan and the Consultants.

The Project Manager is fully responsible to execute the Project works in keeping a close coordination among related Departments and Authorities concerned.

42. As for the basic conception to the organization of the operation and maintenance of the Project, the existing organization should be respected to adopt to the Project. In case of the irrigation, it is proposed to increase the offices and staff in numbers in the sub-divisions, and to provide transportation facilities and communication equipment sufficiently. On the other hand, it is proposed to strengthen the extension services

for the farm management. Especially, there is a necessity to provide the committee so as to establish a close relationship between the irrigation and the agriculture in the Project.

Project Justification

43. The economic feasibility of the Project has been examined by employing the Internal Economic Rate of Return (IERR) method by discounting two series of benefits and costs. The IERR is the rate at which a difference between the present worth of benefits and costs is zero. The direct benefits of the Project are defined as the increase in final agricultural production attributable to the work carried out.

Taking into consideration the foregoing assumptions and 50-year evaluation period, the IERR are estimated at 16.0 per cent and 14.6 per cent for Case-3 and Case-4, respectively, which is considered feasible from the fact that the opportunity cost of capital in Pakistan is regarded as 11 to 15 per cent.

B. CONCLUSION

1. The Project Area and its neighborhood have been left behind the progress up to present. Consequently, the population density of the Area is lower than the average in the Province of Baluchistan as a whole. There might be many reasons to be accounted in this regard, but one of the major reason will be the absence of water resources available for irrigated agriculture under the prevailing conditions as well as such agricultural infrastructural facilities required for rationalized farming, as irrigation and drainage canals and on-farm facilities, which results in no opportunities of employment and low farm income.

   To cope with these present status, the Government is proposing the strategy for development in long term, especially putting emphasis on the integrated agricultural development with irrigated agriculture in the Area.

2. The Project aims to increase agricultural production in the Project Area by more effective use of the Indus River flows available at the existing Guddu Barrage, create the employment opportunities throughout the year, and improve the living environment from the viewpoint of the rural development through the provision of assured irrigation water with improved agricultural supporting services and road system.

   The main works of the Project are widening of the Desert Pat Feeder and the Pat Feeder Canals, improvement of Distributaries, improvement or construction of Minor canals and establishment of the Pilot Project.

3. The proposed scope of the Agricultural Development Project with Widening of the Pat Feeder Canal is, as a conclusion of the feasibility study, judged as follows:

Project Area

Cultivable Commanded Area (CCA) 612,000 acres (248,000 ha)

Proposed Cropping Area

	Case-3	Case-4
Kharif Crops	367,200 acres (60%) (148,700 ha)	306,000 acres (50%) (123,800 ha)
Rabi Crops	367,200 acres (60%) (148,700 ha)	367,200 acres (60%) (148,700 ha)
Total	734,400 acres(120%) (297,400 ha)	673,200 acres(110%) (272,500 ha)

Canals

Main Canals		
Desert Pat Feeder Canal	7.00 Miles	(11.28 km)
Pat Feeder Canal	118.20 Miles	(190.20 km)
Total	125.20 Miles	(201.38 km)
Distributaries		
15 Distrys	236.97 Miles	(381.36 km)
Minor Canals		
Minors	772.78 Miles	(1,243.63 km)
Total Canals Length	1,134.95 Miles	(1,826.47 km)

4. The proposed scope of the Staged Development Plan in separating engineering works from the agricultural development is as follows:

Project Area

Cultivable Commanded Area (CCA)	612,000 acres (248,000 ha)
Proposed Cropping Area	
Kharif Crops	330,500 acres (54.0%) (133,700 ha)
Rabi Crops	145,000 acres (23.7%) (58,700 ha)
Total	475,500 acres (77.7%) (192,400 ha)

Canals

The same canal length with plans of Case-3 and Case-4.

C. RECOMMENDATIONS

1. Water Resources

As far as the water resources for the development project in the Indus River Basin are concerned, the Government of Pakistan is controlling the water distribution to meet the demands among the projects by itself through the Indus River Apportionment Commission. It is considered that the Commission is an authority to arrange the water right of the Widening of PAT FEEDER CANAL PROJECT in consideration with other development projects at downstream of Tarbela and Mangla dam.

It is recommended that the said commission should confirm as soon as possible to give the guarantee of the water right for the Project.

2. Soils

1) Jhatpat Soil Associations, SiC in Texture, occupying around 80 per cent of the whole Area should be further surveyed since most of the extent rather showed different textures from those of SiCl or SiL. This will produce a good result not only in the more accurate genetic classification but also in the better land potential appraisal.

2) Soil Salinity must be monitored because of its prevalence in the Area both for surface and profile status. The monitoring method would better involve soil sodicity and be favourable subjected to an electronic computer system by coding data together with profile characteristics.

3) Although quality of irrigation water has no problem except for sediments contained, continuous care must be taken not to cause salt accumulation in the soil surface. In this regard perennial irrigation is not so recommended to the Areas where saline groundwater exists at shallow level. It should be noted that alternating wet and dry condition is necessary to develop the soil structure.

4) Physiologically acidic fertilizers and organic fertilizers such as compost and green manure are highly recommended including frequent introduction of the deep-rooting legume crops or grasses in the cropping pattern.

5) Further examination on Soil Profile Salinity and then Land Capability Classification will be needed to how efficiently to utilize the data concerned the Project Area by referring the proposed procedures in this study.

