APPENDIX 1

WATER BALANCES

APPENDIX 2

OPTIONS FOR IMPROVED MANAGEMENT OF THE NARYN SYR DARYA CASCADE

Introduction

1. The collapse of the former Central Asian water-energy exchange system after Independence made it difficult to maintain an operational system through the 1990s. Consequently, in 1998 Kazakhstan, Kyrgyzstan and Uzbekistan entered into an interstate framework agreement on the rational use of water and energy resources of the NSDC (Appendix 4). Tadjikistan joined the agreement in 1999 and this framework has since formed the basis for annual negotiations about specific amounts of water to be released and energy to be exchanged, and how these amounts are to be compensated and/or paid for.

2. The objective of the annual Syr Darya agreements between the governments of Uzbekistan and Kyrgyzstan, and between the governments of Kazakhstan and Kyrgyzstan, is to specify compensation deliveries of fossil fuel resources from the downstream countries to Kyrgyzstan in return for electrical energy delivered in summer time. Volumes of these supplies are established annually based on the forecast hydrological situation and water reserves in Toktogul reservoir. The compensation has mainly been in the form of coal, natural gas and heavy fuel oil (mazut). There have been problems in the past resulting from interruptions to gas supplies and the, at times, poor quality of gas and coal delivered to Kyrgyzstan, with consequent high releases of water in winter to provide Kyrgyzstan energy requirements, and resulting wastage of water to Lake Arnasay.

3. There is a steady decline in the water reserves in Toktogul reservoir, which, if it continues, will result in a critical situation in regard to energy and irrigation supplies. Incomplete or untimely fulfilment of their obligations by the parties to the agreements, and unbalanced use of the hydro resources of the Naryn River, will inevitably result in serious consequences for the water and energy systems in the region.

4. Major issues include:

- Kyrgyzstan has a structural deficit in electricity generating capacity and no quick and affordable solutions are available. Construction of Kambarata I and II is not envisaged in the NWG draft plan for the near future, mainly because of the size of the investment, while construction of thermal power stations is not a realistic option. Technical and commercial losses of electricity are very high in Kyrgyzstan, about 35% of the generated energy being reported as losses.
- There is a need to develop an agreed river regulation and electrical generation regime for the Syr Darya-Naryn system that is sustainable in the long term i.e. that does not continue to draw down Toktogul reservoir on a long-term basis.
- There is a need for a mechanism to ensure that all parties to the agreements fulfil their obligations under the agreements, or if this cannot be achieved (in the event of a gas transmission failure, for example), that there is timely notification of the failure and that appropriate compensation is made.

5. There is a similar agreement between Uzbekistan and Tadjikistan which stipulates (i) the volume of water to be released and the amount of electricity to be taken by Uzbekistan in the vegetation period and (ii) the amount of electricity to be delivered by Uzbekistan in winter, plus spare parts, lubricants and other supplies and services for maintenance of Kayrakkum reservoir.

6. A number of options can be considered for improvement of the management of the Naryn Syr Darya Cascade, including:

- Continuation of the existing agreement with some modifications,
- Continuation of the existing agreement with major modifications,
- Continuation of the existing agreement with structural modifications,
- Discontinuation or modification of the agreement for entering into a Water and Energy Consortium,
- Prolongation of the existing agreement without modifications.

7. The first four options are considered in more detail in the following sections.

Continuation of the 1998 Agreement with Some Modifications

8. This option would focus on removing a number of weak or ill-defined points in various articles of the framework agreement.

9. Article II could be amended by moving the first sentence of Article VIII, about the decision-making process and the role of the Vice-prime Ministers, to the end of Article II.

10. Article III could be extended to include the condition that in case a party to the agreement is not able to fulfil its obligations, timely notification of the nature and extent of the failure is to be given to the affected party and prompt action on appropriate compensation is to be agreed upon between the parties concerned.

11. The second paragraph of Article IV could be amended to: 'compensation shall be made in monetary terms as agreed upon, or in equivalent amounts of energy resources such as coal, gas, electricity or fuel oil, and other types of products (labour, services) for annual and multiyear irrigation water storage in the reservoir.

