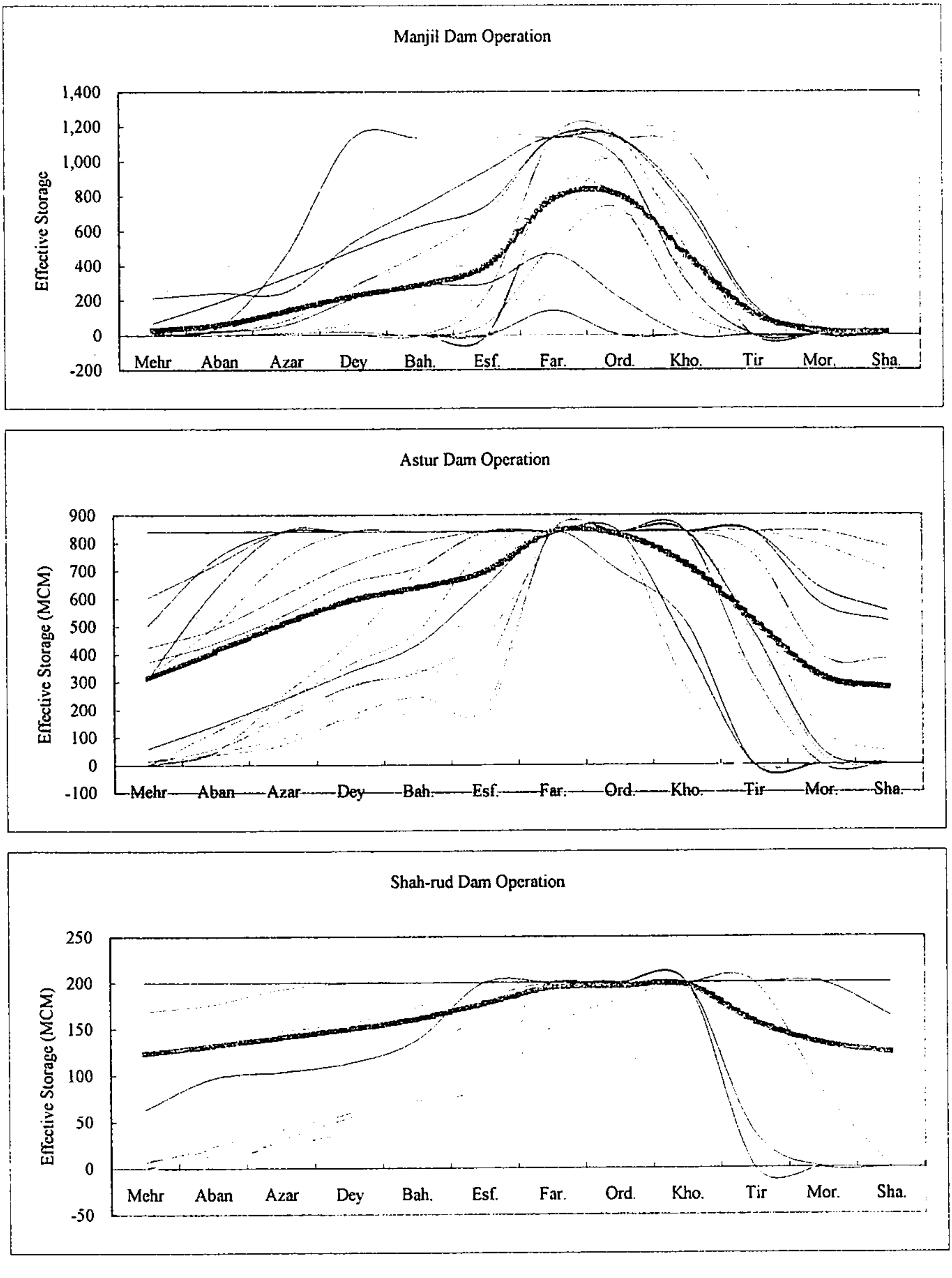
Table 9.4.5.2 Comparison of Manjil Dam Operation (with and without Taleghan/Almout Water Diversion, with Astur and Shah-rud Dams)

Year	without Diversion Plan				with Diversion Plan/Astur Dam				Difference			
	Inflow (1)	Outflow (2)	Spillage (3)	Shortage (4)	Inflow (5)	Outflow (6)	Spillage (7)	Shortage (8)	Inflow (5)-(1)	Outflow (6)-(2)	Spillage (7)-(3)	Shortage (8)-(4)
69-70	4,141.99	3,007.03	1,361.56	637.07	3,637.36	3,644.10	219.86	0.00	(504.63)	637.07	(1,141.70)	(637.07)
70-71	3,460.01	3,301.51	158.50	342.59	2,935.51	2,935.51	0.00	708.59	(524.50)	(366.00)	(158.50)	366.00
71-72	6,894.05	3,644.10	2,889.74	0.00	5,016.46	3,634.38	1,190.36	9.72	(1,877.59)	(9.72)	(1,699.38)	9.72
72-73	4,389.00	3,341.16	1,408.05	302.94	4,231.23	3,644.10	778.85	0.00	(157.77)	302.94	(629.20)	(302.94)
73-74	5,505.00	3,371.62	2,119.66	272.48	4,894.72	3,644.10	1,250.62	0.00	(610.28)	272.48	(869.04)	(272.48)
74-75	3,741.92	3,252.49	503.15	391.61	3,627.61	3,627.61	0.00	16.49	(114.31)	375.12	(503.15)	(375.12)
75-76	4,594.03	3,577.38	1,016.65	66.72	3,644.10	3,644.10	0.00	0.00	(949.93)	66.72	(1,016.65)	(66.72)
76-77	3,311.94	3,311.94	0.00	332.16	3,130.43	3,130.43	0.00	513.67	(181.51)	(181.51)	0.00	181.51
77-78	3,456.38	2,986.95	469.43	657.15	2,857.66	2,857.66	0.00	786.44	(598.72)	(129.29)	(469.43)	129.29
78-79	4,459.28	3,308.63	1,150.65	335.47	3,622.19	3,622.19	0.00	21.91	(837.09)	313.56	(1,150.65)	(313.56)
79-80	3,998.35	3,047.86	950.49	596.24	3,587.62	3,587.62	0.00	56.48	(410.73)	539.76	(950.49)	(539.76)
80-81	5,551.26	3,644.10	1,785.84	0.00	3,936.74	3,644.10	292.64	0.00	(1,614.52)	0.00	(1,493.20)	0.00
81-82	3,558.33	3,059.12	620.53	584.98	3,673.75	3,644.10	29.65	0.00	115.42	584.98	(590.88)	(584.98)
82-83	5,925.54	3,644.10	2,238.63	0.00	4,822.05	3,644.10	1,177.95	0.00	(1,103.49)	0.00	(1,060.68)	0.00
83-84	3,490.35	3,327.76	205.40	316.34	3,644.10	3,644.10	0.00	0.00	153.75	316.34	(205.40)	(316.34)
84-85	6,268.77	3,402.50	2,866.27	241.60	5,365.13	3,644.10	1,721.03	0.00	(903.64)	241.60	(1,145.24)	(241.60)
85-86	3,908.61	3,343.82	564.79	300.28	3,644.10	3,644.10	0.00	0.00	(264.51)	300.28	(564.79)	(300.28)
86-87	3,631.59	3,100.10	531.49	544.00	3,388.00	3,388.00	0.00	256.10	(243.59)	287.90	(531.49)	(287.90)
87-88	7,863.45	3,644.10	4,159.37	0.00	6,225.85	3,644.10	2,581.75	0.00	(1,637.60)	0.00	(1,577.62)	0.00
88-89	3,326.08	2,602.60	783.46	1,041.50	3,932.26	3,507.94	424.32	136.16	606.18	905.34	(359.14)	(905.34)
89-90	3,064.26	2,931.51	132.75	712.59	2,708.70	2,708.70	0.00	935.40	(355.56)	(222.81)	(132.75)	222.81
90-91	3,125.03	2,697.14	427.89	946.96	2,831.38	2,831.38	0.00	812.72	(293.65)	134.24	(427.89)	(134.24)
91-92	6,738.79	3,644.10	2,706.90	0.00	4,954.83	3,644.10	1,094.53	0.00	(1,783.96)	0.00	(1,612.37)	0.00
92-93	4,557.82	3,457.40	1,488.21	186.70	4,498.79	3,644.10	1,070.89	0.00	(59.03)	186.70	(417.32)	(186.70)
93-94	7,432.38	3,498.12	3,934.26	145.98	6,782.75	3,644.10	3,138.65	0.00	(649.63)	145.98	(795.61)	(145.98)
94-95	6,431.56	3,644.10	2,633.46	0.00	5,626.83	3,644.10	1,967.49	0.00	(804.73)	0.00	(665.97)	0.00
95-96	5,336.69	3,477.75	2,012.94	166.35	5,107.46	3,644.10	1,478.59	0.00	(229.23)	166.35	(534.35)	(166.35)
96-97	2,597.28	2,597.28	0.00	1,046.82	3,061.75	3,061.75	0.00	582.35	464.47	464.47	0.00	(464.47)
97-98	4,265.43	3,110.05	1,155.38	534.05	3,633.42	3,633.42	0.00	10.68	(632.01)	523.37	(1,155.38)	(523.37)
Average	4,656.04	3,275.05	1,388.81	369.05	4,104.23	3,476.97	635.08	167.13	(551.81)	201.93	(753.73)	(201.93)
Maximum	7,863.45	3,644.10	4,159.37	1,046.82	6,782.75	3,644.10	3,138.65	935.40	606.18	905.34	0.00	366.00
Minimum	2,597.28	2,597.28	0.00	0.00	2,708.70	2,708.70	0.00	0.00	(1,877.59)	(366.00)	(1,699.38)	(905.34)

Manjil2OutAsturShah.xls

Figure 9.4.5.2 Manjil, Astur and Shah-rud Dams (with Taleghan/Almout Water Diversion Plan)



ManjilOpeGraphMod.xls

Table 9.4.5.3 Comparison of Simulated Results of Manjil (Sefid-rud) Reservoir Operation (Summary)

Average Annual Figures of Major Parameter of Reservoir Operation

Cace	Description	Inflow (MCM)	Demand (MCM)	Outflow (MCM)	Spillage (MCM)	Shortage (MCM)
(1)	Present Situation w/o Diversion (ES=1,133 MCM)	4,657	3,644	3,275	1,388	371
(2)	With Taleghan/Almout Diversion to Above	4,095	3,644	3,078	1,019	567
(3)	With Astur Dam Construction to Above	4,095	3,644	3,444	667	202
(4)	With Shah-rud Dam Construction to Above	4,095	3,644	3,478	635	168

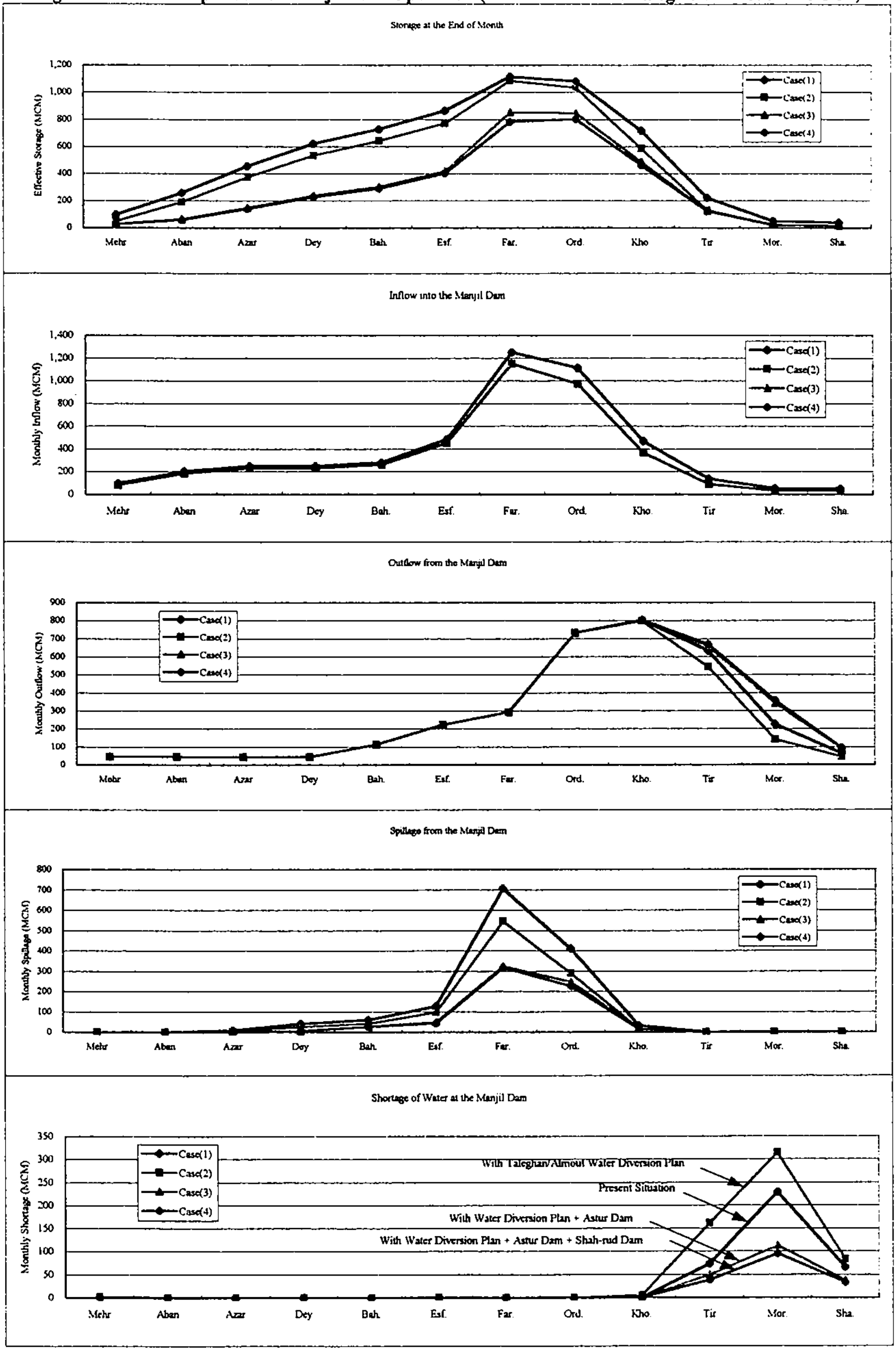
Note: Water demands are those given in Mahab Ghodds Report.