3. Operation and Maintenance

As mentioned in the proposed organization, it is the most important factors to have well relationship between the irrigation division (Sub-Divisional Office) and the extension services division (Village Offices) in the Project Area. Therefore, it is proposed to apply the rotational irrigation methods under proper water management with cooperation of farmers' group under the control of the agricultural division of the Provincial government. It means that there is no progress and improvement concerning the higher agricultural productivity without the cooperation in both divisions including the technical committee, the joint committee and coordinating committee which will function the most important role to support the Project.

4. On-Farm Development

In considering the importance of the on-farm development, it is recommended that the Government should provide sufficient engineering services to farmers in the Project Area regarding the implementation of the on-farm facilities to be undertaken by the farmers themselves and also make sure of successful execution on this matter.

CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

In response to the request of the Government of the Islamic Republic of Pakistan for technical assistance to formulate the Agricultural Development Project with Widening of the Pat Feeder Canal, the Japanese Government decided to carry out the feasibility study on the Project through providing the engineering services of the Japanese Study Team.

Prior to the feasibility study, the Japan International Cooperation Agency (JICA), the governmental agency responsible for the implementation of the Japanese technical cooperation programme had dispatched the preliminary survey team to Pakistan for about three (3) weeks from October 27 to November 15, 1981 in order to make reconnaissance survey on the Project Area, to collect data for the study and to follow necessary procedures for the feasibility study. Based on the results of the preliminary survey, the Japanese Mission was dispatched to Pakistan to discuss the Scope of Works (S/W) for the feasibility study of the Agricultural Development Project with Widening of the Pat Feeder Canal. The above discussion-meeting was concluded on January 23, 1982 in Islamabad.

In compliance with the Scope of Works, the JICA has dispatched the survey team for the feasibility study for about 10 weeks from February 20 to April 30, 1982.

The final report has been prepared by the survey team in accordance with the Scope of Works for the feasibility study covering three major items of the proposed project components; namely, (i) provision of irrigation and drainage facilities including on-farm facilities, (ii) establishment of the pilot project, and (iii) promotion of the agricultural development with introduction of proper water management, strengthening agricultural supporting services as well as establishment of farmers organization. The Project covers

about 612,000 acres (248,000 hectares) of cultivable commanded area (CCA), which occupy a part of Kachhi Plain extending on the right bank of the Indus River, about 190 miles (300 kilometers) South-east of Quetta, provincial capital of Baluchistan Province.

Tabulated hereunder are the Advisory Group members, Team members and Pakistani counterparts personnel assigned to the Project.

Advisory Group Members Assigned to the Project

	Name	Position
1.	Chief Adviser Mr. Kazushige MATSUO	Director Land Improvement Engineering Service Center Ministry of Agriculture, Forestry and Fisheries (MAFF)
2.	Adviser (Irrigation) Mr. Shin TAMURA	Deputy Director Irrigation and Drainage Division Regional Agricultural Administration Office MAFF
3.	Adviser (Hydraulic Structures) Mr. Yasuhiko YAMAMOTO	Deputy Director Planning Division Agricultural Structure Improvement Bureau MAFF
4.	Adviser (Soil & Agronomy) Mr. Isao YANO	Deputy Director Upland Crop Development Division Agricultural Production Bureau MAFF
5.	Adviser (Agro-Economy) Mr. Kunio TANAKA	Director Regional Planning Division Regional Agricultural Administration Office MAFF
6.	Adviser (Economic Evaluation) Mr. Tohru SHIBUICHI	Deputy Manager Overseas Economic Cooperation Fund (OECF)

Team Members Assigned to the Project

	Name	Period stayed in Pakistan
1.	Team Leader Mr. Yoshio ARAI	Feb. 20 to Mar. 10, 1982 Apr. 1 to Apr. 30, 1982 Aug. 27 to Sep. 7, 1982
2.	Meteorology & Hydrology Mr. Ikuzo IWAMOTO	Mar. 11 to Apr. 19, 1982
3.	Irrigation & Drainage Mr. Hiroshi KONDO	Feb. 20 to Apr. 30, 1982 Aug. 27 to Sep. 7, 1982
4.	Canal Planning Mr. Sumio KONISHI	Mar. 1 to Apr. 19, 1982
5.	Canal Structures Mr. Masanori HIOKI	Mar. 1 to Apr. 19, 1982
6.	Construction Planning & Cost Estimate Mr. Takayuki INOUE	Mar. 1 to Apr. 19, 1982
7.	Agronomy Mr. Yasunori HASEGAWA	Feb. 20 to Apr. 30, 1982
8.	Pedology Dr. Yasuo TAKIJIMA	Feb. 20 to Apr. 19, 1982
9.	Agro-Economy Mr. Mitsutomo ANAI	Mar. 1 to Apr. 30, 1982
10.	Survey & Design Mr. Daikichi NAKAJIMA	Mar. 1 to Apr. 19, 1982

Counterparts Personnel Assigned to the Project

	Name	Postion
1.	Liaison Officer (In Quetta) Mr. Shirin Khan Loni	Superintending Engr. E/M Circle Irrigation & Power Dept. Baluchistan
2.	Liaison Officer (in Project) Mr. Mohammad Azam Baluch	Superintending Engr. Sibi Division Irrigation & Power Dept. Baluchistan
3.	Liaison Officer (In WAPDA) Mr. Muzaffar Iqbal	Director Investigation Div. WAPDA Quetta
4.	Irrigation Mr. Gul Mohammad KHOSO	Executive Engr. Pat Feeder Canal, Sibi Div. Irrigation & Power Dept., Baluchistan
5.	Agro-Economy Mr. Mohammad Amin	Senior Economist WAPDA Lahore
6.	Agronomy Mr. Mohsin Wahla	Senior Agronomist WAPDA Lahore
7.	Soil Mr. Malik Zahur Ahmad	Junior Research Officer (Soil) WAPDA Lahore
8.	Structural Design Mr. M. Javed Sheikh	Assit. Director Central Design Office, WAPDA Lahore
9.	Hydrology Mr. Abdul Khaliq Soomro	Junior Hydrologist WAPDA Karachi