12. The third paragraph of Article IV could be specified more clearly, as for instance: 'A uniform tariff policy for all types of energy sources and their transportation shall be applied between the parties for mutual settlement of energy flows falling under this agreement. The uniform tariff policy is based on adopting average quarterly world market prices for coal, gas, electricity and fuel oil published by the International Energy Agency based in Paris, adjusted for quality, and multiplied by a single factor to be approved by annual agreements between all parties, and increased to cover the cost of transportation from the source to the point of delivery. Losses of energy during transportation of whatever nature are at the expense of the supplying party.'

13. Article IV could be amended to reflect the condition that, if compensation is made in equivalent amounts of energy resources, this is to be based on caloric values.

14. Article VIII could be amended in such a way that the binding intergovernmental decisions are implemented by the owners and operators of the hydro-power facilities and by the relevant energy companies as executive bodies. UDC Energy is responsible for the management of interstate electricity transfers under this agreement. The BVO Syr Darya and UDC Energy are responsible for monitoring the execution of the intergovernmental decisions and reporting to the water, fuel and energy organisations.

15. An Article could be added specifying that at all times a minimum release of 100 m3/s is guaranteed to maintain an adequate flow for sanitary purposes in the downstream river reaches.

Continuation of the 1998 Agreement with Major Modifications

16. The focus of the major modifications would be to agree on a long-term sustainable operating regime, e.g. for a five-year period.

17. Article II could be amended as follows:
"To ensure the agreed operating regimes, the water, fuel and energy organisations, headed by Vice-prime Ministers of the signatory countries, will agree on sustainable operating regimes of the hydro-technical facilities and reservoirs of the Naryn-Syr Darya Cascade, and on irrigation water releases for a period of five water management years. The parties deem it necessary annually to coordinate and make decisions on the adjustment of water releases, production and transit of water diversions for irrigation by river reaches, electricity, and compensation for energy losses, on an equivalent basis, depending on the actual water stored in the reservoirs and flow forecasts for the next season. The annual coordination and decision-making on these adjustments will be by intergovernmental agreement by the water, fuel and energy organisations headed by the ministers and directors of these organisations, and subsequent approval by the Vice-prime Ministers."

18. Agreement on a longer-term sustainable operating regime has the advantage that all parties know what can be expected, but more importantly the variability in the natural flow can better be accommodated by carrying over to the next year any surpluses or shortages encountered in the current or previous year with the aim of maintaining the sustainable multiyear regulation of the storage reservoirs.

19. Consideration should be given to the inclusion of an article specifying that Kazakhstan and Uzbekistan would agree to pay a premium on the uniform tariff for the electricity transferred to those countries in the growing period, as partial and proportional payment for the operating and maintenance costs and as a service fee for maintaining the agreed long-term operating regime of the reservoirs in Kyrgyzstan. The premium would be agreed upon annually during the annual coordination and decision-making meeting described in Article II of the agreement.

20. An alternative to the payment of such a premium is to consider that the agreed uniform tariff policy based on an agreed fraction of world market prices for electricity reflects the cost of generation, including operation and maintenance costs. The drawback is that in that approach a premium to reflect the service fee for maintaining a certain regulating regime is not covered.

21. Besides the above essential changes, the amendments proposed under the first option would also figure under this second option.

Continuation of the 1998 Agreement with Structural Reform

22. The focus of a structural reform is that it should fit in the transition to free and open market conditions at a comparable level in all countries concerned. When such conditions are met, a situation could arise leading to a dissociation of water management and energy exchanges by intergovernmental agreement.

23. The main idea is to elaborate the second option further in the sense that an existing regional interstate legal entity will be charged with the keeping of accounts of all volumes and values of energy flows between the parties concerned, and will manage a

credit facility to be able to step in temporarily when one of the parties is occasionally and unintentionally not in a position to fulfil its obligations *vis a vis* another party.

24. In order to establish this mechanism, an international financing institution such as the World Bank or Asian Development Bank could be approached to provide and supervise the credit facility, which would be essential to ensure transparency of the operations of the interstate organisation to be charged with the accounting of the energy flows. The international financing institutions should be approached by the appropriate governmental or intergovernmental organisation to apply for their assistance in creating this mechanism.