Comparison of Above Computations

Description	Inflow (MCM)	Demand (MCM)	Outflow (MCM)	Spillage (MCM)	Shortage (MCM)
Case(2) - Case(1): Showing Influence of Taleghan/Almout Diversion	(562)	0	(197)	(369)	196
Case(3) - Case(1): Showing Influence of Astur Dam Construction	(562)	0	169	(721)	(169)
Case(4) - Case(1): Showing Influence of Shah-rud Dam Construction	(562)	0	203	(753)	(203)

ManjilOpeSumMod.xls

Figure 9.4.5.3 Comparison of Manjil Dam Operation (with and without Taleghan/Almout Diversion)



ManjilOpeSumMod.xls

Table 9.4.5.4 Comparison of Simulated Results of Manjil (Sefid-rud) Reservoir Operation

(1) Inflow into the Reservoir

Case and Description	Mehr	Aban	Azar	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Annum
Case(1): Present Situation w/o Diversion (ES=1,133 MCM)	98	206	252	252	283	486	1,252	1,114	469	139	55	51	4,657
Case(2): With Taleghan/Almout Diversion to Case(1)	83	185	231	232	262	452	1151	973	368	89	33	36	4,095
Case(3): With Astur Dam Construction to Case(2)	83	185	231	232	262	452	1151	973	368	89	33	36	4,095
Case(3): With Shah-rud Dam Construction to Case(3)	83	185	231	232	262	452	1151	973	368	89	33	36	4,095
Difference (Influence) = Case(2) - Case(1)	(15)	(21)	(21)	(20)	(21)	(34)	(101)	(141)	(101)	(50)	(22)	(15)	(562)
Difference (Influence) = Case(3) - Case(1)	(15)	(21)	(21)	(20)	(21)	(34)	(101)	(141)	(101)	(50)	(22)	(15)	(562)
Difference (Influence) = Case(4) - Case(1)	(15)	(21)	(21)	(20)	(21)	(34)	(101)	(141)	(101)	(50)	(22)	(15)	(562)

(2) Storage at the End of Month

Case and Description	Mehr	Aban	Azar	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Annum
Case(1): Present Situation w/o Diversion (ES=1,133 MCM)	98	259	457	622	730	864	1,116	1,083	718	222	51	39	
Case(2): With Taleghan/Almout Diversion to Case(1)	51	191	374	534	641	771	1085	1033	587	130	22	14	
Case(3): With Astur Dam Construction to Case(2)	28	64	148	240	303	421	853	847	486	123	23	15	
Case(3): With Shah-rud Dam Construction to Case(3)	27	60	140	227	290	402	782	804	461	123	23	15	
Difference (Influence) = Case(2) - Case(1)	(47)	(68)	(83)	(88)	(89)	(93)	(31)	(50)	(131)	(92)	(29)	(25)	
Difference (Influence) = Case(3) - Case(1)	(70)	(195)	(309)	(382)	(427)	(443)	(263)	(236)	(232)	(99)	(28)	(24)	
Difference (Influence) = Case(4) - Case(1)	(71)	(199)	(317)	(395)	(440)	(462)	(334)	(279)	(257)	(99)	(28)	(24)	

(3) Outflow from the Reservoir

Case and Description	Mehr	Aban	Azar	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Annum
Case(1): Present Situation w/o Diversion (ES=1,133 MCM)	46	46	44	45	115	225	293	734	804	634	226	63	3,275
Case(2): With Taleghan/Almout Diversion to Case(1)	46	46	44	45	115	225	293	734	799	546	141	44	3,078
Case(3): With Astur Dam Construction to Case(2)	46	46	44	45	115	225	293	734	804	658	342	92	3,444
Case(3): With Shah-rud Dam Construction to Case(3)	46	46	44	45	115	225	293	734	804	670	360	96	3,478
Difference (Influence) = Case(2) - Case(1)	0	0	0	0	0	0	0	0	(5)	(88)	(85)	(19)	(197)
Difference (Influence) = Case(3) - Case(1)	0	0	0	0	0	0	0	0	0	24	116	29	169
Difference (Influence) = Case(4) - Case(1)	0	0	0	0	0	0	0	0	0	36	134	33	203

(4) Spillage from the Reservoir

Case and Description	Mehr	Aban	Azar	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Annum
Case(1): Present Situation w/o Diversion (ES=1,133 MCM)	0	0	9	42	60	127	707	412	31	0	0	0	1,388
Case(2): With Taleghan/Almout Diversion to Case(1)	0	0	3	27	41	98	545	290	15	0	0	0	1,019
Case(3): With Astur Dam Construction to Case(2)	0	0	0	6	27	49	324	246	15	0	0	0	667
Case(3): With Shah-rud Dam Construction to Case(3)	0	0	0	6	27	43	318	226	15	0	0	0	635
Difference (Influence) = Case(2) - Case(1)	0	0	(6)	(15)	(19)	(29)	(162)	(122)	(16)	0	0	0	(369)
Difference (Influence) = Case(3) - Case(1)	0	0	(9)	(36)	(33)	(78)	(383)	(166)	(16)	0	0	0	(721)
Difference (Influence) = Case(4) - Case(1)	0	0	(9)	(36)	(33)	(84)	(389)	(186)	(16)	0	0	0	(753)

(5) Shortage of Water at the Reservoir

Case and Description	Mehr	Aban	Azar	Dey	Bah.	Esf.	Far.	Ord.	Kho.	Tir	Mor.	Sha.	Annum
Case(1): Present Situation w/o Diversion (ES=1,133 MCM)	2	0	0	0	0	0	0	0	0	74	229	66	371
Case(2): With Taleghan/Almout Diversion to Case(1)	2	0	0	0	0	0	0	0	5	162	314	84	567
Case(3): With Astur Dam Construction to Case(2)	2	0	0	0	0	0	0	0	0	50	113	37	202
Case(3): With Shah-rud Dam Construction to Case(3)	2	0	0	0	0	0	0	0	0	38	95	33	168
Difference (Influence) = Case(2) - Case(1)	0	0	0	0	0	0	0	0	5	88	85	18	196
Difference (Influence) = Case(3) - Case(1)	0	0	0	0	0	0	0	0	0	(24)	(116)	(29)	(169)
Difference (Influence) = Case(4) - Case(1)	0	0	0	0	0	0	0	0	0	(36)	(134)	(33)	(203)

Note: Parenthesis denotes negative values.

Note: Water demands are those given in Mahab Ghodds Report.

ManjilOpeSumMod.xls

CHAPTER 10.

QAZVIN IRRIGATION PROJECT

CHAPTER 10 QAZVIN IRRIGATION DEVELOPMENT

10.1 Importance of Qazvin Irrigation Development

10.1.1 Necessity of Taleghan and Almout Water to Qazvin Plain

Qazvin plain has a large agricultural area of 350,000ha and has supplied various agricultural products to the western capital area of Tehran. In order to establish the irrigated agricultural development in the plain, the Taleghan water diversion project to convey the Taleghan water of 200MCM to the north area of Qazvin plain was implemented in 1970s and its water has been well managed and fully used for irrigation in the north area.

One the other hand, the groundwater development by deep wells has been accelerated for agricultural development in overall Qazvin plain since 1960s and extracts about 1,070MCM for agricultural uses at present.

However, the present irrigation area is still small as 116,000ha or 33% of total agricultural area as compared with the high irrigation intensity of 80 to 85% in Tehran and Karaj region.

Agricultural area in the regions of Tehran, Karaj and Hashtgerd will decreased in future due to conversion of farm land to urban and industrial area. Qazvin plain will fulfill the important role to supply agricultural products to the increasing food demand in the Tehran capital area with a large population of 17 million in 2021. It is necessary accordingly to accelerate the irrigated agricultural development in the plain.

(1) Necessity of Taleghan Water

Taleghan river belongs to Qazvin province and its water is planned originally to be used for agriculture of Qazvin plain in the feasibility study on “Taleghan Multipurpose Water Development Project” prepared in 1967.

The existing Taleghan water diversion project to divert the Taleghan water to Qazvin plain without reservoir dam was implemented after feasibility study, completed at 1971 and has been operated upto now. Namely the existing Taleghan water of 200MCM should be considered as the water right of Qazvin plain because the water has been used since 1970s.

Available Taleghan water is expected to increase to 450MCM by the Taleghan dam under construction and proposed to convey the Tehran urban water supply in future. However, the Taleghan water belongs to Qazvin plain administratively, is planned originally to be used for Qazvin plain and has been used for irrigation of the north area. Accordingly the allocation of Taleghan water of 450MCM after completion of dam shall be carried out taking into account the following reasonable conditions;

- The water of 200MCM, which is the existing water right of Qazvin plain, shall be allocated to

Qazvin.

- The remained water of 250MCM shall be allocated equitably to 125MCM for Qazvin and 125MCM for Tehran water supply.

Namely Qazvin will have the water right to use the water of 325MCM at least after construction of Taleghan dam.

(2) Necessity of Almout Water

As the Taleghan water of 310MCM shall be allocated to Tehran urban water supply with the first priority after construction of Taleghan dam, the allocation water to Qazvin decreases to 140MCM. The water deficiency at Qazvin becomes 185MCM (325-140MCM) and shall be compensated by the Almout water.

It is necessary therefore to set up the Almout water diversion plan so as to diver the water of more than 185MCM at least to compensate the Taleghan water to be transferred to Tehran.

10.1.2 Present Agricultural Status in Qazvin Province

(1) Agricultural Area in Qazvin Province

Whole agricultural area in Qazvin province is estimated at 487,000ha as shown in the following table:

Division	Gross Area (ha)	Remark
North Mountain Foot Area	30,000	Area along north mountain streams
Western High Plateau Area	41,000	Area along western streams
North Canal Area	95,000	Area covered with Taleghan water
Central Canal Area	122,000	Area covered with Almout water
Takestan Area	21,000	Area by groundwater
South River Basin Area	178,000	Area by Abhar-rud, Khah-rud & Haji Arab
Total	**487,000**	

In the above table, the north canal area of 95,000ha, central canal area of 122,000ha and Takestan area of 21,000ha will become the service area to be developed by Taleghan and Almout water. The other area will be developed by the small river waters, three rivers of Abhar-rud, Khah-rud and Haji-Arab and is under study by the local consultant.

In accordance with the newest data of 1999 submitted by Qazvin Agricultural Organization, the cultivation area is 257,800ha of which irrigation area for crops and orchard is estimated 128,600ha and about 44,000ha respectively as shown in the following table.

Cropping area in the three sub-provinces (1999) (ha)

Agricultural land	Qazvin	Takestan	Buin	Total
Cultivated area				
Irrigated	52,300	24,900	51,400	128,600
Non-irrigated	21,200	8,800	26,500	56,500
Total	**73,500**	**33,700**	**77,900**	**185,100**
Fruit tree area				
Young tree	5,400	3,000	2,300	10,700
Production tree	27,400	26,700	8,000	62,000
Sub-total	32,800	29,700	10,300	72,700
Total	**106,300**	**63,400**	**88,200**	**257,800**

Source: Qazvin Agricultural Organization (1999). Irrigated area for fruit tree is not described.

Irrigated orchard area is not shown in the data but assumed at 45,000ha equivalent to 60% for planted area of 72,700ha. Those irrigation area includes the area irrigated by unstable water sources such as stream flows presenting the runoff during only two to three months in spring.

All agricultural area has suffered always from irrigation water shortage and low agricultural productivity. For example, the actual irrigated area in the north canal area is 48,200ha in 1988 which is only 60% against the irrigable area of 76,700ha being covered with the irrigation canal networks.

Cultivated crops in the three sub-provinces (1999) (ha)

Crop	Qazvin	Takestan	Buin	Total
Cereals	44,300	15,900	62,200	122,400
Grains	12,000	500	0	12,500
Industrial crops	100	8,100	2,600	10,700
Vegetables (1)	3,500	2,900	2,800	9,300
Vegetables (2)	500	1,100	2,600	4,300
Feed crops	13,100	5,200	7,700	25,900
Total	**73,500**	**33,700**	**77,900**	**185,100**

Source : Qazvin Agricultural Organization

(2) Present Agricultural Development Strategy in Qazvin Province

Following adoption of the national agricultural policies described in the Third 5-year Economic, Social and Cultural Development Plan to attain self-sufficiency in food production, to achieve sustainable development in agriculture, and to promote agricultural investments and agro-industrial activities, the Qazvin Agricultural Organization has formulated an agricultural development plan to supply perennial irrigation water to approximately 60,000 ha of land through the present canal system with the following strategies:

- To ensure supply of 240 MCM of irrigation water comprising 140 MCM of surface water through the present canal system and 100 MCM of ground water to an irrigable area of 60,000 ha on the basis of an agricultural cultivation plan comprising 50% for main crop cultivation, 15% for summer crop cultivation, and 35% for fallow land;

- To recharge 100 MCM of water to the underground aquifer to overcome irrigation water shortages, especially in draught years;
- To put a 22,000 ha of land spread over Takestan sub-province in the Abhar-rud and Khar-rud river basins under perennial irrigation operations with improvement of the present poor canal system;
- To fully develop Qazvin and Takestan to ensure the constant food supply for the largest consuming area of Tehran and its environs;
- To encourage farmers to invest in agricultural activities and to participate in water management; and
- To promote livestock raising and agro-industries, e.g. sugar and wheat milling, food processing, etc.

As can be seen from the above and given the fact that the Qazvin economy is agronomy based with a predominant focus on diversified agriculture, the strategies envision increased demand pull through achievement of high cropping intensity under year-round irrigation, and specialization and commercialization of agricultural products. This will accelerate agricultural production, which in turn will be a catalyst for regional economic growth, generating employment opportunities in both the agricultural and non-agricultural sectors.

(3) Farming Features in Qazvin Province

Farming features of Qazvin Plain is as follow;

① prevalence of predominantly commercialized/specialized agriculture with crop diversification (cereal crops, pulses, industrial crops, vegetables, forage cops, and fruits), functioning as a supply base of foodgrains, vegetables and fruits for the major consumption center of Tehran and its environs;

② small land holdings (1.1 ha for Qazvin, 4.3 ha for Buin Zahra, 1.3 ha for Takestan, and 1.6 ha for the whole Qazvin plain),

③ low productivity due to saline contamination of soil;

④ promotion of livestock and poultry breeding; and

⑤ establishment of agro-industries, such as sugar and wheat flour milling, and food processing and preservation.

Agricultural population in Qazvin province in 1375 (1996/97) has been estimated at 968,300 (approximately 276,700 farm households), comprising 656,900 (187,700 households) for Qazvin sub-province, 151,800 (43,400 households) for Buin Zahra sub-province, and 159,600 (45,600 households) for Takestan sub-province.

Crop-wise production over the period 1374 (1995/96) to 1377 (1998/99) indicates that production of maize, industrial crops (cotton, sugar beets, and oilseeds), and forage crops (alfalfa and clover) was at a modest acceleration rate, while that of cereals such as wheat, barley and pulses showed a downward trend due to draught-induced losses in cropped area as shown below. Food grain production has been estimated to decrease substantially by 40.0% due to irrigation water shortages in 1377 (1998/99), compared with a 26.7% increase in 1376 (1997/98), while industrial crops and vegetables increased by 43.2% and 33.1% in production, respectively. Especially, reduction in the production of barley and wheat was acute at 65.4% and 38.8%, respectively. This was due primarily to decreasing yield per hectare for food grain output on account of the draught, rather than decreasing cropped area.

Crop Production in Qazvin Plain

Crop	1374 (1995/96)	1375 (1996/97)	1376 (1997/98)	1377 (1998/99)
Cereal Crops (%)				
Wheat	35.1	27.4	21.9	13.9
Barley	9.6	9.4	7.1	2.5
Maize	0	0	1.8	2.7
Pulses (%)	1.4	1.1	0.4	0.2
Industrial Crops (%)	24.7	16.7	20.5	30.4
Vegetables (%)	17.1	18.4	14.1	19.5
Forage Crops (%)	12.1	27.0	34.2	30.8
Total (metric tons)	782,223 (100.0)	700,311 (100.0)	1,059,803 (100.0)	1,022,692 (100.0)

Source: Qazvin Agricultural Organization.

(4) Self-sufficiency in Food Production in Qazvin Province

Crop-wise self-sufficiency rates in food production have been estimated on the same assumptions as described in the Section 2.3.4, and are summarized below. It should be noted that the self-sufficiency rates are approximate.