CHAPTER II. ECONOMIC AND SECTORAL BACKGROUND D

CHAPTER II. ECONOMIC AND SECTORIAL BACKGROUND

II.1. National Level

Lying between the latitude of 23°30' to 36°45' North and the longitude of 61° to 75°31' East, Pakistan stretches over 994 miles (1,600 km) north to south and about 550 miles (885 km) east to west. It comprises four provinces: Baluchistan, North West Frontier, the Punjab and Sind. Of these, Baluchistan is the largest province with an area of 134,050 sq.miles (347,188 sq.km), followed by the Punjab with an area of 79,634 sq.miles (206,251 sq.km) including the Federal Capital Area. Sind has an area of 54,406 sq.miles (140,913 sq.km), North-West Frontier 28,773 sq.miles (74,521 sq.km) and the Federally Administrated Tribal Areas (FATA) cover 10,510 sq.miles (27,219 sq.km). The total national land area is 307,373 sq.miles (796,095 sq.km). (See Table II-1, Appendix).

According to the fourth census in 1981, the population stood at 83.782 million as against 65.309 million in 1972, whereas merely 32.500 million in 1947, the time of independence. The density of population was reported at 105 persons per square kilometer in 1981. (See Table II-1, Appendix).

The year 1980-81 was the third year of the country's Fifth Five-Year Plan and witnessed significant gains in the commodity producing sectors, impressive rise in export earnings and notable expansion in the domestic resource share for financing the public sector investment programme. There had been an unexpected rise in the import bill of oil and its products owing to the International inflationary conditions that adversely affected the balance of trade.

The average annual rate of economic growth was 3.7 per cent in GNP and 4.2 per cent in GDP allowing only a marginal improvement in the per capita income during the period 1970-77. However, the GNP recorded a growth rate of 6.7 per cent in 1979-80 and 5.5 per cent in 1980-81, while the GDP recorded an increase by 7.0 per cent in 1979-80 and 5.7 per cent in 1980-81. (See Table II-12, Appendix)

The two main commodity producing sectors of agriculture and manufacturing contributed Rs.25,328 million to the GNP in 1980-81 as compared with Rs.23,886 million in the previous year. Their share in the GNP has increased from 44.8 per cent in 1979-80 to 45 per cent in 1980-81. The contribution of the services sector to the GNP rose from Rs.26,271 million to Rs.27,692 million during 1980-81. Its share to the GNP has slightly declined from 29.3 per cent in 1979-80 to 29.2 per cent in 1980-81.

The present regime realized that the short-term planning on annual basis was capable to produce the desired results. It was, therefore, decided to revert to the medium planning and thus the Fifth Five-Year Plan (1978-83) was launched on July 1, 1978.

Basically welfare-oriented, the Plan involves a development outlay of Rs.210.2 billion of which Rs.148.2 billion or 70.5 per cent are earmarked for the public sector and Rs.62 billion or 29.5 per cent to the private sector. A notable feature of the Plan is that as much as 75 per cent of the total investment will be met through internal resources and national savings and only about 25 per cent will be financed through external resources. The agriculture and water sectors have been given top priority and allocated a sum of Rs.43.1 billion or 20.51 per cent of the total outlay; mining and industry Rs.42.5 billion or 20.22 per cent; power and fuel Rs.33.5 billion or 15.94 per cent; transport and communications Rs.38.6 billion or 18.36 per cent; social and other sectors Rs.29.5 billion or 14.03 per cent; and physical planning and housing Rs.23 billion or 10.94 per cent of the total outlay.

The public sector development expenditure to be met from budgetary resources is estimated at Rs.128 billion, the balance of Rs.20.2 billion will be covered by the development expenditure of the public corporations. The annual development expenditure will increase from Rs.17.40 billion in 1977-78 to about Rs.31.50 billion in 1982-83 showing an annual growth rate of 12.6 per cent. However, the whole the public sector outlays are projected to rise at a rate of 11.4 per cent.

The basic objectives of the Plan are the development of the rural areas including extension of social services like schooling, health and drinking water facilities; easing of urban problems like water supply, drainage, housing and transport, development of backward regions; meeting the basic needs of the population and the promotion of equity between urban and rural population; and laying down of the foundations of a long-term economic growth.

The focus of the Plan covering a wide variety of programmes would be on the rapid development of agriculture based on efficient utilization of the potential of the nation in terms of land, manpower, and water resources as well as expanded and more intensive use of modern inputs and creation of permanent institutions in this vital sector of the national economy. The target of six per cent growth rate in agriculture is essential for meeting the basic needs, stabilizing prices and improving the balance of payments.

The highlights of Agriculture sector are: (a) to achieve a growth rate of six per cent per annum; (b) to mark a transition from self-sufficiency in wheat, as the man concern, to export agricultural products as prime objective, to increase production of rice both for domestic consumption and export, and to increase the export of other agricultural commodities to a feasible extent, based on proved natural advantage and world market prospects; (c) to increase oilseeds production for minimizing imports of vegetable oil; (d) to accelerate production of protein-rich foods such as pulses, meat,

milk, egg and fish at a rate higher than the population growth with a view to improve nutritional level of the middle-class (e) to increase production and productivity of cotton and sugarcane; (f) to accelerate production of fruits and vegetables both for local consumption and exports; (g) to upgrade agricultural production in the ill-endowed areas (arid, hilly, sailaba and barani) through integrated plan for exploitation of natural resources to minimize inter-regional farm income disparities; (h) to improve productivity of small farmers in the irrigated areas who constitute majority of the farming community; (i) to diversify agriculture, possibly through multiple cropping system and by promoting such minor crops as soyabean, sunflower, etc., and (j) to increase and protect wooded area and to develop range lands for livestock production.