25. In this option, the proposals for change made under the first and second options would apply as well.

Water and Energy Consortium

26. In Article VIII of the framework agreement of 1998, the establishment of the International Water and Energy Consortium and its executive body was foreseen. They would be charged with the implementation of the decisions taken on management of the Naryn Syr Darya Cascade. To date, draft texts on the mandate and functions of a Water and Energy Consortium are circulating between various organisations concerned. Formally speaking, the Water and Energy Consortium has not been established to date.

27. From a review of draft proposals by Kazakhstan and Kyrgyzstan on the Consortium, it is concluded that they do not describe the core of the matter on what would be managed by the Consortium and how it would do that. The texts are very general and would require major revisions to make it work. It is generally understood that a Water and Energy Consortium would act as a (commercial) executor of the annual intergovernmental agreements within the framework agreement of 1998. The idea seems to have support in Kazakhstan and Kyrgyzstan and from various international organisations.

28. It is doubtful whether a Water and Energy Consortium can be established under the present conditions: (i) yet another organisation would be created, (ii) the energy sectors in the four countries concerned are organised entirely differently from each other, from privately-owned companies in one country to fully State-controlled operations in another, (iii) laws and regulations governing the energy sectors in the countries differ, and it would be very difficult to establish a consortium that would be recognised legally by all countries and be empowered to operate effectively.

29. In conclusion, pursuing the establishment of a Water and Energy Consortium would be a long and difficult process, leaving the current problems basically unresolved.

APPENDIX 3

LIST OF TRANSBOUNDARY WATERS AND FACILITIES ON TRANSBOUNDARY WATERS IN THE ARAL SEA BASIN

Transboundary Waters in the Aral Sea Basin

Surface waters

Piandj *	Tadjikistan, Afghanistan
Kyzyl Su	Kyrgyzstan, Tadjikistan
Zerafshan	Tadjikistan, Uzbekistan
Amu Darya*	Tadjikistan, Turkmenistan, Uzbekistan, Afghanistan
Surkhandarya	Tadjikistan, Uzbekistan
Karshi Main Cascade	Turkmenistan, Uzbekistan
Amu Bukhara Main Canal	Turkmenistan, Uzbekistan
Tashaka Canal	Turkmenistan, Uzbekistan
Klychbay Canal	Turkmenistan, Uzbekistan
Kipchakbozsu Canal	Turkmenistan, Uzbekistan
Murgab	Turkmenistan, Afghanistan
Tedjen	Turkmenistan, Iran and Afghanistan
Naryn	Kyrgyzstan, Uzbekistan
Karadarya	Kyrgyzstan Uzbekistan
Syr Darya	Uzbekistan, Tadjikistan, Kazakhstan
Chirchik	Kazakhstan, Uzbekistan
Bozsu	Kazakhstan, Uzbekistan
Ugam	Kazakhstan, Uzbekistan
Dostlik Canal	Uzbekistan, Kazakhstan
Zakh Canal	Uzbekistan, Kazakhstan
Khanym Canal	Uzbekistan, Kazakhstan
Achinau Canal	Uzbekistan, Kazakhstan
Gazalkent Diversion Canal	Uzbekistan, Kazakhstan
Big Fergana Canal	Uzbekistan, Tadjikistan, Kyrgyzstan
North Fergana Canal	Uzbekistan, Tadjikistan
Big Namangan canal	Kyrgyzstan, Uzbekistan,
Chatkal	Kyrgyzstan, Uzbekistan
Gavasai	Kyrgyzstan, Uzbekistan
Sumsar	Kyrgyzstan, Uzbekistan
Kasansai	Kyrgyzstan, Uzbekistan
Chanach	Kyrgyzstan, Uzbekistan
Podshaota	Kyrgyzstan, Uzbekistan
Mailisuu	Kyrgyzstan, Uzbekistan
Karaungur	Kyrgyzstan, Uzbekistan
Kugart	Kyrgyzstan, Uzbekistan
Akbura	Kyrgyzstan, Uzbekistan
Aravansai	Kyrgyzstan, Uzbekistan
Isfairamsai	Kyrgyzstan, Uzbekistan
Shakhimardan	Kyrgyzstan, Uzbekistan
Sokh	Kyrgyzstan, Uzbekistan
Isfara	Kyrgyzstan, Tadjikistan, Uzbekistan
Khodji-Bakirgan	Kyrgyzstan, Tadjikistan
Aksuu	Kyrgyzstan, Tadjikistan
Lakes Balancing Collector	Uzbekistan, Turkmenistan
Collecrtor Daryalyk	Uzbekistan, Turkmenistan
Central Hunger Steppe Collector	Uzbekistan, Kazakhstan