Crop-wise Self-sufficiency Rates

Province	Crop	Production (metric ton)	Per Capita Consumption (kg/person)	1375 (1996/97) (%)	1400 (2021/22) (%)
Qazvin	Wheat	158,211	149.9	106.4	76.3
	Barley	28,874	0.53	5,491.9	3,939.2
	Maize	8,230	34.9	23.8	17.1
	Paddy	27,470	0.77	3,596.3	2,579.6
	Beans	1,860	1.67	112.3	80.5
	Potatoes	48,730	40.3	121.9	87.4
	Onions	4,179	16.0	26.3	18.9
	Tomatoes	168,252	30.7	552.5	396.3
	Grapes	292,018	23.6	1,247.3	894.7

Source: 1) "Food Balance Sheets", FAO.
2) "Agricultural Production Costs, 1376778", Agricultural Statistics and Information Department, Ministry of Agriculture.

The self-sufficiency rate of wheat in Qazvin province is forecast to decrease from 106.4% in 1375 (1996/97) to 76.3% in 1400 (2021/22) if the present farming practices remain unchanged over the future. The crops making it possible to attain self-sufficiency in 1375 were wheat, barley, maize, beans, potatoes, tomatoes and grapes. Barley and maize are used mostly for animal feed.

In these circumstances, it is deemed essential to promote further agricultural development, including livestock and poultry with the view to reducing the heavy dependence on government subsidies for wheat and other basic food imports and eventually enhancing the role of Qazvin province as a stable food supply base for Tehran and its environs, suffering from increasing population pressure, through the attainment of self-sufficiency in food production with an adequate surplus. In this respect, the implementation of the proposed central irrigated agricultural project is highly important.

10.2 Conceptual Plan of Irrigation Development by Taleghan and Almout Water

10.2.1 Irrigation Service Area by Taleghan and Almout Water

Irrigation service area in Qazvin plain to be developed by the Taleghan and Almout water is selected taking into account the following conditions;

- Available Taleghan water at present in Qazvin plain is 200MCM per annum consisting of 140MCM for actual irrigation use, 30MCM for the water losses in deteriorated canal and 30MCM for recharging amount for groundwater. This available water will increase to 300MCM in 2011 after completion of Taleghan dam, because Tehran urban water demand is still 150MCM in 2011 and the Taleghan reservoir has allowance to supply the water of 300MCM to Qazvin plain.

  However, available Taleghan water to Qazvin in 2021 will decrease to 140MCM because Tehran urban water demand requires the Taleghan water of 310MCM.

- Accordingly the Almout water diversion project will be implemented by 2011 to compensate the decreasing Taleghan water to Qazvin plain. The Almout water diversion project could supply the water of 250MCM in addition to Taleghan water of 140MCM. Namely irrigation water of 390MCM in total could be used in Qazvin plain after the year of 2011.

- The existing north irrigation area has the priority to use the above Taleghan and Almout water. Though the existing north area has a large irrigable area of 76,700ha, the actual irrigation area at present is 48,200ha equivalent to the irrigation intensity of 63%. In order to increase the irrigation intensity in future and use the Almout water effectively, the north area is divided into two parts, one is the higher area lying on the elevation of higher than 1,250m, which could be irrigated by Taleghan water of 140MCM through the existing north irrigation canal, the other is the lower area being located at the elevation of lower than 1,250m and irrigated by the Almout water because the Almout water is diverted with a gravity system in Qazvin plain with the elevation of 1,250m.

- A part of Almout water shall be supplied to the central area which has been irrigated by groundwater but suffered from water shortage in order to allocate the Almout water to the north and central area equitably and develop the both areas without difference.

(1) Diversion of Existing North Irrigation Area

The existing north irrigation area is divided into the higher and lower area as shown in the following table.

Higher and Lower Area in Existing North Irrigation Area

Secondary Canal	Higher Area (ha) Above 1,250m	Lower Area (ha) Below 1,250m	Total (ha)	Remarks
L-1	600	3,800	4,400	Irrigated mostly by Almout
L-2	700	6,000	6,700	- do -
L-3	1,200	17,300	18,500	- do -
L-4	2,700	200	2,900	Irrigated mostly by Talegan
L-4A	2,700	700	3,400	- do -
L-5	2,400	0	2,400	- do -
L-6	4,000	5,400	9,400	Irrigated by Taleghan & Almout
L-7	9,800	100	9,900	Irrigated mostly by Taleghan
L-8	6,800	3,600	10,400	- do -
L-9	3,400	0	3,400	- do -
L-10	3,300	0	3,300	- do -
L-20	1,000	1,000	2,000	Irrigated by Taleghan & Almout
Total	**38,600**	**38,100**	**76,700**	

The present irrigation intensity of 63% in the higher and lower area is improved to 75% in future by the Taleghan and Almout water resources development.

(2) North Takestan Area

North Takestan area being expanded at the end of the existing north main canal has a potential irrigable area of 9,000ha and is presently irrigated by groundwater. However the actual irrigation area is small as 6,000ha equivalent to the irrigation intensity of 67% and the groundwater level is lowering year by year. Accordingly, this area will be irrigated by the existing north canal conveying the Taleghan water. The present irrigation intensity of 67% is increased to 75%.

(3) Central Area

The central area locates adjoining the lower area of existing north irrigation area and has a irrigable area of 60,900ha which is irrigated by groundwater. However the actual irrigation area at present is 28,000ha equivalent to the irrigation intensity of 46% due to insufficient groundwater. Accordingly the central area will be irrigated by the Almout water. The irrigation intensity in future increase to 75%. Since the farm land with saline problem is existing in the central area, irrigable area shall be selected carefully by carrying out the soil survey in Feasibility Study.

(4) Summary of Irrigation Service Area

Proposed irrigation service area is summarized in the following table taking into account the available Taleghan and Almout water and existing groundwater. The present net irrigation area of 81,200ha will increase to 109,600ha in 2021 by the Taleghan and Almout water. The increment area is 28,400ha. Of course, this allocation of irrigation area is tentatively proposed on the conceptual plan level and shall be reviewed in the future Feasibility Study.

Summary of Irrigation Service Area

Unit: ha

Division	Irrigable Area	Present Net Irrigation	Proposed Net Irrigation	Increment Area	Water Sources
1. Existing North Area					
North High Area	38,600	24,200ha (63%)	28,900 (75%)	4,700	Taleghan
North Low Area	38,100	24,000ha (63%)	28,500 (75%)	4,500	Almout
Sub-total	76,700	48,200ha (63%)	57,400 (75%)	9,200	
2. Takestan Area	9,000	6,000ha (67%)	6,700 (75%)	1,700	Taleghan
3. Central Area	60,900	27,000ha (44%)	45,500 (75%)	17,500	Almout
Total	**146,600**	**81,200ha (55%)**	**109,600 (75%)**	**28,400**	

10.2.2 Proposed Irrigated Water Demand

(1) Proposed Cropping Area

Cropping area is planned based on the data and information from the study report prepared by Qazvin Agricultural Organization. Discussion with experts of related agencies was also reflected on the planning. As the result, rate of the cropping area is planned as follows.

Proposed Cropping Area

Crop	Cropping area (%)
Cereals (wheat, barley)	58.7
Grains (pea, beau, lentil)	1.8
Industrial crops (sugar beet, sunflower)	5.2
Vegetables (water melon, potato, tomato, etc)	3.0
Feed crops (alfalfa, grass, corn, etc)	10.2
Fruit tree (grape, fruit garden, etc)	21.1
Total	**100.0**

In the proposed cropping area, cereals such as wheat and barley have biggest share, occupying 59 % of the total cropping area. As the next crop, fruit garden area occupies 21 %. Remaining is in grass, vegetable and others.

According to the water quality test, salty groundwater is observed in the south part of the central area and the cropping pattern in its area will be carefully studied in future taking into account distribution of saline soil and groundwater.

(2) Unit Irrigation Requirement

Unit irrigation requirement for different crops is studied and proposed by the Qazvin Irrigation Company based on the past water operation experience for the cropping pattern irrigation schedule, diversion water at canal turnout, etc and its result is shown in the following table.

Unit Irrigation Requirement for Major Crops (m^3/ha)

Crop	Standard by Irrigation Company (*2)
Wheat	8,000
Barley	6,000
Lentil	5,500
Alfalfa, Clover	16,500
Corn	11,000
Water melon	7,000
Potato	12,500
Tomato	16,000
Sugar beet	16,500
Sunflower	7,000
Grape	16,500
Fruit garden	18,500

The average unit irrigation requirement is estimated at 10,700m^3/ha based on the rate of cropping area mentioned in the above (1) and the above unit irrigation requirement. This value of 10,700m^3/ha is estimated under the present irrigation conditions and seems to be slightly high taking into account the existing low irrigation effecy.

However the average unit irrigation requirement will increase in future, in case the cropping area for summer crops increases.

Accordingly the average unit irrigation requirement of 11,000m^3/ha is adopted with some allowance, because the irrigation plan by the Almout water diversion is only conceptual basis.

(5) Present Available Irrigation Water

Present available irrigation water in the north irrigation area, Takestan area and central area is assumed as follows based on the availability of Taleghan water and groundwater.

Present Available Irrigation Water

Division	Actual Irrigation Area (ha)	Water Demand (MCM)	Available Irrigation Water (MCM)					
			Taleghan Water (MCM)	Groundwater			Total Irrigation Water
				No of Wells	Yield/Well (m^3)	Amount (MCM)	
(1) North Irrigation Area							
Higher Area	24,200	266.0	80.0	380	500,000	190.0	270.0
Lower Area	24,000	246.0	60.0	420	500,000	210.0	270.0
Sub-total	48,200	530.0	140.0	800	-	400.0	540.0
(2) Takestan Area	6,000	66.0	0	240	300,000	70.0	70.0
(3) Central Area	27,000	297.0	0	1,360	250,000	340.0	340.0
Total	**81,200**	**893.0**	**140.0**	**2,420**	**-**	**810.0**	**950.0**

- Water demand is estimated based on the average unit irrigation requirement of 11,000m^3/ha.
- The north higher area can take easily the Taleghan water as compared with the north lower area

because the higher area is lying on the upstream of the lower area along the lateral canal. Accordingly, Taleghan water of 80MCM is assumed to be used for the higher area and 60MCM for the lower area.

- In accordance with the inventory survey result, about 800 wells with average annual yield of 500,000m^3 are provided for irrigation in the north area and the groundwater of about 400MCM is extracted.
- In Takestan area, groundwater of 70MCM per annum is extracted for irrigation by 240 wells. The groundwater level in Takestan area has been lowering as shown in figures for groundwater analysis in Chapter 3 due to the over extraction of groundwater. Accordingly, groundwater recharge program will be required at the area to extract the groundwater of 70MCM every year.
- In the central area, the large groundwater amount of 340MCM developed by shallow and deep wells of 1,360 units is used presently for irrigation. Groundwater yield in the central area is as small as 250,000m^3/well as compared with 500,000m^3/well in the north area because the recharging capacity and recharging surface water in the central area is smaller than those in the north area.

(6) Proposed Available Irrigation Water

Proposed available irrigation water is estimated and allocated with the following conditions.

- As Taleghan water of 140MCM is controlled water by Taleghan dam, it can be used fully for irrigation based on the irrigation schedule without releasing the water in winter season from the reservoir.
  Out of 140MCM, 130MCM is allocated to the higher area of north irrigation area and 10MCM to Takestan area.
- As Almout water of 250MCM is the diversion water without control by reservoir, the usable water for irrigation is 210MCM and the surplus water of 40MCM in winter season is used for groundwater recharge.
  Out of 210MCM, 90MCM is allocated to the lower area of north irrigation area and 120MCM to the central area.
- Groundwater to be used for irrigation in the higher area of north irrigation area is estimated at 190MCM equivalent to the present extracted amount.
- Groundwater for the lower area is estimated at 230MCM which is 20MCM larger than the present value because groundwater recharging volume in the lower area will be increased by increasing return flow of irrigation water in the north irrigation area and recharging water of Almout.

- Groundwater for the central area is estimated at 380MCM which also is 40MCM larger than the present value because of increasing irrigation return flow and recharging water by Almout water diversion.

In accordance with the above estimation for available irrigation water, the water allocation plan for each irrigation area is summarized as shown in the following table.

Proposal Available Irrigation Water at Each Irrigation Area

Area	Net Irrigation Area (ha)	Water Demand (MCM)	Available Irrigation Water (MCM)			
			Taleghan Water (140)	Almout Water (250)	Ground-water (870)	Total (1,260)
(1) North Irrigation Area						
Higher Area	28,900	318	130	-	190	320
Lower Area	28,500	314	-	90	230	320
Sub-total	57,400	632	130	90	420	640
(2) Takestan Area	6,700	74	10	-	70	80
(3) Central Area	45,500	501	-	120	380	500
Total	**109,600**	**1,207**	**140**	**210**	**870**	**1,220**
Recharging Water	**-**	**-**	**-**	**40**	**-**	**40**

Note: Water demand is estimated at 11,000m^3/ha for net irrigation area.

10.2.3 Rehabilitation of Existing North Canal System

The existing north irrigation canal system has been operated since 1970s and deteriorated and as the result the Qazvin irrigation company has faced the following problems in the canal water management.

- Difficulty of water supply to beneficial farmers based on the contracted amount with them.
- Many water losses through the regulator and turnout gates and concrete structures which are already bracken.

JICA Team has carried out the inventory survey of the rehabilitation works for the existing canal structures by employing the Lar Consulting Engineers. Kinds and quantity of rehabilitation works are as shown in the following table.

Quantity of Rehabilitation Works

Rehabilitation facilities	Quantity	Rehabilitation items
Rehabilitation of concrete structures	588 places	Reinforcement with concrete
Repair of gate		
- Repair/replacement of gate body	133 places	Repair, replacement
- Replacement of arch gate	250	Type from 50 lit to 1,000 lit
- Replacement of other gates	200	
- Replacement of gate frame	200	

Source: Inventory survey (2000)

There are existing 63 combined wells along the north canal but the active wells is only 11 units at present. In accordance with the inventory survey result, 32 wells require replacement of pumping equipment and 20 wells require the new pumping station including pumping houses.

Rehabilitation works shall be carried out firstly at the main canal and the lateral canal covering the higher area. The works for the lower area will be carried out after the feasibility study for the central irrigation development project because the lateral canal in the lower area may be changed its structural dimension to convey the Almout water.

10.2.4 Preliminary Design of Central Canal

The existing north irrigation canal system is not changed at all except the lateral canal in the lower land area and could convey the Taleghan water of 140MCM to be controlled by the reservoir to the high land beneficial area. However, the central canal is newly proposed to convey the Almout water of 250MCM to the lower land area and the central area being located at the elevation below 1,250m.

(1) Basic Plan

The basic plan of the central canal shall be formulated with the following concept.

- The canal alignment is set up so as to cover the area with the elevation below 1,250m.
- The lower land area in the north irrigation area, which is under irrigation by Taleghan water has a priority to use the Almout water.
- The central farm area to be irrigated by the Almout water shall be selected based on the soil and land classification in the area because some area in the central is suffering from saline soil and not suitable for agriculture.
- Recharging ponds for groundwater shall be provided at the end of lateral canals in the higher land area in order to collect the drain water from the lateral canal. Those recharging ponds will be provided along the alignment of the central canal.
- Large recharging ponds for groundwater also shall be provided at C6 and C7 places along the canal alignment. Those places are consisting of vast and deep alluvial plain not suitable for agriculture but for recharging ponds.
- Combination wells to extract groundwater in summer season also shall be provided along the lateral canals.
- The central canal will be extended to Buin Zahra district being suffered from chronic water shortage if possible, though the canal length becomes longer.

(2) Canal Structure Design

The proposed canal structure is designed as shown in the attached figure and Database Map taking into account the following conditions;

- The water level of Almout water diversion tunnel is set up at 1,250m.
- The central canal will start at the regulating reservoir to control the Almout water, which is located at the downstream of No.2 Lateral canal and near the railway.
- The canal alignment is placed so as to cover the central area as large as possible by gravity flow system and the canal slope of 1 to 5,000.
- Discharge capacity of canal is 22.5m3/sec.
- 10 secondary canals are provided to cover the irrigation area.
- Main and secondary canal is designed with concrete living.
- The central main canal reaches finally to Buin area with the length of 125km.