Under the Plan, wheat production is projected to increase sufficiently to eliminate the need for huge imports besides achieving substantial increase in the export of cotton and rice by the end of the Plan period. An increase of 2.5 per cent per annum is projected in the irrigated cropped acreage and yields are expected to increase by over four per cent per annum. Special attention is to be paid to fertilizer consumption which is expected to double over the Plan period, the bulk of which will be produced within the country.

The supreme importance of agriculture in the economy of Pakistan has by no means diminished despite the rapid pace of industrialization in the large urban areas. Although its share in the GNP slightly declined from 29.3 per cent in 1979-80 to 29.2 per cent in 1980-81, it is still the largest single sector of the economy. Pakistan is predominantly an agricultural country and about 75 per cent of its population comprises agriculturists and farmers who toil in producing the maximum quantity of the foodgrains for the entire nation and raw materials to the domestic industry. Because of bumper wheat, sugarcane and maize crops, the growth rate of agricultural production during 1980-81 is expected at 4.4 per cent. The wheat

crop was estimated at 11.34 million tons, sugarcane crop has created a new record at 32.15 million tons and maize production is up by 2.9 per cent as compared with that in 1979-80. The cotton production is expected at the last year's level. Only rice production recorded a decline by 4.4 per cent to 3.075 million tons from 3.216 million tons in the previous year.

During 1980-81 the Government continued its policy of subsidizing the essential agricultural inputs and setting support prices for some of the major crops. The element of subsidy has, however, been reduced with a view to move towards its gradual withdrawal. This was supplemented with the streamlining of the input distribution system to ensure timely availability of the essential inputs. The support prices of the important crops like wheat, rice (paddy), seed cotton (phutti) and sugarcane for 1980-81 were revised upward well before their sowing. The Agricultural Price Commission has been set up to advise the Federal Government on the pricing policies of the crops and the inputs and other relevant aspects of the agricultural development.

The work is progressing on three on-going agricultural projects, which, on completion, will place agricultural growth on secure foundations in the coming years. The seed industry projects, being implemented in the Punjab and Sind, will ensure the supply of good quality seed throughout the country. The projects contain the important elements of development and distribution of the seed suited to the requirements of different regions. Similarly, the pilot extension projects are also to be undertaken in the two provinces. These projects will be much more closely structured and supervised than the present services. These pilot projects and other extension projects will be replicated throughout the country after testing and readjustment in the light of the experience thus gained.

Likewise, the water management projects have been started on pilot scale in the irrigated zones to put down water losses in transmission, which are estimated to be 45 to 60 per cent. the pilot on-farm management projects have already resulted in the improvement of nearly 500 water courses and benefitted an area of about 85,000 acres. Meanwhile, the Punjab Government has started a crash programme to improve another 10,000 water courses. This would save nearly one million acre feet of water.

The Federal Government decided to enhance the limit of interest-free production loans from Rs.5,000 to Rs.6,000 per borrower per year subject to a limit of Rs.500 per acre. The salient features of this scheme with the latest amendments are: (A) interest-free loans are admissible only to the small farmers of subsistence holding; (b) the loans are only for the purchase of seeds, fertilisers and pesticides; (c) the genuine additional credit needs of the small farmers can also be met as per forms and procedure laid down but interest as prescribed will be charged on the amount in excess of Rs.6,000; and (d) the farmers will be given two months' period after the harvest to repay the loan and get the exemption of the interest. However, if they fail to repay within the prescribed period, their loans will become interest-bearing with retrospective effect.

II.2. Provincial Level

Baluchistan is the largest province of Pakistan in terms of area and the smallest in terms of population. It spreads, virtually as plateau, over 134,050 sq.miles (347,188 sq.km) about 44 per cent of the total area of the country. In contrast, the population of the province was reported in 1981 census at 4.3 million, forms only 5.1 per cent of the total population of the country. The density of population is low as around 23 persons per sq.km as compared with the average national density of 105 persons per sq.km.

The Province has an extremely arid climate and the area is mostly hilly and barren. According to geo-physical characteristics, it can be divided into the upper highlands, the lower highlands, the plain and the desert. There is very little rainfall in the Province, the annual average rainfall varying from two inches (50 mm) to eight inches (200 mm). This average is too little to support profitable cultivation of agricultural crops. There is hardly any perennial river flow to attract cultivation and permanent settlement except for occasional oasis and sporadic fertile valleys watered by mountain springs and underground channels called Karez.

The Province is situated at the eastern flank of the middle East and strategically, located close to the sea lanes leading into the Persian Gulf. The Province has a very long border in the north with Afghanistan and in the west with Iran, and in the south faces a sea coast line extending more than 400 miles (644 km). While the fisherman-settlers inhabit a part of the sea coast, the area on the land borders with Iran and Afghanistan are particularly sparsely populated in want of road and rail infrastructure as well as the harsh environment.

The size of Provincial development outlays during this period increased from Rs.140 million in 1971-72 to Rs.360 million in 1979-80. Similarly federal development expenditure in Baluchistan

also increased substantially. Several projects which basically lie in the provincial sphere have been taken up by the Federal Government for financing to accelerate the pace of development in the Province. Besides, the Federal Government helped the Provincial Government in meeting the deficit in its non-developmental budget which has gone up from Rs.194 million to Rs.857 million during 1979-80. The incremental expenditure arose, not only out of the expanding administrative organization, but also due to set-up of health and education facilities.