Groundwaters

Aquifers at the fringe of the Ferghana Valley	Kyrgyzstan, Uzbekistan
Aquifers between Termez and Uchbersen	Uzbekistan, Turkmenistan, Tadjikistan, Afghanistan
Aquifers in the Zerafshan River valley	Tadjikistan, Uzbekistan

Note * Piandj, including the tributaries coming from Tadjikistan and Afghanistan; Amudarya, including the tributaries coming from Tadjikistan and Uzbekistan.

It is missing two rivers in the list: Vakhsh river and Kafirnigan river, which can be considered as tributaries, hence to consider them as transboundary waters. BVO Amudarya has large intake facilities on these rivers. Vakhsh river forms 20 billion m^3 flow of Amu Darya river, and on this river there is a large Nurek reservoir of seasonal regulation, and in future Rogun reservoir of over-year regulation will be commissioned.

LIST OF FACILITIES ON TRANSBOUNDARY WATERS IN THE ARAL SEA BASIN

Amu Darya Basin: List of the Structures on Trasnboundary Waters

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
I.	**Vakhsh river**					
1	Rogun reservoir	Over-year regulation	TAD			
2	H/p Komsolobad	Water discharge and level measuring	TAD	TAD HYDROMET	TAD HYDROMET	TAD
3	Nurek reservoir	Seasonal regulation	TAD	TAD	TAD BARKITOJIK	TAD
4	H/p Saryguzar	Monitoring Q и H	TAD	TAD HYDROMET	TAD HYDROMET	TAD
5	Diversion structure on TC25+20 of Dangara Main Canal (MC)	Intake	TAD	TAD MWR	TAD MWR	TAD MWR
6	Intake structure on TC7 of Yavanoobiki MC	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
7	Headwork MC Samotyochny	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
8	Headwork MC Vakhsh	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
9	Headwork Shurabad MC	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
10	Garauty Pump Station (PS)	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
11	H/p Tigrovaya Balka	Monitoring Q and H, in a future a quality	TAD	TAD HYDROMET	TAD HYDROMET	TAD
II.	**Piandj river**					
1	H/p Ishkashim	Monitoring H	TAD	TAD HYDROMET	TAD HYDROMET	TAD
2	H/p Hyrmandjou	Monitoring Q and H	TAD	TAD HYDROMET	TAD HYDROMET	TAD
3	Headwork Dekhkanabad	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
4	Headwork Khalkayar	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
5	Headwork Surkhob	Intake	TAD	TAD MBX	TAD MWR	TAD MWR
6	H/p Nijni (Downstream) Piandj	Monitoring Q and H, in future a quality	TAD	TAD HYDROMET	TAD HYDROMET	TAD