(3) Recharge Pond

In order to recharge the winter and surplus water in the Almout water and the drainage water at the lateral canals in the higher land area to groundwater, the recharge ponds shall be provided along the central canal alignment.

(4) Drainage Canal System

The east part of the central plain is located at the low land near the salt marsh and has always saline problem. In order to drain the surplus surface and irrigation water and prevent the saline water, the drainage system shall be provided at the lower area.

(5) Outline of Qazvin Irrigation Canal System

Outline of Qazvin irrigation canal system is summarized in the following table based on the preliminary design.

Outline of Qazvin Irrigation Canal System

Item	Existing North Area		Proposed Central Canal	
1. Irrigable Area (ha)	North, Higher	38,600	North, Lower	38,100
	Takestan	9,000	Central	60,900
	Total	**47,600**	**Total**	**99,000**
2. Net Irrigation Area (ha)	North, Higher	28,900	North, Lower	28,500
	Takestan	6,700	Central	45,500
	Total	**35,600**	**Total**	**74,000**
3. Irrigation Intensity (%)		75		75
4. Available Irrigation Water (MCM)				
Talegan water		140		-
Almout water		-		210
Groundwater		260		610
Total		**400**		**820**
5. Recharging Water		-		40
6. Irrigation Canal System				
Main Canal	Q=30m^3/sec, L = 94km		Q=22.5m^3/sec, L=125km	
Secondary Canal	12 units, L = 220km		10 units, L=150km	
7. Production Wells		800units		1,600units

(6) Implementation Schedule

The existing north canal system has been deteriorated and require the rehabilitation works.

In order to carry out the smooth water management for the canal system and minimize the water losses through canal system, the rehabilitation works shall be implemented as early as possible.

As the central canal is newly implemented to use the Almout water, the feasibility study, detailed design and construction will be carried out in parallel with the Almout water diversion project.

The proposed implementation schedule is as follows;

Implementation Schedule for Qazvin Irrigation Project

	2003	2004	2005	2006	2007	2008	2009	2010	2011
North Canal	◄	Rehabilitation	►						
Central Canal	◄ F/S ►	◄ D/D	►	◄		Construction			►

10.2.5 Project Cost Estimation

(1) Construction Cost

As the construction of Qazvin irrigation canal could be easily carried out by the contractor, the construction cost is estimated with the prevailing unit price for the civil and mechanical works of the canal.

10^3US$

Item	Total Amount	Foreign Portion	Local Portion	Remark
1. Temporary Works	1,986	920	1,066	
Sub-total	1,986	920	1,066	
2. Rehabilitation Works				
North Main Canal	2,357	1,092	1,265	FP=46.3%
Pump at Combined Well	248	115	133	LP=53.7%
Sub-total	2,605	1,207	1,398	
3. Qazvin Central Canal				
Main Canal	6,244	2,894	3,350	
Secondary Canal	4,713	2,184	2,529	
Recharge Ponds	947	439	508	
On Farm Facility	20,205	9,365	10,840	
Sub-total	32,109	14,882	17,227	
Total	**36,700**	**17,010**	**19,690**	

(2) Project Cost

Project cost shall include the other expenses of engineering administration, land acquisition, environmental mitigation, etc in addition to the construction cost and estimated as follows;

Item	Total Amount	Foreign Portion	Local Portion	Remark
1. Construction Cost	36,700			F.C %
2. Engineering/Administration Expenses	1,800	0	1,800	F.C 0 L.C 100%
3. Land Acquisition Expenses	3,000	0	3,000	
Total	**41,500**			

10.3 Project Evaluation

10.3.1 Evaluation Criteria

(1) General

Economic evaluation aims at assessment of the Project in terms of contribution to the national economy, while financial evaluation is carried out to estimate the profitability of individual household economies after project implementation. On the basis of project benefit and cost comparison for the two cases of (a) future without project (hereinafter called FW/O) and (b) future with project (hereinafter called FW), the economic viability of the Project is examined in terms of the three criteria of Net Present Value (NPV), Benefit/Cost Ratio (B/C Ratio), and Economic Internal Rate of Return (EIIR). Financial evaluation, on the other hand, focuses on farm income analysis in the Qazvin irrigation area of the benefit area.

(2) Basic Evaluation Criteria

(a) Interpretation of Future Without Project Case

For the FW/O case, evaluation is in terms of future prices; however, it is assumed that the present farming system including unit yield and farming technology will remain unchanged over the future.

(b) Project Life

Project life is set at 59 years considering the utility life of the proposed water diversion and irrigation facilities, including the construction period of 9 years.

(c) Project Benefit and Cost

Under financial evaluation, project benefit and cost are expressed in terms of market prices (financial prices). Economic evaluation is in terms of border prices (economic prices) with elimination of transfer payment and application of conversion factors.

(d) Inputs and Outputs

(i) Traded Goods

Economic prices of traded goods such as agricultural products and chemical fertilizers are based on 1389 (2010/11) international market prices (1378: 1999/00 constant prices) as shown in Table 10.4.1.1 in the Supporting Report. As a result, inflation is not considered for evaluation.

Farm-gate prices of agricultural products and chemical fertilizer are based on FOB/CIF prices and take into account tariffs and marketing cost including transport/handling costs, after which tariffs and taxes are then eliminated and the necessary conversion factor applied. Financial and economic prices of agricultural commodities and inputs are shown in Table 10.4.1.2-19 in the Supporting Report.

(ii) Non-traded Goods

In the case of non-traded goods, domestic market prices have been applied for financial prices. On the other hand, in the case of economic prices the composition of non-traded goods has been broken down into traded component, non-traded component, labour and transfer payment. In the case of the traded, non-traded, and labour components, border price, standard conversion factor (SCF), and shadow wage rate (SWR) are applied, respectively. SCF has been estimated at 0.97 as shown in Table 10.4.1.20 in the Supporting Report.

(e) Capital

The World Bank's estimated value of 12% is applied as the opportunity cost of capital for Iran.

(f) Foreign Exchange

The prevalent exchange rate system is based on the dual official exchange rates (the floating rate at 1,750 rials per U.S. dollar for imports of essential food commodities, and agricultural inputs such as chemical fertilizers and agro-chemicals, and the export rate at 3,000 rials per

U.S. dollar for exports of non-oil commodities and imports of industrial goods and raw materials) and the free market rate at 8,000 rials per U.S. dollar. Accordingly, the official and free market exchange rates are adopted in case of the financial analysis, while a shadow exchange rate, US$ 1 = Rials 4,900, an average of the floating rate at 1,750 rials and the free market rate at 8,000 rials is used for the economic analysis.

(g) Labour

The nominal wage rate is applied under financial analysis. Under economic analysis, the shadow wage rate (SWR) for unskilled labour is estimated at 0.485 by setting the opportunity cost of unskilled labour at 0.5, multiplied by the SCF of 0.97, due to high unemployment at 6.1 – 6.8% in the Study Area. The unemployment situation including underemployment is acute, indicating an excess supply of labour in the labour market, especially in rural areas.

10.3.2 Project Cost

Total project cost comprises the construction cost (diversion dam, diversion tunnel and pipeline, rehabilitation of existing facilities, the Qazvin central canal system, access road, O & M office, etc.), the engineering and administration cost, other related costs, the annual O & M cost, and the replacement cost of equipment.

(1) Project Cost

In order to convert costs for individual construction work items (financial prices) into economic prices, transfer payment was eliminated and conversion factors applied as shown in Table 10.4.2.1 in the Supporting Report. Consequently, the Project cost in economic terms has been estimated at US$ 129,189,500 (equivalent to 633,028.6 million rials) (see Table 10.4.2.2 in the Supporting Report). The salvage value of the facilities was not included in the calculation of the Project cost.

(2) Annual Operation and Maintenance Cost

O&M cost in economic terms has been estimated at 3,421.6 million rials by applying an SCF of 0.97 as shown in Table 10.4.2.3 in the Supporting Report.

(3) Replacement Cost of Equipment

Replacement cost in financial terms is converted to economic terms applying an SCF of 0.97 as shown in Table 10.4.2.4 in the Supporting Report.

10.3.3 Project Benefit

The benefits to be generated by the Project are diverse, including external economic benefits (secondary benefits); however, water supply for agricultural development in the Qazvin plain is computed as the direct benefit under the Project.

For agricultural development, the benefit from increased production of agricultural products was calculated on the basis of comparison of the FW/O and FW cases in the relevant benefit area. Financial prices were converted into economic terms by eliminating transfer payments and applying the SCF of 0.97 as summarized below (see Table 10.4.3.1-9 in the Supporting Report).

Achievement of target yields under the Project for agricultural products is assumed to be 80% in the first year of cultivation possible in the benefit area, and 90% and 100%, respectively, in the second and third years (see Table 10.4.3.10-12 in the Supporting Report).

Agricultural benefits in the benefit area have been calculated based on expansion of the existing cropped area as shown in Table 10.4.3.13 in the Supporting Report. Annual financial benefits under the Project have been calculated at 81.3 billion rials at full development in the benefit area, while economic benefits are accounted at 147.6 billion rials as shown in the following table;

Summary of Agricultural Benefits at Full Development in Beneficial Area

Crop	Incremental Cropped Area (ha)	Benefit Per ha 10^3 rials		Total Benefit 10^6 rials	
		Financial	Economics	Financial	Economics
	①	②	③	④=①×②	⑤=①×③
Wheat	10,479	1,554.5	3,826.9	16,289.6	40,102.1
Barley	6,021	712.0	2,076.5	4,287.0	12,466.5
Maize	625	3,541.6	7,174.6	2,213.5	4,484.1
Cotton	28	2,923.4	2,870.2	81.9	80.4
Sugar Beets	1,022	3,648.0	8,965.1	3,728.3	33,424.2
Oilseeds (sunflower seeds)	426	603.4	697.8	257.0	179.4
Pulses (navy and kidney beans)	511	785.6	1,036.7	401.4	529.8
Potatoes	398	2,481.0	2,985.3	987.4	1,188.1
Onions	85	4,089.4	4,380.0	347.6	372.3
Water Melons	398	6,362.2	6,635.8	2,532.2	2,641.0
Forage Crops (alfalfa)	2,471	7,273.2	7,093.4	17,972.1	17,527.8
Grapes	5,936	5,418.1	5,835.0	32,161.8	34,641.9
Total	**28,400**			**81,259.8**	**147,637.6**

10.3.4 Financial and Economic Analyses

(1) Economic Viability of the Project

In terms of the three criteria in the previous section 10.4.1, economic viability indicators are summarized below (see Table 10.4.4.1-5 in the Supporting Report).

Summary of Economic Viability Indicators

NPV (10^6 rials) (12% discount rate)	B/C Ratio (12% discount rate)	IRR (%)
94,790.2	1.3	14.5

The above result shows that this project is economically viable, with even greater benefit when indirect ripple impact of the project is considered.

(2) Sensitivity Analysis

The following cases were assumed in analyzing the impact of economic uncertainty on the economic viability indicators of the project.

Case ①: Total project cost increases by 10% due to increased prices for construction materials, equipment and labour.

Case ②: Total project benefit drops by 10% due to difficulty in achieving target yields, and other negative factors.

Case ③: Combination of cases ① and ②.

Results of sensitivity analysis on the basis of the above three cases are summarized below (see Table 10.4.4.6 in the Supporting Report).

Summary of Sensitivity Analysis

Case ①	Case ②	Case ③
13.6%	13.5%	12.5%

Although project economic viability is more sensitive to decrease in project benefit rather than increase in project cost, no significant negative effect on economic justifiability is anticipated.

(3) Farm Income Analysis

Farm income analysis estimates the incremental benefits arising from farming activities as a result of project implementation. The impact of implementation on the farm incomes of households in the benefit area will be considerable with a shift from either (a) seasonally irrigated agriculture (which presently suffers from unavailability of adequate irrigation water during the dry months) or (b) rainfed agriculture, to year-round irrigated agriculture with crop diversification in line with the national agriculture policy.

With project implementation, average annual net farm incomes from which agricultural input expenses are subtracted will increase considerably as shown below (see Table 10.4.4.7 in the Supporting Report).

Summary of Net Farm Income

Benefit Area	Net Income W/O (Rials/year)	Net Income FW/O (Rials/year)	Net Income FW (Rials/year)	Net Increment FW - FW/O (Rials/year)
Qazvin	3,318,034	3,631,224	4,618,560	987,336
Buin Zahra	13,011,381	14,220,787	17,842,566	3,621,779
Takestan	3,938,431	4,306,961	5,572,024	1,265,063
Average	4,844,543	5,300,583	6,768,982	1,468,399

With project implementation, average farm incomes will increase by 27.7% in the whole benefit area, being highest at 29.4% for Takestan, and lowest at 25.5% for Buin Zahra. The highest increase in net farm income is recorded in Takestan, thereby leading to a high degree of poverty alleviation, simultaneously with acceleration of agro-industrial development.

(4) Indirect Ripple Impact

In addition to the direct benefit from the Project as a result of the increased production of agricultural products, the following indirect ripple impact would occur.

(a) Forward Related Impact

With the increased production of agricultural products, agricultural inputs such as chemical fertilizer and agro-chemical consumption will also increase, which will in turn stimulate industries related to the production and marketing of these items and thereby generate increased employment opportunities. Estimated annual retail margin increase for agricultural inputs sales in the benefit area is indicated below (see Table 10.4.4.8 in the Supporting Report).

Forward Related Impact

Agricultural Inputs	Incremental Retail Margin (million rials)
Seeds	7,341.4
Chemical Fertilizer	
- Urea	3,106.1
- Ammonium Phosphate	1,594.6
- Ammonium Nitrate	91.7
- Sub-total	4,792.4
Agro-chemicals	1,161.3
Total	**13,295.1**

(b) Backward Related Impact

Increased production of agricultural products will be expected to induce an annual income increase for local collectors and millers.

(c) Generation of Employment Opportunities

Project implementation will generate an estimated 1,271,000 man-days of unskilled labour employment comprising 770,200 man-days during the overall construction period, and 500,800 man-days annually during the farming period at full development (see Table 10.4.4.9 in the Supporting Report).

(d) Enhanced Standard of Living

Increased farm income will improve farmer standard of living, also increase farmer purchasing power, and further stimulate commercial activity in the benefit area. This will also contribute to rectifying the gap in living standards between urban and rural areas.

(e) Generation of Value Added

With project implementation, a considerable portion of the project cost will be directed at the procurement of locally produced construction materials. Also, large scale employment of local labour during the construction period will increase the purchasing power of these workers. Accordingly, production activities will be stimulated in the construction materials and consumer goods sector, leading ultimately to generation of new value added for produced items.

Consideration of the above indirect ripple impact indicates a considerable overall socio-economic profitability to emerge under the Project.

(5) Other Benefits

(a) Socio-economic Impacts

- Relief of critical water shortages in 3 large cities (Tehran, Karaj Bozorg, Qazvin) and other industrial and urban cities, and rural areas due to conversion of irrigation water from the Taleghan dam to domestic water destined for large urban areas;
- Stable supply of perennial irrigation water to make possible a multiple cropping system in the agricultural areas in the Qazvin plain;
- Mitigation of occasional inundation damages to the existing farmlands along the Alamut river, contributing to agricultural development for good-quality paddy cultivation in the Shah-rud river basin;
- Fostering of regionally-based industries (including agro- and cottage industries), and promotion of commercial activities (including agri-business) in urban and rural areas;
- Braking massive migration to Tehran, thereby easing population pressure through agricultural development in the Qazvin plain;
- Rectification of regional imbalance, especially in the Qazvin plain;
- Poverty alleviation in the benefit area;
- Up-grading of literacy rate in the benefit area; and
- Reduction in government subsidy burden on food procurement.