A number of schemes in agriculture sector have been initiated and allocations in this respect increased from Rs.9 million in 1970-71 to, Rs.57 million in 1979-80. There was a substantial rise in the use of fertilizer and the area under aerial spray for the plant protection was doubled in a ten-year period to around 38,980 sprayed hectares in 1979-80. Similarly efforts were intensified in the water resources sector where development outlays increased seven-fold in a period of ten years. Eight small dams were constructed and around 200 tubewells were installed. A substantial expenditure was also incurred on extension re-modelling and enlargement of canals. As a result of land development and irrigation programmes, the cultivated area increased from 1.17 million hectares in 1970-71 to 1.38 million hectares in 1977-78.

A general improvement in agricultural production was experienced. Wheat production rose from about 77 thousand tons in 1970-71 to about 234 thousand tons in 1979-80 and rice production increased from 28 thousand tons to 101 thousand tons over this period. In order to ensure regular supplies of food grains to the population, (the province will be deficit in foodgrains, particularly wheat) the storage capacity was increased from 56 thousand tons in 1970-71 to about 62 thousand tons in June, 1980.

Special efforts were made to develop fruit and vegetable production in the Province. A number of projects for vegetable and

potato seeds production were launched. The Provincial Government also initiated programmes on the distribution of seedlings of improved varieties of fruits. Consequently, the production of vegetable has increased from 59 thousand tons in 1970-71 to about 108 thousand tons in 1977-78. Production of fruits has increased from 191 thousand tons in 1970-71 to about 255 thousand tons in 1977-78.

The resources potential of Baluchistan is known to be enormous but has remained unexploited for several reasons. Firstly, as stated earlier the Province remained to be a neglected region before independence and even in early years after the establishment of Pakistan, sufficient attention was not devoted to the development of this area. Secondly, due to vastness of its area, the prohibitively heavy requirement of investment in infrastructure detersed accelerate development. Thirdly, lack of physical, financial and social infrastructure acted as a disincentive for the private sector, the primum mobile of development strategy followed in the country in the fifties and sixties.

With the structure of production and employment agricultural, medium term development plans for the Province must lay stress on this sector. Such an account is important because it would bridge the gap between food requirements and availability in not easily accessible areas, increase employment and income for the population and help the normadic groups settle down.

At present, only seven per cent of the cultivable area (3 per cent of the total area) is under cultivation. There is a scarcity of surface water in the region which has resulted in the practice of primitive irrigation method. The region, on the other hand, has immense resource of fertile land. The estimated cultivable area is around 47.7 million acres (19.3 million hectares). Development of water resources by providing dependable and adequate irrigation is, therefore, of paramount importance of utilization of land and for

improving the standard of living of the inhabitants.

Recently, some expenditure has been made on investigation of water resources of the region. The unexploited potential can be harnessed by an full development of groundwater, rehabilitation and extension of irrigation through Karezes (subterranean channels), construction of dams at Mirani on the river Dasht and at Bolan on the river Bolan, improvement and expansion of existing flood irrigation system, harmonizing of stream for small irrigation schemes and remodelling of the Pat Feeder which is the only major canal in the Province fed by the Indus river system.

The basic concept of this chapter has been worked out based mainly on the data and information carried in the following two sources and some quotation are made therefrom as well.

Sources: Pakistan Year Book
1981 - 82 11th Edition
(East and West Publication Company)

Development Plan and Strategy for Development of Baluchistan (Plan and Development Dept., Government of Baluchistan)

CHAPTER III. THE PROJECT AREA

CHAPTER III. THE PROJECT AREA

III.1. Location and General Features

III.1.1. Geographical Location and Road Systems

1) Location

The province of Baluchistan is located between Latitude 25°N to 32°N, and Longitude 61°E to 71°E, and the Project Area is included in the Kachhi plain of the Baluchistan plateau, lying between Latitude 28°N to 28°N 33'N, and Longitude 67° 30' to 69° 34'. The Area is about 190 miles (300 kilometers) south-east of Quetta, the capital of Baluchistan Province. At south and south-east, the Project Area faces the commandable area by the Khirther Branch Canal and irrigation scheme of the Desert Canal respectively in Sind Province.

2) Road System

There are some inadequacy in providing the infrastructures in the Project Area, and especially, the road systems are under developed in the Project Area and its surrounding areas. At present, the national metalled road has been constructed to connect two cities, Quetta and Karachi with each other running through the central part of Project Area from west-north to south-east.

There is only one provincial road available in connecting the provincial towns with each other; namely, Dera Murad Jamali, Jhatpat, Sui, Kashmor, Mirpur Bibiwan etc., which are located in the Project Area or in its vicinity.

On the other hand, there is the national railway running in parallel with the national metalled road to connect main cities in

the country. It is considered that the railway has higher availability for the development of the province.

As for the feeder roads and farm roads, there are the operation and maintenance roads of the irrigation facilities in the Project Area, and they are so far utilized as the feeder and farm roads. However, there is inadequacy for supporting the good farm management in hauling the agricultural inputs and the outputs. Especially, the roads and the crossing facilities over the cannals are so poorly provided as to be unavailably for rainy days due to slippery, clayey soils of the top of embankment.

III.1.2. Population and Living Conditions

1) Population

a) National and Provincial Level

According to the fourth census in 1981, the population stood at 83.782 million as compared with 65.309 million in 1972, although merely 32.500 million in 1947 at the time of Independence.