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
III.	**Kafirnigan river**					
1	H/p Tartki	Monitoring Q and H, in future a quality	TAD	TAD HYDROMET	TAD HYDROMET	TAD
2	Gate Dam	Water Release	BVO AD	BVO AD	TAD MWR	TAD MWR
3	Headwork Beshkent MC	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
4	Headwork Kabadiyan MC	Intake	BVO AD	BVO AD	TAD MWR	TAD MWR
IV	**Amu Darya river**					
1	Gulbakhor PS	Intake	UZB	UZB	UZB	UZB
2	Amuzang PS	Intake	UZB	UZB	UZB	UZB
3	H/p Termez	Monitoring Q and H	UZB	UZB	UZB	UZB
4	Djaykhun PS	Intake	UZB	UZB	UZB	UZB
5	MC-9 PS	Intake	UZB	UZB	UZB	UZB
6	Kattakhum PS	Intake	UZB	UZB	UZB	UZB
7	H/p Kelif	Monitoring Q and H	TUR	TUR HYDROMET	TUR HYDROMET	TUR
8	Headwork Chorshanga	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
9	Headwork Garagumdarya	Intake	TUR	TUR	TUR	TUR
10	Kuytandag PS	Intake	TUR	TUR	TUR	TUR
11	Yulangiz PS	Intake	TUR	TUR	TUR	TUR
12	PS of Karshi MC	Intake	UZB	UZB	UZB	UZB
13	H/p Atamurat (Kerki)	Monitoring Q and H, in future a quality	TUR	TUR HYDROMET	TUR HYDROMET	TUR
14	Headwork Khodjambas	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
15	Khodjambas PS	Intake	BVO AD	BVO AD	BVO AD	TUR
16	Headwork Esenmengli	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
17	Mekan PS	Intake	BVO AD	BVO AD	BVO AD	TUR
18	Headwork Karabekaul	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
19	H/p Karabekaul	Monitoring H	TUR	TUR HYDROMET	TUR HYDROMET	TUR
20	Burdalyk PS	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
21	Headwork Sayat-Naukhana	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
22	Tashrabad PS	Intake	BVO AD	BVO AD	BVO AD	TUR
23	Headwork Kul-Arik	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
24	Headwork ABMC	Intake	BVO AD	BVO AD	BVO AD	TUR/UZB via BVO
25	Headwork Shikh-Bitykh	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
26	Shikh-Bitykh PS	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
27	Headwork Berzen	Intake	BVO AD	BVO AD	BVO AD	TUR via BVO
28	H/p Chardjou	Monitoring Q and H, in future a quality	TUR	TUR HYDROMET	TUR HYDROMET	TUR
29	H/p Ilchik	Monitoring Q and H, in future a quality	TUR	TUR HYDROMET	TUR HYDROMET	TUR
30	Kranch-Khan-Yab PS	Intake	TUR	TUR	TUR	TUR
31	H/p Darganata	Monitoring Q and H, in future a quality	TUR	TUR HYDROMET	TUR HYDROMET	TUR
32	PS of Khorezm in Tuprakalin Massif (HP Darganata-HP Tuyamuyun)	Intake	UZB	UZB	UZB	UZB
33	Tuyamuyun reservoir	Seasonal regulation	UZB	UZB	UZB	UZB
34	Gate dam with hydro power station	Water release	UZB	UZB	UZB	UZB
35	Intake structure for Turkmendarya and Left Bank Canals	Intake	UZB	UZB	UZB	UZB
36	Headwork Pitnyak-arna	Intake	UZB	UZB	UZB	UZB
37	Headwork Right Bank Canal	Intake	UZB	UZB	UZB	UZB
38	H/p Tuyamuyun	Monitoring Q and H, in future a quality	UZB	UZB HYDROMET	UZB HYDROMET	UZB
39	Headwork Tashsaka (new)	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
40	Headwork Tashsaka (old)	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
41	Shark-Yulduzi PS	Intake	UZB	UZB	UZB	UZB
42	Headwork Pakhta-Arna	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
43	Headwork Bayram-Saka	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
44	Headwork Karamazy-Saka	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD
45	Dustlik PS	Intake	UZB	UZB	UZB	UZB
46	Headwork Urgench-Arna	Intake	BVO AD	BVO AD	BVO AD	BVO AD
47	Headwork Daryalyk	Intake	BVO AD	BVO AD	BVO AD	BVO AD
48	Kylchynak PS	Intake	UZB	UZB	UZB	UZB
49	H/p Beruny	Monitoring H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
50	Nayman-Beshtam PS	Intake	UZB	UZB	UZB	UZB
51	Jaykhun-1 PS	Intake	UZB	UZB	UZB	UZB
52	Jaykhun-2 PS	Intake	UZB	UZB	UZB	UZB
53	Headwork Turanga-Saka	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD
54	Berunin area PS (3 objects)	Intake	UZB	UZB	UZB	UZB
55	Headwork Klychniyazbay	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD
56	Alibobo-1 PS	Intake	UZB	UZB	UZB	UZB
57	Ozodyargan PS	Intake	UZB	UZB	UZB	UZB
58	Shykh-Jamal PS	Intake	UZB	UZB	UZB	UZB
59	Erlantau PS	Intake	UZB	UZB	UZB	UZB
60	Tash-Yab PS	Intake	UZB	UZB	UZB	UZB
61	Headwork Kipchakbozsu	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD
62	PS inflow to Kipchakbozsu	Intake	UZB	UZB	UZB	UZB
63	Chigir PS	Intake	UZB	UZB	UZB	UZB
64	Nazarkhan PS	Intake	UZB	UZB	UZB	UZB
65	H/p Kipchak	Monitoring Q and H, in future a quality	UZB	UZB HYDROMET	UZB HYDROMET	UZB
66	Keneges PS	Intake	UZB	UZB	UZB	UZB
67	Astantay PS	Intake	UZB	UZB	UZB	UZB
68	PS on tributary canal to Khan-Yab	Intake	UZB	UZB	UZB	UZB
69	Headwork Djumabaysaka	Intake	BVO AD	BVO AD	BVO AD	TUR/BVO AD