(b) Institutional Impacts

- Checking and revision of available data and information on water resources, and integrated management processing of such data and information;
- Necessity for establishment of an integrated water management center;
- Establishment of a legal framework on over-pumping of groundwater, and penalty thereto;
- Promotion of a water-save campaign for the public; and
- Promotion of interagency coordination among line agencies.

(c) Technical Impacts

- Transfer of technological know-how in respect of integrated water management and tunnel construction;
- Optimization of currently available water resources;
- Formulation of optimal water resources management policy and measures; and
- Promotion of learning-by-doing practice.

(d) Environmental Impacts

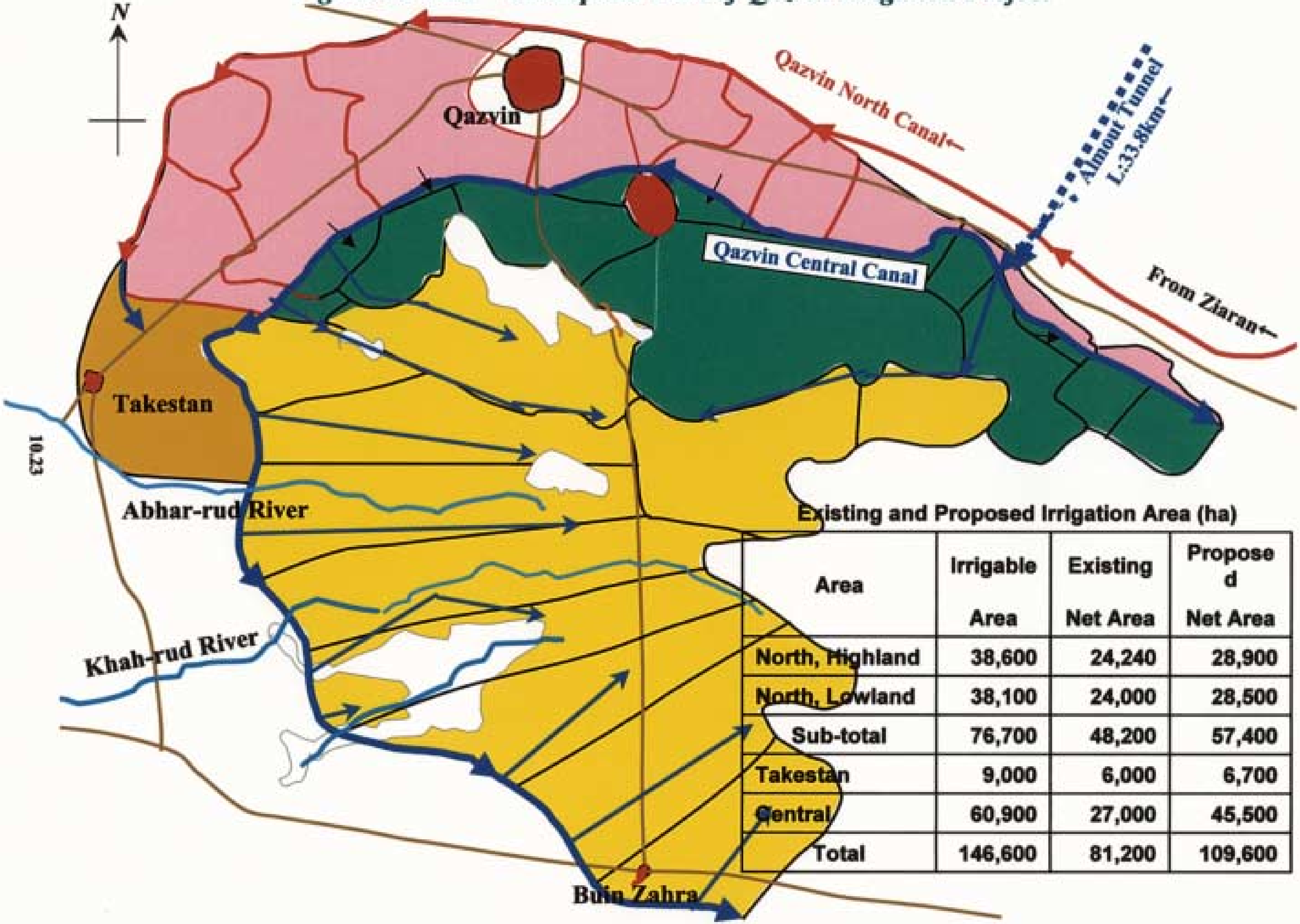
- Run-off decreases in Shah-rud river basin (negative impact);
- Conservation of local fauna and flora to the maximum possible extent;
- Appropriate disposal of tunnel excavation residue;
- Sustenance of the local eco-system and other environmental localities at Alamut by adopting environmentally-friendly measures in implementing the Project; and
- Promotion of tourism (provision of a recreation area) at Alamut;

As discussed earlier, Iran continues to remain heavily under the effects of water shortages not only in urban areas but in agricultural areas. Tehran has experienced its worst water crisis over the last decades due to excessive water consumption by Tehranis, the industrial and commercial sectors, and extraordinary climatic conditions, i.e. poor rainfalls during the winter of 1376 (1998) and spring of 1377 (1999). This severe situation is expected to be further aggravated by the impact of uncontrolled migrants to Tehran unless (i) appropriate and urgent measures are taken to exploit new water resources in conformity with the Third 5-year Plan, (ii) prevalent water resources are tapped to maximum effectiveness to relieve the increasing urban population pressure, and (iii) a legal framework for controlling and monitoring the utilization of groundwater resources is formulated.

Agriculture as well is severely suffering from inadequacy of irrigation water, and is in danger of backsliding. The current five-year development plan seeks to increase agricultural efficiency to generate food surpluses for export and develop domestic food-processing industries. However, unless otherwise stable irrigation water supply can be secured to increase the productivity and cropping intensity of existing farmland, Iran will still remain a long way from achieving the level of self-sufficiency in food production necessary to significantly reduce the huge amount of wheat import bill.

Under these circumstances, the above situation will be further aggravated unless otherwise an appropriate solution can be found. This Project is, therefore, of great importance from socio-economic points of view to provide a catalyst both for security of potable water to meet rapid urban population growth, and for attainment of sustainable agriculture in the Qazvin plain, which is a food supply base for the Tehran capital area and its environs.

Figure 10.1.2.1 Conceptual Plan of Qazvin Irrigation Project



Existing and Proposed Irrigation Area (ha)

Area	Irrigable Area	Existing Net Area	Proposed Net Area
North, Highland	38,600	24,240	28,900
North, Lowland	38,100	24,000	28,500
Sub-total	76,700	48,200	57,400
Takestan	9,000	6,000	6,700
Central	60,900	27,000	45,500
Total	146,600	81,200	109,600

Table 10.3.3.1 Irrigation Water Allocation of Taleghan, Almout and Groundwater in Canal (2021)

Canal No.	Irrigable Area (ha)	Net Irrigation Area (ha)	Irrigation Demand (MCM)	Surface Water Allocation (MCM)	Groundwater Allocation (MCM)
1. Irrigation by North Canal (Taleghan Water)					
1.1 North Higher Area (Higher than EL 1,250m)					
L1	700	500	5.5	2.2	3.3
L2	700	500	5.5	2.2	3.3
L3	1,200	900	10.0	4.1	5.9
L4	2,700	2,000	22.2	9.0	13.2
L4-A	2,700	2,000	22.2	9.0	13.2
L5	2,400	1,800	19.9	8.1	11.8
L6	4,000	3,000	33.2	13.5	19.7
L7	9,800	7,400	81.9	33.3	48.6
L8	6,800	5,100	56.5	23.0	33.5
L9	3,300	2,500	27.7	11.2	16.5
L10&20	4,300	3,200	35.4	14.4	21.0
Sub-total	**38,600**	**28,900**	**320.0**	**130.0**	**190.0**
1.2 Takestan New Area					
L20-1	9,000	6,700	80.0	10.0	70.0
Sub-total	**9,000**	**6,700**	**80.0**	**10.0**	**70.0**
Total	**47,600**	**35,600**	**400.0**	**140.0**	**260.0**
2. Irrigation by Central Canal (Almout Water)					
2.1 North Lower Area (Lower than EL 1,250m)					
L1-1	2,300	1,700	19.1	5.4	13.7
L1-2	1,500	1,100	12.4	3.5	8.9
L2-1	5,100	3,800	42.7	12.0	30.7
L2-2	200	200	2.2	0.6	1.6
L2-3	700	500	5.6	1.6	4.0
L3-1	1,300	1,000	11.2	3.2	8.0
L3-2	16,000	12,000	134.7	37.9	96.8
L4-1	200	200	2.2	0.6	1.6
L4A-1	700	500	5.6	1.6	4.0
L6-1	1,000	700	7.9	2.2	5.7
L6-2	4,400	3,300	37.1	10.4	26.7
L7-1	100	100	1.1	0.3	0.8
L8-1	1,100	800	9.0	2.5	6.5
L8-2	2,500	1,900	21.3	6.0	15.3
L20-1	1,000	700	7.9	2.2	5.7
Sub-total	**38,100**	**28,500**	**320.0**	**90.0**	**230.0**
2.2 Central Area					
C-1	3,100	2,300	25.3	6.1	19.2
C-2	7,900	5,900	64.8	15.6	49.2
C-3	6,600	4,900	53.8	12.9	40.9
C-4	3,300	2,500	27.5	6.6	20.9
C-5	4,200	3,200	35.2	8.4	26.8
C-6	9,800	7,300	80.2	19.2	61.0
C-7	4,100	3,100	34.1	8.2	25.9
C-8	3,000	2,200	24.2	5.8	18.4
C-9	2,800	2,100	23.1	5.5	17.6
C-10	9,000	6,700	73.6	17.7	55.9
C-11	7,100	5,300	58.2	14.0	44.2
Sub-total	**60,900**	**45,500**	**500.0**	**120.0**	**380.0**
Total	**99,000**	**74,000**	**820.0**	**210.0**	**610.0**
Grand Total	**146,600**	**109,600**	**1,220.0**	**350.0**	**870.0**

Note (1) The Taleghan water of 140MCM is controlled by Taleghan dam and can be used fully for irrigation.
(2) The Almout water of 250MCM includes the water of 40MCM in winter season, which is not used directly for irrigation but for groundwater recharge. Accordingly the Almout water of 210MCM can be used for irrigation in central canal.

10.4 Introduction of Irrigation Development in Three River Basin Area in South Qazvin Plain

The three rivers of Abhar-rud, Khah-rud and Haj Arab are flowing into the south Qazvin plain. A large agricultural area of 178,000ha is expanding in those three basin and has been cultivated mostly under dry farming condition.

Irrigation development plan in three basin area is under studied by the local consultant engineers of Absoo and Abfan and summarized as follows; JICA has not studied the irrigation plan in those area because the area is located higher than the elevation of 1,300m and can not be developed by the Taleghan and Almout water.

10.4.1 Hydrological Conditions of Three Rivers

Average monthly runoff of three rivers is shown in the following table.

Monthly Runoff Pattern in Three Rivers

Unit: MCM

River & Station	C.A (km^2)	Meh	Aba	Aza	Day	Bah	Est	Far	Ord	Kho	Tir	Mor	Sha	Total
1. Abhar-Rud														
Qerveh	1,926	1.0	2.0	3.3	4.2	5.3	10.5	21.8	8.5	2.5	0.7	0.6	0.7	61.1
Poletakestan	2,600	0.3	0.9	1.5	2.8	3.8	8.7	16.3	5.6	2.0	0	0	0	41.9
2. Khah-Rud														
Abegarm	2,520	4.7	7.7	8.9	8.2	9.2	14.3	24.1	18.7	3.2	1.6	1.7	2.2	104.5
Rahimabad	4,089	3.4	7.8	10.6	11.7	15.0	25.9	44.3	31.2	8.1	0.7	0.5	0.8	160.0
3. Haji Arab														
Haji Arab	560	0.4	0.9	1.0	1.1	1.2	2.8	6.9	6.3	2.5	0.8	0.7	0.4	25.0
Rostamabad	905	0.7	1.0	1.3	1.4	1.7	3.0	8.3	7.5	3.6	0.7	0.8	0.4	30.4

- Poletakestan station in the Abhar-rud, Rahimabad station at the Khah-rud, and Postamabad station in the Haji Arab are located at the downstream of the river and their runoff is mostly flowing into the salt marsh without being used for irrigation. Namely the runoff of more than 200MCM is releasing to the salt marsh.
- The runoff upstream the above stations has been used for irrigation and groundwater recharge.
- Three rivers presents rich runoff of 40% against annual runoff in winter season from Aban to Esfand which does not require irrigation water and 50% in spring season from Farvardin to Khordat but the scarce runoff of 10 to 5% in the summer season from Tir to Mehr.
- Accordingly winter crops such as wheat and barley are irrigated by using a rich runoff in spring season but summer crops are cultivated by only groundwater due to very scarce runoff in summer season.
- The runoff shown in the above table is considered as the surplus runoff which is not used at present and could be developed for irrigation water and groundwater recharge.

10.4.2 Proposed Irrigation and Water Supply Project

In accordance with the local consultant information, the following irrigation and water supply projects are proposed and under study.

(1) Proposed by Absoo Consulting Engineers

- Three diversion dams of Dakhrejin, Avaj and Hesar are prosed in the Khah-rud river to irrigate about 21,500ha. The irrigation water demand is estimated at 260MCM which could be supplied by the Khar-rud runoff of 100MCM and the groundwater of 160MCM.

(2) Proposed by Abfan Consulting Engineers

- Kineh Vars reservoir dam is proposed at Kineh Vars tributary of the Abhar-rud river to the drinking water for Abhar and Khoram cities and irrigation at the area between Abhar and Takestan cities. The available water to be developed by dam is about 19MCM, of which 9 MCM is used for drinking water and 10MCM for irrigation.
- The surface water resources development of 190MCM consisting of 140MCM at the Khah-rud and 50MCM in the Abhar-rud and Haj-Arab are proposed.
- The groundwater development to extract 45MCM by deep wells and recharge 40MCM by recharging ponds is proposed at three river basins.

The irrigation and water supply projects mentioned in the above is still under study but will be implemented near future to stabilize the irrigated agriculture and domestic and industrial supply in three basins.

It is recommendable however that the irrigation development and groundwater recharge project at the downstream area in three rivers shall be carefully studied together with the irrigation and groundwater recharge project at the central area under the Almout water diversion in order to use effectively the Almout water and three river’s water.

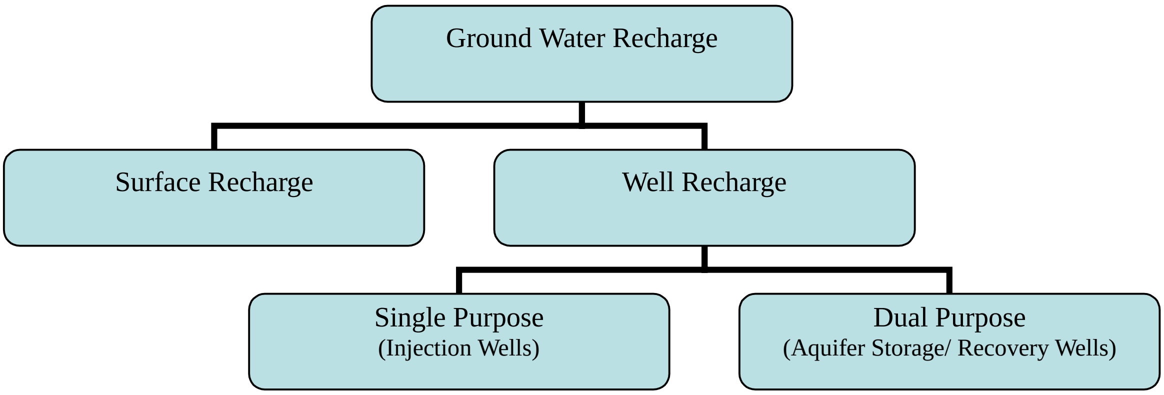
The feasibility study of those irrigation project in three river basins shall be carried out when the study on for the irrigation project by the Almout water diversion will be proposed.