The population of the national level has increased by 18.4 million over eight and a half years from 1972 to the census in 1982. This enabled to work out a growth rate by 28.28 per cent or an average rate of around 2.98 per cent per annum as shown in Appendix III.1.2. The population of Baluchistan has been estimated at 4.3 million in the fourth census.

The density of population per square mile increased from 24 in 1972 to 31 in 1981. The ratio of male and female population was estimated at 53 per cent to the male for total population.

b) Project Area

The Project covers a total cultivable commanded area (CCA) of 771,300 acres (312,000 ha) in Nasirabad District of Baluchistan Province. Out of this, 612,000 acres (248,000 ha) will be under the command of gravity flow canal (Phase-I) and the balance of 159,300 acres (64,000 ha) of upland will be commanded later by irrigation by with pumping-cum-gravity canal (Phase-II).

Population in the Project Area was estimated at 244,000 persons at a density of 273 persons per sq.mile (105 person per sq.km).

2) Living Condition

a) Provincial Level

i) Source of Drinking Water

Fifteen per cent of the population use the pipeline system for the supplying of the drinking water, and a few per cent of the inhabitant is supplied with drinking water by handpumps. One the other hand, 85 per cent of the people has been supplied with the drinking water by ponds, wells, springs, rivers and streams.

ii) Source of Lighting

In Baluchistan Province, only 14 per cent of the households has shared the benefit of electricity and the remaining 86 per cent uses kerosene oil as lighting sources. This electrification level is about a half of the national average.

iii) Source of Cooking Fuel

Eighty Seven per cent of Baluchistan households uses fire wood for cooking, eight per cent use cow-dung, three per cent uses kerosene oil. The households in Baluchistan being used fire wood for cooking occupy 17 per cent more than the level of the whole country.

b) Project Area

i) Education

The education system is composed of three categories, primary education, secondary education and college education in the district.

Regarding the primary education, it is reported that the children attending school was estimated at 15 per cent of the schoolable children of 5 - 9 years, and 85 per cent of children are out of school. Especially, a very few facilities of primary education for girls are found available, and also same status for middle school.

The students enroled in secondary education as of 1979 are 23 percent for those specified in the age group of 10 - 14 years of the schoolable boys. There is a college at Usta Mohammad with enrollment of 170 students.

ii) Health and Social Welfare

A hospital providing with 50 beds is available in the whole district. The ratio of beds to population is 1:4,500. Inspite of the limited number of the hospital beds, the beds were occupied only by 70 per cent in 1979.

The possible reasons of low utilization of hospital beds might be poor staffing, and definite lack of equipment and drugs.

iii) Drinking Water

In rural area of Nasirabad, the main sources of drinking water are the water hund-pumped up from canals, ponds and wells. In the urban areas of Jhatpat, Usta Muhammad and Dera Murad towns, the domestic water supply is available by pipeline to a limited population. The storage reservoirs with capacity of 24,000 and 10,000 gallons have been operated at Jhatpat and Usta Muhammad towns, respectively.

iv) Electricity

All the three tehsil and towns have facilities of electric supply. The total electric connections are 1,460, out of which 45 per cent is commercial. In the rural area, 57 villages in the District have been electrified.

III.2. Physical Conditions

III.2.1. Topography

1) Provincial Level

Physically, Baluchistan Province is roughly divided into two; the highland and the extensive plains . The upper highland known locally as "Khorasan" rises to nearly 12,000 feet. (3,658 m) with the valley floor of about 5,000 ft. (1,524 m) above mean sea level, and the lower highland includes the Mekran, Kharan and Chaghai ranges in the west and Sulaiman, Pab and Kirthar in the east.

The extensive plain is divided into three; the Kachhi plain, the plain of Las Bela and the plain of the River Dasht. The north-western section known as the Chaghai basin, is deserted with an area of inland drainage dissipating into "Hamus" lake that is generally dry.

On the whole plateau of Baluchistan presents a scene of rugged, barren and arid land with isolated paths of green on the plains.

2) Project Area

The Project Area stretches as part of the Kachhi Plain, and the Area is separated from the desert lands by the Pat Feeder Canal as the boundary at north, and bunded by the Nari river at west. On the other hand, the Area is bounded by the boundary of Sind province at south, in contacting with the commanded area of the Khirthar Canal at east.

The Project Area is in rectangle with the side of about 60 miles (96 km) west to east and the other with 15 to 20 miles (24 to 32 kms) north to south.

The slope of land varies gradually with gradient 1 to 2,000 or 1 to 3,000 from north to south and the land at high elevation in the Area is located along the Pat Feeder Canal at about 200 to 230 feet (61 to 70 m), and the land at the lower elevation appears at about 160 to 185 feet (49 to 56 m) in the south of the Project Area.

III.2.2. Climate

1) Observation Station

There are four meteorological observation stations around the Area, of which three stations, QUETTA, USTA MOHAMMAD and SIBI are in Baluchistan Province and the other one, JACOBABAD, is in Sind Province.

The USTA MOHAMMAD observatory is selected as the representative station that is considered most available among three for the Project

Area having been operated and maintained by the Surface Water Hydrology Project of WAPDA LAHORE since December 1965.

The station of USTA MOHAMMAD is located in Agricultural Seed Farm at latitude 28°11', and Longitude 68°04'E. (See location map in Appendix)

2) General Climate

According to the classification of climate provided by the World Meteorological Organization, the climate of Balichistan Province belongs to the arid zone type.