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
70	Headwork Khan-Yab	Intake	BVO AD	BVO AD	BVO AD	TUR/BVO AD
71	Headwork State Rayon Power Station	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
72	Headwork Kyzketken	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
73	H/p Kyzketken	Monitoring H, in future a quality	UZB	UZB HYDROMET	UZB HYDROMET	UZB
74	Hydrosystem Takhiatash	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
75	Gate Dam	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
76	Right Bank Double Structure	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
77	Shipping Lock	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
78	Left Bank Double Structure	Intake	BVO AD	BVO AD	BVO AD	UZB/BVO AD
79	H/p Samanbay	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
80	Uzbekistan PS	Intake	UZB	UZB	UZB	UZB
81	H/p Takhyatash	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
81	Uzbekistan PS	Intake	UZB	UZB	UZB	UZB
82	H/p Raushan	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
83	Uzbekistan PS	Intakes	UZB	UZB	UZB	UZB
84	H/p Kzyldjar	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
85	Uzbekistan PS	Intake	UZB	UZB	UZB	UZB
86	H/p Porlatau	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
87	Tashsaka system with facilities	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD
88	Klychniyazbay system with facilities	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD
89	Kipchakbozsu system with facilities	Intake	BVO AD	BVO AD	BVO AD	UZB/TUR/BVO AD

LIST OF FACILITIES ON TRANSBOUNDARY WATERS IN THE ARAL SEA BASIN

Syr Darya Basin: List of the Structures on Transboundary Waters

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
I.	**Naryn river**					
1	Toktogul reservoir	Over-year regulation	KYR	KYR ENERGY	KYR ENERGY	KYR
2	Headwork of Left Bank Naryn Canal and canal itself	Intake and Main Canal (MC)	KYR			KYR
3	Headwork of Big Namangan Canal and Canal itself	Intake and MC	KYR			KYR
4	Headwork of Big Fergana Canal (BFC)on Naryn river (upstream tract)	Intake	UZB/KYR/TAD	BVO SD	BVO SD	UZB
5	Upstream tract of Big Fergana Canal at the length of 49 km	MC	UZB/KYR/TAD	BVO SD	BVO SD	UZB
6	Upstream tract of Big Fergana Canal Sector below 49 km	MC	UZB/KYR/TAD	UZB MWR	UZB MWR	UZB
7	Uchkurgan hydrosystem	Intake	UZB/TAD	BVO SD	BVO SD	UZB
8	North Fergana Canal (NFC), initial sector of 1 km with headwork	Intake	UZB/TAD	BVO SD	BVO SD	UZB
9	Sector of North Fergana Canal downstream of 1 km	MC	UZB/TAD	UZB MWR	UZB MWR	UZB
10	Headwork of tributary Canal and Canal itself at the length of 6 km	Intake and MC	UZB/TAD	BVO SD	BVO SD	UZB
11	Tributary structures and structures downstream of 6 km, including Big Andijan Canal	MC	UZB/TAD	UZB MWR	UZB MWR	UZB
12	Small diversions from Naryn river	Intakes	UZB	UZB MWR	UZB MWR	UZB
13	H/p Uchkurgan	Monitoring Q and H, in future a quality	UZB	UZB HYDROMET	UZB HYDROMET	UZB
II.	**Karadarya river**					
1	Andijan reservoir	Flow regulation	UZB	UZB MWR	UZB MWR	UZB
2	Diversion Canal of Andijan reservoir	Water supply for south	UZB/KYR	UZB MWR	UZB MWR	UZB