CHAPTER 11.

CONCEPTUAL PLAN OF GROUNDWATER RECHARGE

CHAPTER11 CONCEPTUAL PLAN OF GROUNDWATER RECHARGE

The concept of artificial groundwater recharge is "nothing new under the sun" adjacent to Iranian countries. The Kara Kum Plain located beside Caspian Sea is the birth place of "groundwater recharge during the past several hundred years. "Groundwater Recharge System" comprising of recharge trenches, infiltration pits and hand-dug wells was built by the ancient people to capture and manage the limited water resources. Now a day, this concept has been evolutionally developed into several types of systems, as below:



"Surface Recharge" systems work well in situations where soils are permeable from ground surface to the water table and where adequate land area is available at reasonable cost to accommodate the recharge facilities. Solids that accumulate at the surface are periodically removed following a series of wet-dry cycles that maintain the long-term infiltration rate. At the suburb of Qazvin, there are vacant spaces in between farming lands, and high permeability are expected at the top soils. Very high infiltration-rate over 200 mm/day was obtained from the performance data of existing recharging ponds built along the irrigation canals, as follows:

Name of Recharging Ponds	No of Ponds	Infiltration Amount of Water	Area of Recharge Ponds	Depth of Ponds	Infiltration Rate Estimated
		lit./sec	sq.m	m	mm/day
L-1	4	250	101,745	1.1-2	212
L-2	4	250			
L-3	6	400			
L-4	6	500			
L-5	4	300			
L-6	5	750	160,260	1.5-2.6	404
L-7	4	340			
L-8	4	300			
L-9	5	750	134,850		481
L-10,RG	1	240			
L-11	2	500			
				Average	366

In fact, the groundwater table adjacent to recharging ponds were rising up in last 10 years up to 10 meters in maximum. Therefore, the “Surface Recharge“ is thought of adequate system among other types of groundwater recharge.

In different situations where low permeability soils are present between ground surface and the water table, or where land availability at reasonable cost is limited, “Surface Recharge” may not be cost-effective. The method of “Well Recharge” becomes alternatives for the “Surface Recharge”. “Well Recharge” are of two types: “Injection Well” and “Storage and Recovery Wells (Aquifer Storage Recovery Wells).

Aquifer Storage Recovery (ASR)
Aquifer Storage Recovery, called as ASR. This word means as water management tools through storing the water in the suitable aquifer through a well during times when water is available, and recovery of water from the same well during times when it is needed.

“Injection Well” systems have been utilized to achieve the single limited objective of getting water into the ground. Since the quality of water required for injection well systems to minimize plugging has to be much better than that required for “Surface Recharge” systems.

“Aquifer Storage Recovery” may give better alternative for “Surface Recharge” in particular situations where a need exists for the recovered water at the recharge site, where treatment of the water would be required anyway and where the storage zone contains native water of poor or brackish water. This may be applicable for controlling the seasonal water demand in domestic use of the urban area (Tehran, Karaj city and etc.) and in irrigation use by re-used waster (Tehran South, Karaj).

11.1 Applications and Objective of Groundwater Recharge

Where the water table is deep and relatively flat, and overlying land use is not likely to contaminate the stored water, can be viable and cost-effective. Most groundwater recharge applications in the Plain are thought to be for seasonal, long-term, or emergency storage of drinking and irrigation water, as below:

The application of groundwater recharge
Seasonal Storage: Water is stored during wet months, or months when it is available, and is recovered during dry months, or months when it is needed. Where water is plentiful, it may be stored during times when quality is best and recovered during times of poor quality. The duration of seasonal recovery periods may be several days to several months. Storage zones can be confined, semi-confined, or unconfined aquifers containing fresh, brackish, or saltwater.
Long-term Storage: Water is stored during wet years, or during years when new supply, treatment, and distribution facilities have spare capacity, and is recovered during drought years, or years when the capacity of existing facilities is inadequate to meet system demand. This type of storage is sometimes referred to as "water banking."

Emergency Storage: Water is stored, when available, to provide an emergency supply or strategic reserve to meet demands when the primary source of supply is unavailable, whether due to accidental loss, contamination, warfare, or natural disaster. This type of storage is particularly appropriate for water systems that rely heavily on a single source and a long transmission pipeline.

Many other applications have been considered or implemented at groundwater recharge sites. At the begging stage of designing groundwater recharge system in the Plain, concrete objectives or applications must be considered to ensure those facilities are situated in such a way as to achieve these multiple objectives.

It is important to carefully consider the range of recharge objectives for any proposed project and to select and prioritize those that are applicable. The objectives of groundwater recharge expected in the Plain are:

Objective and Application of Groundwater Recharge
1) Seasonal storage and recovery of water
2) Long-term storage, or "water banking
3) Emergency storage, or "strategic water reserve"
4) Disinfections by-product reduction
5) Diurnal storage
6) Restore groundwater levels
7) Reduce subsidence
8) Maintain distribution system pressure
9) Maintain distribution system flow
10) Improve water quality
11) Prevent saltwater intrusion
12) Reduce environmental effects of stream flow diversions
13) Agricultural water supply
14) Nutrient reduction in agricultural runoff
15) Enhance well field production
16) Defer expansion of water facilities
17) Compensate for surface salinity barrier leakage losses
18) Reclaimed water storage for reuse
19) Soil aquifer treatment
20) Stabilize aggressive water
21) Hydraulic control of contaminant plumes

11.1.1 Conceptual Plan of Groundwater Recharge in the Study Area

Suitable storage zones for groundwater recharge may be unconfined or semi-confined aquifers, some of which have been partially dewatered due to over-development. These hydro geologic conditions are very similar to the Qazvin groundwater basin.

The probability of successfully implementing and groundwater recharge programs can be enhanced by natural conditions of “Water Supply”, “Recharge Water Quality”, “Water Demand” and “Hydrogeologic Condition”. In addition to natural conditions, “Social Support” is also be necessary to address environmental, legal, regulatory, political, and possibly other issues. These items are also regard as substantial criteria for evaluation of groundwater recharge program. The initial evaluation of viability for respective areas are summarized as below:

Area/Sub-basins	Yield	Water Supply	Water Quality	Water Demand	Hydro -geologic Condition	Social Support	Method Applied
Haji Arab river	30	○	○	○	◎	◎	
Khurud river	149	◎	○	◎	◎	◎	S/R
Abuharud river	56	○	○	◎	◎	◎	
Northern small rivers							
Takistan north(Sub-basin6)	104	◎	◎	○	○	◎	S/R
Qazvin north(Sub-basin7)	88	○	◎	◎	○	◎	S/R
Qazvin northeast(Sub-basin8)	42	○	◎	○	○	◎	
Abyek(Sub-basin9)	35	○	◎	◎	◎	◎	
Hastgerd(Sub-basin10)	54	○	◎	◎	○	◎	S/R
Kordan river	112	◎	◎	◎	○	◎	S/R
Karaj river	59	○	◎	◎	○	◎	S/R
Kan river	10	—	○	◎	◎	◎	ASR
Tehran city and Tehran							
Tehran city(Sub-basin14)	13	○	◎	◎	△	—	ASR
Tehran city(Sub-basin15)	29	○	○	◎	○	—	ASR
Tehran south(Sub-basin16)	9	△	—	◎	—	—	ASR
Tehran south(Sub-basin17)	6	△		◎	—	—	ASR

◎ : well applicable ○: fair applicable △: poor applicable
— : not evaluation due to scarce information
S/R : Surface Recharge, ASR: Aquifer Storage Recovery

An informed decision can usually be made at this point regarding the recharge process or processes that appear appropriate. Consideration of water supply and demand factors will usually indicate the annual volume of water available for recharge or required for recovery. If the hydrogeologic evaluation indicates that surface recharge is probably feasible, it is then possible to conduct an evaluation of possible sites for in-stream or off-stream “Surface Recharge” facilities. Once potential sites are identified, a preliminary screening can usually indicate whether sufficient recharge capacity is likely to be present to fully utilize available recharge flows. If land availability and hydrogeology are favorable, “Surface Recharge” is usually the most cost-effective recharge approach if the objective is limited to getting the recharge water into the ground. Where either of these factors becomes limiting, then “Well Recharge” should be considered. At Khah-rud river, small northern streams and Kordan river, “Surface Recharge” is thought to be applicable. While, the urban area such as Tehran and Karaj city and Kan river are regarded as poor viability for “Surface Recharge”.

Hereby, these areas are required to promote the groundwater restoration with ASR for in the future.

11.1.2 Necessary Information for Accessing Conceptual Plan

Necessary information to access groundwater recharge programs are substantially of water supply, recharge water quality, water demand, and hydrogeologic condition and social support , as below:

Initial Criteria for groundwater Recharge Program
Water Supply: Careful consideration of alternative sources of water for recharge is essential. Each source should be evaluated as to the average flow available, monthly or other variability in flow rate, and any trends in flow. Water may be available for recharge at a higher rate initially, declining with time as other, higher priority demands for that source arise. Monthly variability is also common, based upon raw water source availability, seasonal variations in quality competing demands, legal or regulatory constraints, or other characteristics of each system. It is usually insufficient to know the average and peak rate of water
Recharge Water Quality: Recharge water quality also has to be addressed carefully. Frequently, average values mask an underlying seasonal cycle or long-term trend, which can affect recharge activities. Months when high flows are available for recharge can also be months when significant water quality issues are prevalent that would create water treatment difficulties. An important water quality consideration is the suspended solids content of the recharge water source. Once recharge quality and quantity issues have been addressed, it is possible to combine the two and thereby evaluate those times of the year when recharge water is available in a useful quantity and with suitable quality. This provides the basis for determination of annual recharge volume potentially available in the initial and subsequent years. Quality requirements for the recovered water also need to be evaluated to aid in assessment of the potential treatment requirements. Usually it is only necessary to disinfect the recovered water prior to distribution. In some cases pH adjustment may also be required, either to maintain stability within a desired range or to maintain disinfection effectiveness.
Water Demand: In most situations it is important to evaluate water demands, including average demands, monthly variability, and trends. The rate of recovery in such situations may determine the number of ASR wells required to meet system demands. In other situations, the number of wells may be determined by the recharge rate necessary to store the volume of water required to meet demands during the recovery period. Consequently, it is not uncommon for water systems to have a substantial amount of idle capacity during much of the year. This capacity can be utilized for treatment and storage of water during off-peak months, using ASR and other recharge facilities.
Hydrogeologic condition: This is frequently the most time-consuming element of feasibility assessment. Careful evaluation of area hydrogeology can lead to the selection of suitable storage zones, recharge water sources, and treatment requirements, and usually affects the location and design of groundwater recharge facilities. This information is required at the beginning of groundwater recharge plan - Stratigraphy, including geologic cross-sections - Aquifers (areal extent, thickness, and depth) - Confining layers or aquitards (aerial extent, thickness, and depth) - Lithology of aquifers and confining layers - Potential availability of cores - Hydraulic characteristics of the surface layer (infiltration rate, unsaturated permeability, etc.) - Hydraulic characteristics of aquifer (transmissivity, storativity, Leakance, hydraulic Conductivity, porosity, etc.) - Typical well construction and production rates - Mineralogy of clays, sands, and other soil components - Geophysical logs - Water quality of each aquifer - Geochemical compatibility of recharge and native water with formation minerals - Structure (unconsolidated, consolidated, fractures, bedding planes, solution

Features, fissures, etc.)
- Recharge and discharge boundaries
- Water table levels or potentiometric surface
- Local gradient of the potentiometric surface
- Natural groundwater velocity and direction
- Well inventory within a reasonable radius
- Groundwater withdrawals within the surrounding area
- Proximity of potential sources of contamination
- Proximity of potential contamination plumes that may be affected by re-charge operations

Besides, the information in the context of existing water treatment processes, utility operations, water chemistry and design of pipelines, pumping station, location of contaminant, availability of aquifer simulation modeling and economics are to be required in the feasibility assessment of groundwater recharge.

11.2 Proposed Groundwater Recharge Plan

Many small streams in the north and west mountain areas and three large rivers of the Abhar-rud, Khah-rud and Haji Arab are flowing into Qazvin plain. Those streams and rivers present rich runoff in spring season but are mostly drying up in the other season. Though a part of spring runoff has been used for irrigation at the area along the streams and rivers and natural recharge to groundwater, many runoffs are still flowing down in the Qazvin plain, emptying into the salt marsh and lost by evaporation and outflow to the Shoor river. The surplus water emptying into the salt marsh is assumed at 150MCM in total consisting of 40MCM from mountain streams and 110MCM from three rivers.

Utilizing this surplus water, artificial recharge is planned as conjunctive use of surface and groundwater resources. The peak runoff of Khur-Rud and other streams on northern mountain, which is corresponding to a significant part of total discharge of the river, occur during a particular season of the year that usually coincides with the smallest water demand. As possible solution for that program, storing the water in the ground are recommended as valuable alternative. This conjunctive use of surface and groundwater consists of harmony combining the use of both source of water in order to minimize the undesirable physical, environmental and economical effects of each solution and to optimise the water demand/supply balance. This is also considered within a river "Basin Management Programme" because of both river and the aquifer belonging to the same basin. Thus, the operation plan of artificial recharge must be considered as such "Basin Management Programs".

Underneath the Qazvin plain, there is huge free space (reservoir) between the ground surface and water table for recharging by surplus water during, which water is not needed, and for easily returning the stored water when needed. The hydrogeological condition required by the plan is ascertained by future surveys.

The most reliable method for recharging comparatively large amount of river water into groundwater basin is to accelerate the percolation of river water from the riverbed. For this, the fixed weir should be constructed every 100 m along the river course to create an artificial pond with a water depth of 1 to 2 m. (refer to Database Map 11.1) The sediment deposited in the pond should be removed at least 2 times/year in order to keep a pervious riverbed as much as possible.

The construction cost of fixed weir and cost for removing sediment are roughly estimated as shown in table below. From this table, it is said that the permeability of riverbed should be kept to be more than around 10^{-3} cm/sec from economical point of view. Before implementation of the groundwater recharge project, it is recommendable to carry out the tests for confirming available groundwater amount by means of the construction of fixed weir. Those tests should be carried out in Khah-rud river near Rahimabad.