Generally, a year has two seasons as winter (November to April) and summer (May to October) in Baluchistan. In the Project Area, however, the winter seems to last shorter than the summer, which will begin in April.

The daily observation data collected for ten years (1966 - 1975) at Usta Mohammad have been rearranged on the mean monthly basis and evaluated as follows;

a) Precipitation

The Project Area belongs to the arid zone as mentioned above, and the average annual amount of rainfall affected by the monsoon is 3.43 inches (87.1 mm) in the Project Area as shown in Fig. III.2-2, Appendix.

b) Temperature

The mean monthly temperature in June is recorded highest throughout the year by 96.9°F (36.1°C), while that in January recorded lowest by 55.7°F (13.2°C).

The temperature records available at the observation station have two kinds of measurement values of the mean monthly maximum air temperature and mean monthly minimum air temperature. The highest the mean monthly maximum air temperature has been recorded by 111°F (43.9°C) in June whereas the minimum is by 40°F (4.4°C) in January.

c) Relative Humidity

Generally, high humidity occurrs in July to February and low humidity in March to June. (See Appendix Fig. III.2-2). At the observation station, relative humidity has been measured two times a day, namely, morning (8.0 AM) and evening (5.0 PM).

According to both the values observed, there are much difference in the Project Area about 10 to 20 per cent in each month.

d) Evaporation

According to the measurement data by PAN-A method at Usta Mohammad, the mean annual amount of evaporation was estimated at 118.65 inches (2,966.5 mm) as shown in III.2.7, Appendix. Fluctuation of the mean monthly evaporation observed for ten years ranges from 18.94 inches (473.5 mm) in May at the highest with 16.84 inches (421.0 mm) in June as the second highest, to 3.19 inches (79.8 mm) in December at the lowest as illustrated in Fig. III.2-2.

e) Wind Velocity

The mean monthly wind velocity observed for ten years is shown in Appendix Fig. III.2-2, The data, however, on the wind direction at the maximum and the minimum wind velocities are not available.

The ten-year observation data shows that the mean maximum wind velocity takes place in June. As illustrated in Fig. III.2-3, Appendix, the mean monthly wind velocity is 61 miles/day (1.14 m/sec) and sometimes the strong wind blows in March.

f) Sun-shine Intensity

The sun-shine intensity has been observed at JACOBABAD Station as shown in Table III.2-15 Appendix. Through the observation period for ten years, the highest intensity has occurred at 82.4 per cent in October, and the lowest one in July because of the monsoon season.

4) Particular Meteorology

a) Storm

In the Province, most of the rainfall has occurred in association with storms which have two types as follows;

i) Tropical storms or summer storms which are responsible for summer rainfall or monsoon rainfall.

ii) Extra-tropical cold weather storms, known in this sub-continent as "Western disturbances", which produce winter precipitation.

i) Summer Storms (Monsoon)

The advance of the monsoon is usually associated with the westward-moving depressions from the Bay of Bengal. These depressions often begin to weaken during their westward march and generally lose much of their activity by the time that they reach the central India. Sometimes they recurve northeast or northwest from Rajputana and break over the western Himalayas or the Kashmir hills.

On a few occasions, they continue to be active and travel into Iranian area through Baluchistan. On such occasions the Province experiences firly prolonged unsettled weather and rainfall occurs more or less continuously for one or two days.

Otherwise, the precipitation over the Area in the summer season is usually in the nature of thunder-showers and occurs in the afternoon or early evening when connection is most marked.

Occasionally, monsoon depressions cross into Baluchistan from the Arabian sea and, moving north or northeast, enter the Punjab and then break up over the Punjab hill.

On the other hand, the speed of movement of the monsoon depression varies with the season. They move slowly at the beginning of the season on an average speed of 6 - 10 miles per hour in June. As the season advances, their speed increases to 10 - 12 miles per hour in July and to 12 - 15 miles per hour in August and September.

ii) Winter Storms

In winter, the Province is affected by disturbances of extra-tropical origin which move from west to east, especially during the months of November to April. These disturbances are known as cold weather storm or more popularly as "Western disturbances". Some of these disturbances induce lows either at sea level or in upper air which also travel west to east. These secondary lows sometimes induce strong wind currents from the Arabian Sea and become very active.

Although isolated or scattered heavy rain may occur over and near the hills, the phenomenon of locally heavy precipitation is rare. Winter precipitations are more uniform than that in summer and the intensities are much low.

Occasionally, a winter storm is associated with active warm and cold fronts. Then, severe thunder-showers occur with its passage followed by biting cold and strong north-westerly to northerly winds.

iii) Heavy Daily Rainfall

Through observation period at Usta Mohammad, the maximum daily rainfall was measured at 3.9 inch (99.1 mm) in 1975. Regarding the daily rainfall intensity (frequency), it has been analyzed with the Gumbel-Chow formula based on data observed for ten years.

The results of the analysis are shown in Table III.2-2 Appendix, and the said value observed (3.9 inches) is equivalent approximately to 25 years return frequency.

iv) Air Temperature

The air temperature in the Project Area would be evaluated as one of the hottest region in Pakistan and also in the world from the results of the investigation, and this could be confirmed with the scientific yearbook published in 1978.

III.2.3. Hydrology

1) Water Resources

a) Run-off of the Indus River Basin

The catchment area of the Indus River was estimated at 367,000 square miles (950,000 sq.km), and the Indus River has its length by 1,800 miles (2,900 km) approximately, being ranked the 15th longest in the world.

There are six main tributaries of the Indus River in its basin, the river of Kabul, Jhelum, Chenab, Ravi, Sutlej, and Beas.