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
		irrigation systems of Fergana valley				
3	Right Bank Canal	MC	UZB/KYR	UZB MWR	UZB MWR	UZB
4	Teshiktash hydrosystem	Intake	UZB	UZB MWR	UZB MWR	UZB
5	Pakhtaabad Canal	MC	UZB	UZB MWR	UZB MWR	UZB
6	Ulugnar Canal	MC	UZB	UZB MWR	UZB MWR	UZB
7	Kuiganyar hydrosystem	Intake	UZB/TAD	BVO SD	BVO SD	UZB
8	Head regulator and initial sector of downstream tract of BFC	Intake	UZB/TAD	BVO SD	BVO SD	UZB
9	Downstream tract of BFC	MC	UZB/TAD	MWR UZB/TAD	MCBX UZB/TAD	UZB/TAD
10	Head regulator of Siza canal	Intake	UZB	BVO SD	BVO SD	UZB
11	Siza canal	MC	UZB	UZB MWR	UZB MWR	UZB
12	H/p Uchtepe	Monitoring Q and H, in future a quality	UZB	UZB HYDROMET	UZB HYDROMET	UZB
III.	**Syr Darya river**					
1	Kayrakkum reservoir	Flow regulation	TAD/UZB/KAZ	TAD ENERGY	TAD ENERGY	TAD
2	Shardara reservoir	Flow regulation	KAZ/UZB	KAZ WRC	KAZ WRC	KAZ
3	Headwork of Canal named by Akhunbabaev	Intake	UZB	BVO SD	BVO SD	UZB
4	Canal named by Akhunbabaev	MC	UZB	UZB MWR	UZB MWR	UZB
5	Headwork of Diversion Canal of Farkhad hydro power station and canal itself	Water supply for power station and South Hungry Steppe Canal (SHSC)	UZB/KAZ	UZB ENERGY	UZB ENERGY	UZB
6	Headwork of SHSC	Intake	UZB	BVO SD	BVO SD	UZB
7	SHSC	MC	UZB	UZB MWR	UZB MWR	UZB
8	Headwork of Bekabad canal	Intake	UZB	BVO SD	BVO SD	UZB
9	Bekabad canal	MC	UZB	UZB MWR	UZB MWR	UZB
10	Headwork of upstream Dalverzin canal	Intake	TAD	BVO SD	BVO SD	UZB
11	Upstream Dalverzin canal	MC	TAD			TAD
12	Headwork of downstream Dalverzin canal	Intake	UZB	BVO SD	BVO SD	UZB

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
13	Downstream Dalverzin canal-	MC	UZB	UZB MWR	UZB MWR	UZB
14	Dustlik canal's system with headwork and other structures	Intake, transportation and water distribution	UZB/KAZ	BVO SD	BVO SD/KAZ	UZB/KAZ
15	Stationary PS of Uzbekistan upstream of Kayrakkum: Chiganak, Dangara, Besharyk, Abdusamat, Syrdarya, Dustlik	Intake	UZB	UZB MWR	UZB MWR	UZB
16	Stationary PS of Tajikistan: Chukumjar, Ettitepa, Asht, Kokkurak, Samgar, Palas, Simchak, Kyzyltukay, Aktsh, Poymennaya, Shurkul, Arkin, Makhram, Koktyurlyuk, Undjin,Yavvaaral, Rokhi, Digmay, Nauss, Mekhnat, Zafarabad (except Khojibakirgan PS)	Intake	TAD			TAD
17	Khojibakirgan PS	Intake	TAD/KYR			TAD
18	PS of Uzbekistan downstream of Kayrakkum: stationary #1, 3, 6 and temporary	Intake	UZB	UZB MWR	UZB MWR	UZB
19	Hydrosystems, canals and h/p dowenstream of Shardara reservoir		KAZ	BVO Aral SD	BVO Aral SD	KAZ
20	H/p Kal	Monitoring Q and H, in future a quality	UZB	UZB HYDROMET	UZB HYDROMET	UZB
21	H/p Akjar	Monitoring Q and H, in future a quality	TAD	TAD HYDROMET	TAD HYDROMET	TAD
22	H/p Kyzyl Kishlak	Monitoring Q and H, in future a quality	TAD	TAD HYDROMET	TAD HYDROMET	TAD
23	H/p downstream of KMC	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
24	H/p Nadejdensky	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
25	H/p Kokbulak	Monitoring Q and H, in future a quality	KAZ	KAZ HYDROMET	KAZ HYDROMET	KAZ
26	H/p Keles	Monitoring Q and H	KAZ	KAZ HYDROMET	KAZ HYDROMET	KAZ
27	H/p downstream of Shardara reservoir (about 10 objects)	Monitoring Q and H	KAZ			KAZ