Water Cost of Groundwater Recharged from Artificial Pond Created by Fixed Weir

Permeability	Percolated Amount / year*	Annual Cost	Water Cost
10^{-2} cm/sec	5,450,000 m^3/year	14,800 US$	0.00272 US$ = 20 Rial
10^{-3} cm/sec	545,000 m^3/year	14,800 US$	0.02716 US$ = 220 Rial
10^{-4} cm/sec	54,000 m^3/year	14,800 US$	0.27407 US$ = 2,200 Rial

Groundwater Amount Recharged by Artificial Pond

Permeability	Percolated Amount:[1)] / day	Percolated Amount / year[* 2)]
10^{-2} cm/sec = 8.640 m/day	60,500 m^3/day	5,450,000 m^3/year
10^{-3} cm/sec = 0.864 m/day	6,050 m^3/day	545,000 m^3/year
10^{-4} cm/sec = 0.086 m/day	600 m^3/day	54,000 m^3/year

[*1)] : Groundwater recharged by artificial pond of 7,000 m^2 (70 m x 100 m) surface area,

[*2)] : spring (3 months) only

Annual Cost of Groundwater Recharge Facilities on Khah-rud River

Fixed wear (made of masonry) Construction Cost	Depreciation Cost[*2)]	O/M Cost[*3)]	Annual Cost
127,400 US$[*1)]	11,900 US$	2,900 US$	14,800 US$

[*1)] : 50 m^3/m (masonry) x 70 m x 28 US$/$m^3$ x 1.3 = 127,400 US$

[*2)] : Amortization rate = 0.0937 (i = 8 %, n = 25 year), 127,400 US$ x 0.0937 = 11,900 US$

[*3)] : Cost for removing sediment deposited in river land every 2 time / year
= 70 m x 100 m x 0.2 m x 2 times x 0.8 US$/ m^3 x 1.3 =2,900 US$

In addition to above, the following facilities will be applied for the groundwater recharging plan.

(1) Recharging Dike and Trench

- A number of dikes protected by gabion and wire sausage are constructed crossing the river bed in order to prolong the flowing length and times and accelerate the recharge action to groundwater.

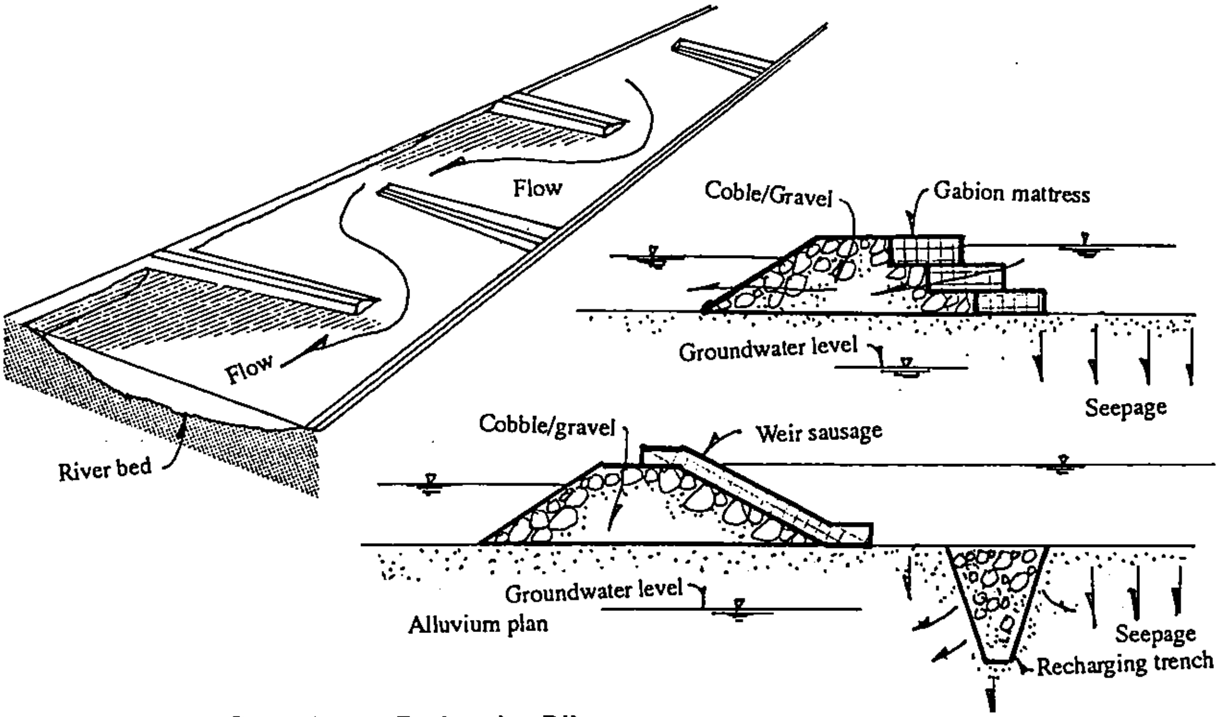
- Trench with a depth of 4 to 5m and a width of 3 to 5m is excavated crossing the river bed and backfilled by gravel in order to accelerate the seepage action of river flow into under ground.

(2) Recharging Dam and Cut-off Wall

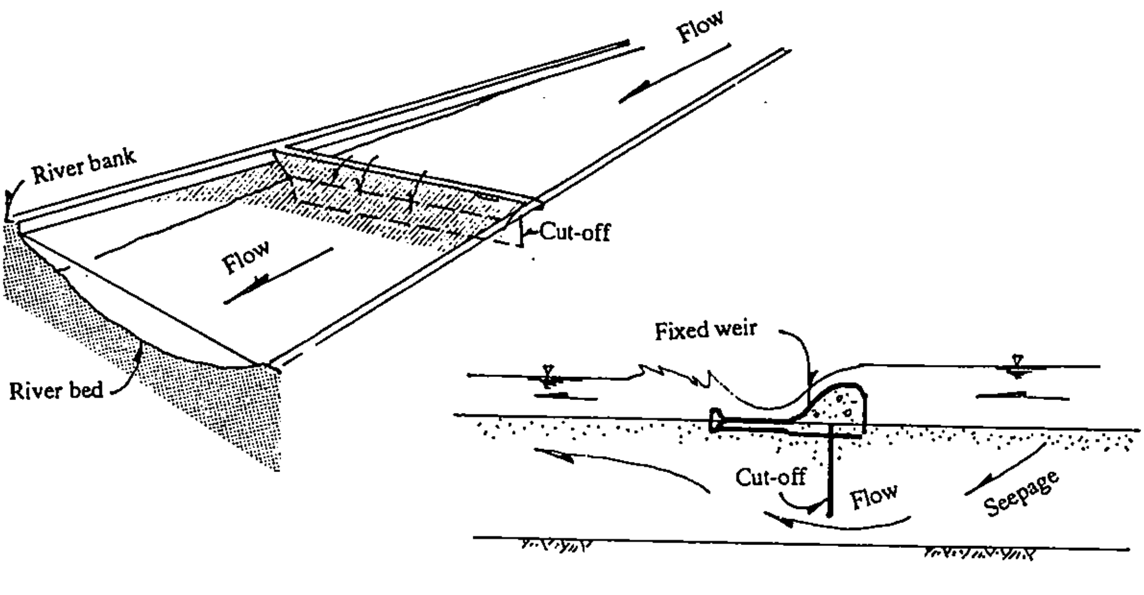
- Recharging dam to regulate the peak spring flood is constructed on the alluvial plain with a deep depth. The regulated spring flood is penetrated into alluvial plan in the river bed and then used as the groundwater at the downstream alluvial plain.
- Cut-off wall with a depth of 15 to 30m is installed at the alluvial plain crossing the alluvial plain to recharge the surplus river flow and use it by pumping up.

The above mentioned groundwater recharging project had been implemented already by JICA Team at Oman and U.A.E and is effectively operated at present. As the river bed of Khah-rud river consists of vast and deep alluvial plain and has a high potential to increase the groundwater recharge, this groundwater recharge plan will be studied and implemented.

Figure 11.2.1 **Groundwater Recharging Dike and Weir**



Groundwater Recharging Dike



Groundwater Recharging Weir

CHAPTER 12.

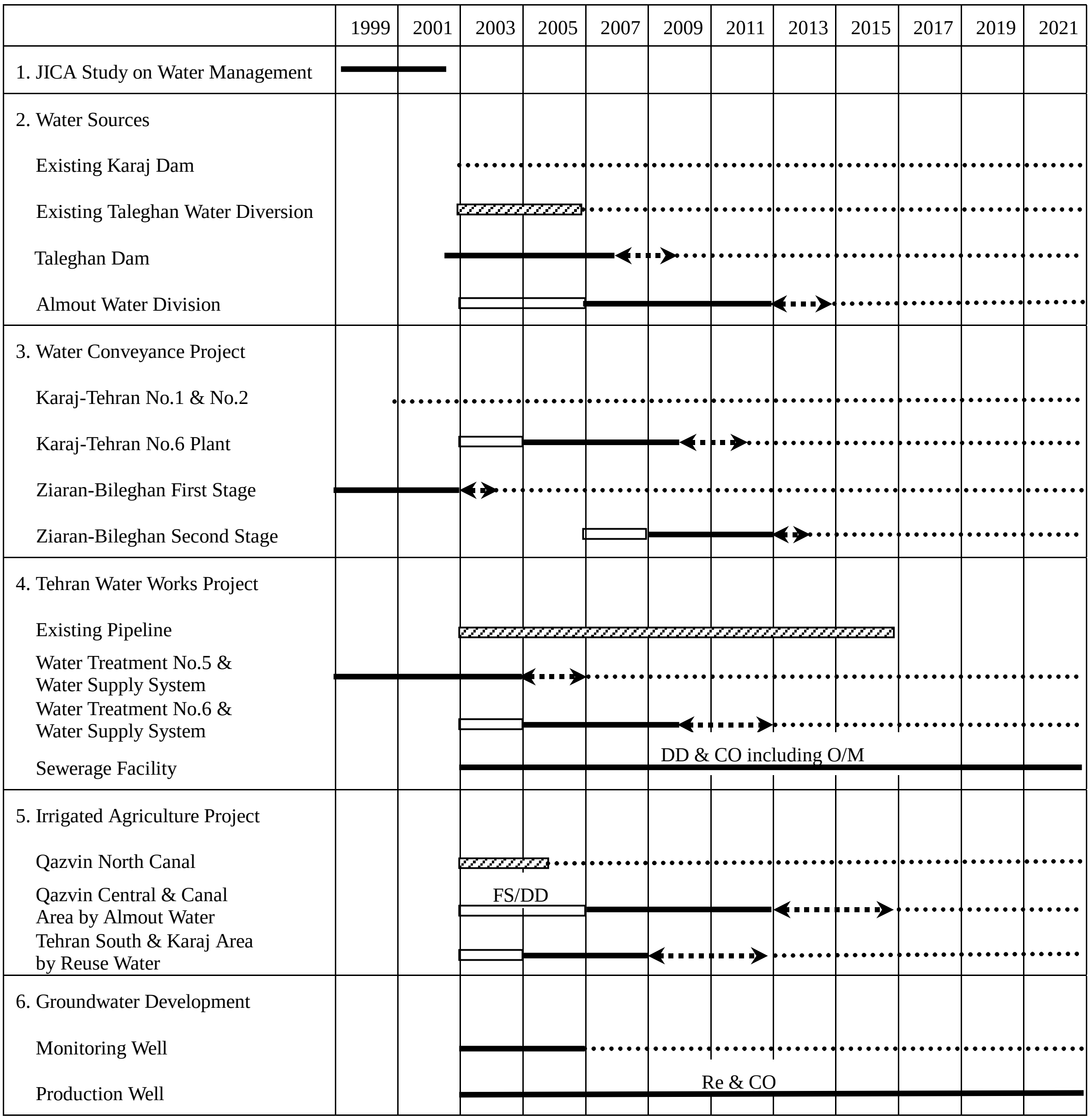
IMPLEMENTATION PROGRAM OF WATER MANAGEMENT

CHAPTER 12 IMPLEMENTATION PROGRAM OF WATER MANAGEMENT

12.1 Proposed Implementation Schedule

The implement schedule of water management is studied taking into account the rehabilitation period of the existing projects and the implementation period for the proposed project consisting of the study for feasibility and detailed design and the construction. The project is classified into the sectors of water sources, water conveyance, Tehran water works, irrigated agriculture and groundwater. The proposed schedule is shown in the following table.

Proposed Implementation Schedule of Water Management Project



Note: F.S & D.D, Feasibility Study and Detailed Design
CO, Construction
Re, Rehabilitation
W.O, Water Operation Test
W.M, Water Management

Proposed schedule of implementation of projects is also shown in Figure 12.1.1 together with the allocation plan of water supply from various sources of either existing or proposed to meet water demands required from various water user sectors.

12.2 Implementation Program for Each Project

12.2.1 Water Source Project

The important water source project in the Study Area is the projects for the Karaj, Taleghan and Almout water.

(1) Karaj Water Source

The Karaj water has been controlled by the existing Karaj dam and supplied to Tehran urban water supply and Karaj irrigation covering the area of Sharivar and Robatkarim since 1960s. Once the allocation of the Karaj water was 250MCM per annum for Karaj irrigation and 180MCM for Tehran urban water supply but changes presently to 130MCM to Karaj and 300MCM to Tehran because of increasing population and urban water demand in tehran city.

As the present water allocation to Tehran and Karaj will not change toward 2021, Karaj reservoir operation rule shall be improved so as to release the reservoir water of 300MCM with the same monthly outflow to Tehran water supply and the remained water of 130MCM with a rich outflow in spring and no or scarce outflow in winter to Karaj irrigation.

(2) Taleghan Water Source

The existing Taleghan water diversion project has supplied the water of 200MCM per annum to irrigation in the north Qazvin area. This water operation management will be continued by 2007 and change in case of completion of Taleghan dam.

The existing Taleghan tunnel to divert the Taleghan water to Qazvin plain has been deteriorated and requires the rehabilitation works. As the Annuel will be fully used through the year for Tehran water supply after completion of Taleghan dam, the rehabilitation works shall be carried out urgently at winter season from 2002 to 2004 avoiding the irrigation season in the north Qazvin area.

Taleghan dam will be completed by 2006 but require more two year to fill the reservoir up to the full water level because the reservoir shall be operated releasing irrigation water to Qazvin area under the following monitoring and testing works.

- Water leakage through dam body and dam foundation.
- Reservoir water level fluctuation under the reservoir operation rule previously set up.
- Changes of the area surrounding the reservoir such as gully erosion, land sliding, accumulation of sediment, etc.

- Gate operation to release the reservoir water based on the operation rule.
- Design outflow to the downstream river.

Taleghan reservoir will be operated so as to release the water of 300MCM to Qazvin irrigation and 150MCM to Karaj irrigation by 2008, because the water conveyance project to supply the Taleghan water from Bileghan site in Karaj river to Tehran No.6 plant will not be completed before 2008.

After completion of the above project from Bileghan to Tehran No.6 plant, the supply amount of Taleghan water to Tehran will reach 150MCM at 2011, 250MCM at 2016 and 310MCM at 2021.

Accordingly the Taleghan reservoir shall be operated placing the priority for Qazvin irrigation from 2002 to 2011 and for Tehran water supply after 2011.

(3) Almout Water Source

The Almout water diversion project will require a long implementation period of about ten years taking into account the difficult tunnel works with a long distance of 34km. Four years will be required for feasibility study, detailed design and international tender work, and six years for the construction of tunnel.

If the feasibility study is commenced at 2002, the construction of the project will be completed at 2011 and the full water diversion of 250MCM will be started 2013 after two years for the water operation test including tunnel inspection.

As the Taleghan water of 250MCM shall be conveyed to Tehran urban water supply in 2016 and Qazvin irrigation water from the Taleghan decreases, the Almout project shall be completed before 2016.

12.2.2 Water Conveyance Project

The important water conveyance project is consisting of two parts, one is the project from Ziaran to Karaj and other is from the Karaj to Tehran.

(1) Ziaran-Bileghan Water Conveyance Stage 1

Ziaran-Bileghan water conveyance pipeline stage 1 is already completed and Taleghan water of 120 to 150MCM could be transferred to Bileghan site at the end of 2001. This Taleghan water, however, could not be conveyed to Tehran due to incompletion of the water conveyance project from Karaj to Tehran No.6 plant and the turbid water by the Taleghan river flow without control of the reservoir, which could not be treated easily by the existing No.1 and No.2 water treatment plant in Tehran city.