The Kabul River originates in Afganistan, while other tributaries' origins are in India. According to the general information published in the report of Indus Water Treaty, the mean annual run-off in the Indus River Basin was estimated at 168 million acre-feet (207,400 million cu.m), and the tributaries occupy 47 per cent for the total run-off in the river basin. However, the run-off pattern of the basin has been changed in the downstream by the basin development program since 1967, and particularly, after the construction of the Tarbela Dam, the flow pattern has varied in winter (Jan. to Mar.) since 1979. (See Fig. III.2-4, Appendix)

Fortunately, the daily discharges observed at Guddu Barrage are available for eleven years (1971 - 1981) with cooperation of the provincial government of Sind. From these data collected, the most useful data have been selected and revised for the purpose of irrigation as tabulated in Table III.2-22, Appendix. According to the Appendix Table III.2-23, the total run-off is expected to be about 84 million acre-feet (103,614 MCM) in volume at the Guddu Barrage, and the monthly fluctuation of the run-off is shown in Fig. III.2-4, Appendix.

b) Intake Discharge at Guddu Barrage

There are three intake structures at the Guddu Barrage, one constructed at the left bank and other two constructed at the right bank, namely, Desert Pat Feeder Canal and Begari Sind Feeder Canal intakes. From data collected at Project site, there is the mean monthly intake discharge amount estimated at each project as shown in Tabled III.2-22, III.2-24, Appendix. At present, the estimated value is 10 million acre-feet as mean yearly total amount taken from Guddu Barrage, and three million acre-feet to the Desert Pat Feeder Canal,

and 1.05 million acre-feet to the Pat Feeder Canal respectively. The variation of the mean monthly intake discharge is illustrated prepared in Fig. III.2-3, Appendix.

c) Consideration of Water Balance at Guddu Barrage after the Project

The water demands with the Project were estimated for the Project Area based on the proposed cropping pattern and crops' water requirements which are calculated with the meteorological data. In this case, three kinds of case studies were made to have the most available development plan for the Project Area in view of economy and water resources availabity at the Indus River Basin. The results of the water balance study are tabulated in Tables III.2-26, III.2-27 and III.2-28, Appendix. According to the results, Case-1 shows definite lack of water supply in Rabi crops from December to February, and Case-3 is most stable in water supply from the basin. However, there are no considerations on the maintenance water at downstream of the Indus River in the water balance study.

The aforesaid study has included various unknown factors to be cleared in future, and particularly, the operation rules of Tarbela and Mangla Dams should be revised to utilize the water resources more effectively in the river basin based on the future development plan, and the arrangement of distribution plan will be carried out by the Indus River Treatment Committee.

2) Sedimentation

a) Data Collection and Analysis

In the Indus River Basin, the Surface Water Hydrology Project WAPDA, has carried out to observe and analyze the data of the sediment, since 1960.

According to the information collected, the sediments have been observed at eleven stations in the basin, seven stations of which are located along the Indus River, and the rest four stations along tributaries of the Indus River referred to in Fig. III.2-5, Appendix. However, the observation stations are concentrated in the upstream of the basin in their locations except Sehwan so as to apply the data available through observation to the development plans on dam projects. The WAPDA published the report in May 1980 as for the results of the analysis on data observed at the stations, and they are rearranged more clearly and tabulated as Tables III.2-29 and III.2-30, Appendix.

From these tables, an average sediment concentration by weight was estimated at 2,500 ppm to 3,600 ppm in the main stream of the Indus River and measured at about 1,100 ppm to 2,100 ppm for the tributies in the basin, but these values have been determined without any consideration of the influence of Tarbela Dam into the main stream of Indus River. As illustrated in Table III.2-29 and III.2-30, Appendix, the contents of suspended materials have been analyzed into sand, silt, and clay, respectively, and the contents of sand decrease gradually from the upstream to the downstream, while the contents of silt and clay increase gradually increased toward the downstream.

On the other hand, the collection of sample materials along the Desert Pat Feeder Canal had been carried out and the analysis was made for the contents of the materials as shown in Table III.2-31, Appendix, and the distribution of the contents has indicated that the sandy materials deposit the upstream of the canal, while the siltor the clay materials deposit at the downstream of the canal.

b) Evaluation of Sedimentation at the Desert Pat Feeder Canal

i) Water Balance of the River Basin

According to the data prepared by WAPDA in May, 1980, the mean annual run-off of the Indus River measured at Massan for four years (1972 - 1975) was 89.3 million acre-feet. On the other hand, the mean annual run-off at the Guddu Barrage in the same period was taken at about 90.5 million acre-feet. From this, that of the tributaries have taken by about 1.2 Million acre-feet as the mean annual run-off, and the said value seems to be small in comparison with its catchment area.

ii) Estimation of Average Sediment Yield at the Guddu Barrage

The sediment yield at Massan in the Indus River was measured by about 304 million tons in the mean annual yield. After the construction of Tarbela Dam, however this value will probably be reduced to about ten percent of the present in due consideration of the example of the investigation of the similar projects. And also, the yield of the tributaries was estimated at 2.96 million tons (1,480.2 MCM x 0.002), so that the total mean annual yield at the Guddu Barrage would be at 33.36 million tons. From this value, an average sediment concentration at the Guddu Barrage could be evaluated at about 320 ppm (0.032% by weight) by the mean annual run-off at the Barrage.

iii) Average Sediment Yield of Desert Pat Feeder Canal

The case study discussed in the report revealed that Case-3 and Case-4 could be applied as a final development plan for the Project, and the total water requirement for the Case-3 scheme and the Desert Canal Area was estimated totally at 5.70 million acre-feet (7,031 MCM).