The Taleghan water will be used for agriculture in Karaj area from 2002 to 2008.

As Taleghan water has been used only for Qazvin irrigation purpose by 2001, it is necessary to carry out carefully the water operation test to divert the Taleghan water to Karaj irrigation and Qazvin irrigation and to set up its operation rule.

(2) Ziaran-Buleghan Water Conveyance Stage 2

The Ziaran-Bileghan water conveyance pipeline stage 2 is required to convey the additional water of 160MCM from the tunnel outlet in Ziaran to Bileghan site in Karaj river and will be completed by 2013 when the Taleghan reservoir water of more than 150MCM is to be conveyed to Tehran water supply.

Accordingly the implementation schedule shall be defined taking into account the Almout water diversion project because Taleghan reservoir water of more than 150MCM could not be conveyed to Tehran before completion of Almout project and supply of irrigation water to Qazvin plain.

(3) Karaj-Tehran No.1 and No.2 Plants

Karaj-Tehran water conveyance pipelines to No.1 and No.2 water treatment plant have been operated without any trouble since 1960s and will be operated in future without any variation.

(4) Karaj-Tehran No.6 Plant

Karaj-Tehran No.6 plant water conveyance project shall be urgently implemented, otherwise the Taleghan water being conveyed upto Bileghan site from Ziaran can't be transferred to Tehran urban water supply.

It is not necessary to carry out the feasibility study but chek the comparison study for the conveyance facility by the tuunel from the downstream of Karaj regulation damsite to No.6 plant or by the pipeline and pumping station with a high pumping head of more than 200m from Bileghan to No.6 plant.

It is recommendable to carry out the project with the turn key basis together with the design and construction as well as project cost because of urgent project implementation.

12.2.3 Tehran Water Works Project

Tehran water works projects related to the water conveyance from the Karaj and Taleghan are No.6 water treatment plant and sewerage water treatment plant. The former will be implemented is parallel with the new Karaj-Tehran water conveyance project and the latter will be implemented independently but its reuse water shall be used for irrigation in Tehran south and Karaj plain.

Those water works have been studied by Tehran S.W.C and their implementation schedule also is subject to Tehran S.W.C.

12.2.4 Irrigated Agricultural Development Project

(1) Karaj Irrigation Project

The Karaj irrigation project area by the Karaj water is located mainly at the Sharivar and Robat

Karim districts and covered with the canal system.

This irrigation area has suffered from chronic water shortage due to conversion of Karaj water from irrigation to Tehran urban water supply. Groundwater level also has been decreased largely by excess extraction by deep well.

It is necessary therefore to return the stabilized irrigation area by the following water supply schedule.

- Taleghan water to be conveyed from 2002 to 2008.
- Reuse water from sewerage treatment plant after 2011.

(2) Qazvin North Irrigation Project

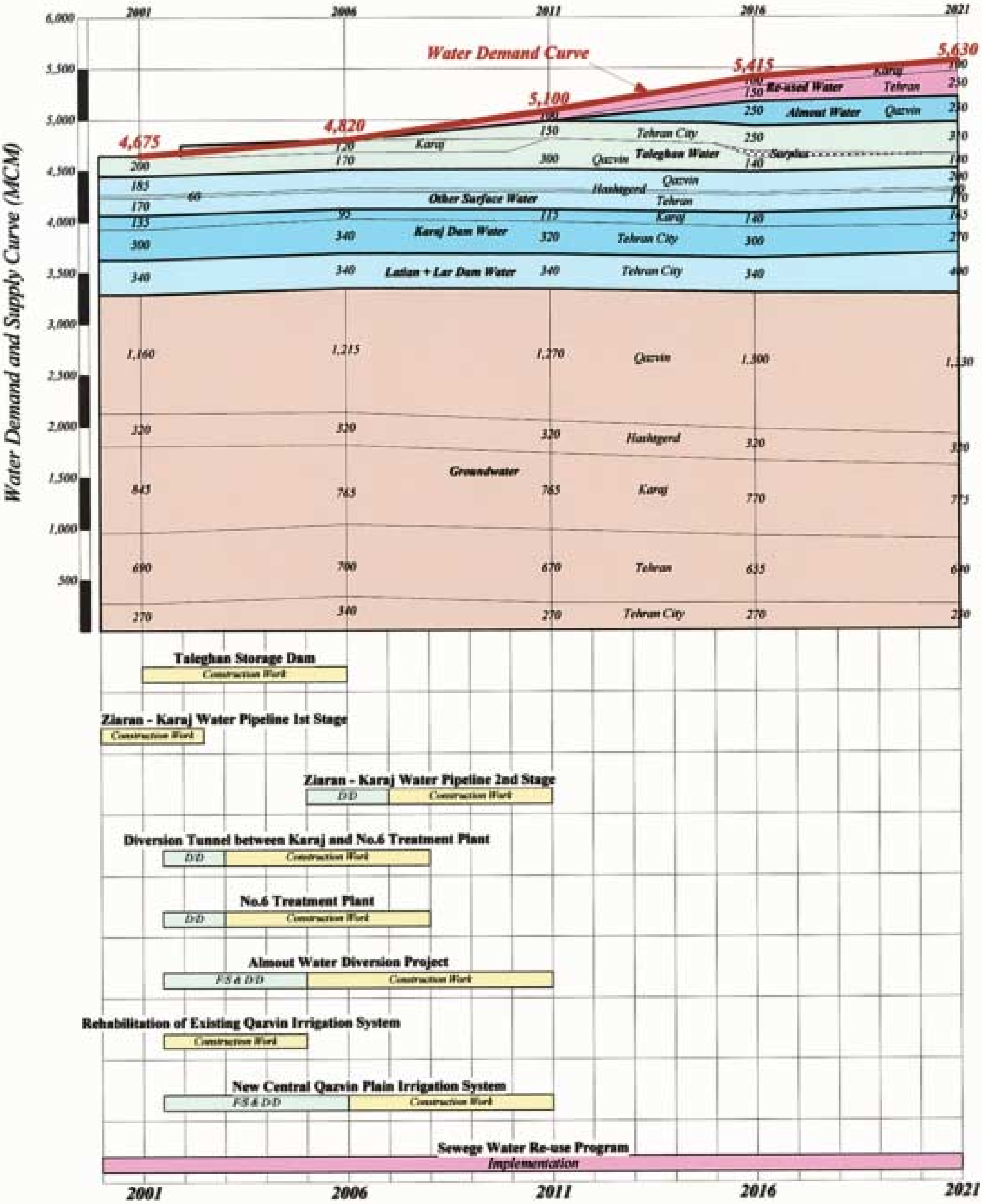
Qazvin north irrigation project has been operated by the canal system since 1970s but requires the rehabilitation works, which shall be implemented urgently from 2002 to 2005. This canal system shall convey the Taleghan water in future after completion of Taleghan dam.

(3) Qazvin Central Irrigation Project

As Qazvin central irrigation project is implemented newly to use the Almout water, its schedule for the feasibility study, detailed design and construction shall be set up with the same one as the Almout water diversion project. The water management of the Qazvin central canal is little complicated and shall be carried out with the following manner.

- As Taleghan water to be allocated to Qazvin plain is limited to be 140MCM in average year, its water will be used in principal for the high land in the north canal system which can't be irrigated by the central canal.
- As Taleghan water can be controlled easily by the reservoir, the winter crop area in the north high land will be expanded in case of the wet year with sufficient available water in the reservoir but will decrease in case of the dry year with small available water, which is only used for summer crops.
- As the central area and the low land in the north area is irrigated by the Almout water with a rich runoff in spring and small runoff in summer, the rich spring water will be mainly used for irrigation of winter crops and summer water for summer crops with combination of groundwater.
- As the Almout water has a discharge fluctuation of 1.0 to 2.0m3/sec on daily and monthly basis, the discharge supplied to the central canal from the tunnel outlet shall be regulated at the regulating pond provided at the outlet of tunnel.

Figure 12.1.1 Implementation Program of Water Resources Development and Management



AllocationPlan.mcd

CHAPTER 13.

CONCLUSION AND RECOMMENDATION

CHAPTER 13 CONCLUSION AND RECOMMENDATION

13.1 General Description

At present in 2001, 4,675 MCM per annum of water, 1,390 MCM from surface sources and 3,285 MCM from groundwater, are consumed in the western capital area of Tehran with 1,595 MCM supplied for urban use and 3,080 MCM for agriculture. This order of water supply and use will be extended to 5,630 MCM in 2021 inclusive of 1,965 MCM of surface water, 359 MCM of re-use water and 3,315 MCM of groundwater for 2,320 MCM of urban use and 3,310 MCM for agriculture, supported by the governmental policy of population absorption in the capital area. Potential resources of both surface water and groundwater are limited in the area and the use of available water resources has been stretched to the limits. Of the potential surface water resources of 2,460 MCM, present use accounts for 1,390 MCM (57%) and the usable water in future will be, at most, 1,965 MCM or 80% of the potential. On the other hand, groundwater resources, which provide 3,285 MCM per annum of water at present, have tended to decrease showing annual imbalance of more than 700 MCM toward the final drying up unless proper measures are taken immediately. In order to expect the sustainable development of the area within the available resources, such resources are to be managed and operated properly and effectively.

Water supply in Tehran City depends on stored water in Karaj dam and Latian dam connected with Lar dam and groundwater. Supply from surface sources has, however, leveled off since 1993 due to hydrological limitation and in turn extraction of groundwater has been increasing rapidly indicating obvious decline of groundwater tables at many locations. Surface water sources remain undeveloped within the territory of the area are Taleghan river and Almout river, and aiming at conversion of use of Taleghan water from agriculture in Qazvin plain to water supply in the capital area, the government has started construction of the Taleghan storage dam at immediate downstream of the existing Taleghan diversion dam and also construction of water pipeline to connect the outlet of the Taleghan tunnel and Karaj river has just completed in 2001. Both Taleghan and Almout rivers belong to Qazvin province and therefore development of Almout water to compensate for such a conversion of water use is indispensable. Irrigated agriculture in Qazvin plain is also to be expanded in order to expect smooth implementation of the water conversion plan, and is absolutely necessary for wide and equitable distribution of social benefit arising from the implementation of the water diversion project. Fortunately, implementation of the Almout water diversion project is judged feasible and viable from both engineering and economic points of view.

Moreover, to cope with increasing water demand towards the target year of 2021 opportunely, related works such as rehabilitation of existing water diversion facilities, construction of Karaj to Tehran water diversion facility, phase 2 work of water pipeline between Ziaran and Karaj are to be studied and implemented timely. Integrated water management program, development of surface water resources and groundwater management are to be properly implemented as described in the following paragraphs.

In the area, water supply works for both urban water supply and irrigation and sewerage are conducted by semi-governmental companies and they are well managed including activities for tariff collection. In order to cope with increasing demand of water accompanied by the growth of population, development and management of water resources will become more essential. However, such an effort inevitably has a limit, and necessary measures to restraint demand of water, such as control of population growth in the capital area, is to be surveyed when longer view after 2021 is taken into consideration.

13.2 Integrated Water Management Program

Total available water for domestic, industrial and agricultural uses in the Study Area is estimated at about 5,600 MCM 2021, consisting of the surface water of 2,300 MCM and groundwater of 3,300 MCM. This volume of available water is not thoroughly sufficient to satisfy the future water demand when the per capita value of available water, 320 cubic meter only, is taken into consideration, because this value is considerably smaller as compared with the world average. Accordingly, the integrated water management program to use and allocate the developed water properly and effectively among various water demands becomes inevitably necessary and is to be implemented urgently. In this concern, it is recommendable to pay the particular attention for the following water management in the western capital area.

- Reservoir operation and reservoir water use.
- Combination water use for surface water and groundwater
- Evaluation and management of groundwater
- Water allocation rule with reasonable and equitable use
- Water use on the service area level to minimize the water losses

13.3 Surface Water Sources Development

Potential surface water in the Study Area is evaluated at 2,445MCM, of which 1,935MCM could be developed and available to cover the proposed water demand toward 2021 in the area. However, the following study and implementation for the water sources development are to be carried out properly and on schedule.

(1) As for the Karaj surface water, the new Karaj water conveyance project to convey the Karaj water to the proposed No.6 water treatment plant through a tunnel under gravity or a pipeline with pumping station has to be urgently studied and implemented. Otherwise the proposed allocation of Taleghan water to be conveyed through the existing Taleghan tunnel, water pipeline from Ziaran to Bileghan and existing pipeline to connect Bileghan and No.1 and 2

treatment plants will not be achieved to satisfy the future water supply in Tehran City. This project keeps the first priority among the proposed water resources development projects.

(2) As for the Taleghan surface water, it is important to complete the Taleghan dam project just on schedule. It is also urgently necessary to survey, study and implement the rehabilitation of the existing Taleghan tunnel, because that this tunnel has been operated for more than 25 years and has become superannuated, and will be used for another several ten years or even 100 years after completion of the Taleghan storage dam of which construction work has just started now. After the completion of the Taleghan dam, rehabilitation work of Taleghan tunnel is impossible because water will pass in the tunnel throughout a year to supply the urban water demand in Tehran City.

(3) As for the Almout surface water, it is very important and urgently necessary to implement the Almout Water Diversion Project to divert the Almout water to Qazvin irrigation because the Taleghan water, which has been used for Qazvin irrigation since 1970s, will be converted to Tehran urban water supply and its deficiency has to be compensated by the Almout water.

Fortunately the Almout Water Diversion Project has the high viability in accordance with the technical, economical and environmental studies made by JICA on the pre-feasibility level. It is recommendable however to carry out urgently the further study for the water diversion tunnel with a long distance of 33.8km which is the most difficult construction works involved in the project.

13.4 Groundwater Management

Groundwater being used for the domestic and industrial water supply and irrigated agriculture in the western capital area is evaluated at 3,300MCM, showing much larger volume as compared with available surface water of 1,935MCM in the area. However the available groundwater of 3,300MCM is judged to be the maximum limit taking into account the available recharging water in the area such as rainfall, surplus surface water in rivers, return flow from irrigation and domestic and industrial water supply, etc.

It is recommendable to study and implement the following groundwater management in order to carry out the effective and sustainable use of groundwater.

(1) Establishment of monitoring and evaluation system including the rehabilitation of monitoring wells and the provision of new organization to evaluate and control the groundwater properly and accurately.

(2) Study and implementation of groundwater recharge program by recharging dam and dike in the Khah-rud river basin in Qazvin plain and the Kordan river basin in Hashtgerd region.

13.5 Promotion of Information Disclosure

Official presentation of the Draft Final Report of the Study was held as a seminar on 20th August, 2001 in Tehran. About 150 officials and engineers were attended to the seminar at the head of Japanese ambassador to Iran, Iranian parliament members and the vice-minister of the Ministry of Energy. Uninterruptedly on 21st, workshop was held on the themes “Modern Technology of Tunnel Construction”, “Groundwater Survey, Analysis and Management” and “General Concept of Water Management”, where 50 engineers were attended. Both the seminar and workshop achieved a great success.

For development and management of regional resources such as water, measures to exceed stereotyped solution are required. Mutual understandings and reliance on the necessity of development and management of resources are essential between inhabitants of donor basins and persons who are to benefit in order to achieve the most effective solution. Precise awareness is the base of mutual understandings and reliance, and the best shortcut to achieve a success is to promote constitution of common consent through deep discussions among persons concerned. Disclosure of necessary information to support such discussions is therefore necessary, and the seminar and workshop conducted at the occasion of the presentation of the Draft Final Report would be a good example for information disclosure.