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
IV.	**Chirchik river**					
1	Charvak reservoir and downstream cascade of Hydro power stations	Flow regulation	UZB	UZB ENERGY	UZB ENERGY	UZB
2	Gazalkent hydrosystem	Intake	UZB	UZB ENERGY	UZB ENERGY	UZB
3	Headwork of Parkent canal	Intake	UZB	BVO SD	BVO SD	UZB
4	Parkent canal	MC	UZB/KAZ	UZB MWR	UZB MWR	UZB
5	Upstream diversion canal	Complex	UZB/KAZ	UZB ENERGY	UZB ENERGY	UZB
6	Headwork of Big Keles Main Canal (BKMC)	Intake	UZB/KAZ	BVO SD	BVO SD	UZB
7	BKMC, Zakh and Khanym canals	MC	UZB/KAZ	KAZ WRC		KAZ
8	Bozsu tract below Upstream diversion canal	Complex	UZB	UZB ENERGY		UZB
9	Chirchik upstream intake system	Intake	UZB	BVO SD	BVO SD	UZB
10	Headwork of Karasu Left Bank Canal	Intake	UZB	BVO SD	BVO SD	UZB
11	Karasu Left Bank Canal	MC	UZB	UZB MWR	UZB MWR	UZB
12	Small diversions downstream of Chirchik upstream intake systems	Intakes	UZB	UZB MWR	UZB MWR	UZB
13	H/p Chirchik-Chinaz	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
14	H/p Syrdaraya-Chinaz	Monitoring Q and H, in future a quality	UZB	UZB HYDROMET	UZB HYDROMET	UZB
15	H/p Bozsu-Chinaz	Monitoring Q and H	UZB	UZB HYDROMET	UZB HYDROMET	UZB
V.	**Small rivers**					
1	Aravansay	Intake	UZB/KYR			
2	Gavasay	Intake	UZB/KYR			
3	Kasansay	Intake	UZB/KYR			
4	Padshaata	Intake	UZB/KYR			
5	Koksereksay	Intake	UZB/KYR			
6	Tentyaksay	Intake	UZB/KYR			
7	Maylisay	Intake	UZB/KYR			
8	Isfara	Intake	UZB/KYR/TAD			

#	Facility	Purpose	Status			
			Owner by balance sheet	Operation and Maintenance		
				Operated by	Maintenance	
					Authority	Finance Source
9	Sokh	Intake	UZB/KYR			
10	Isfayramsay	Intake	UZB/KYR			
11	Shakhimardansay	Intake	UZB/KYR			
12	Aksu	Intake	KYR/TAD			
13	Khodjabakirgan	Intake	KYR/TAD			
14	Isfana	Intake	KYR/TAD			

APPENDIX 4

LONG-TERM PERSPECTIVE FOR INSTITUTIONAL STRENGTHENING

International Approaches to River Basin Institutional Strengthening

1. International experience in many river basins, such as in Australia and the countries of the Lower Mekong River Basin (Thailand, Laos, Cambodia and Vietnam), has confirmed that sustainable water resources management and development can best be achieved at the regional (basin) level.

2. Ideally, the most senior representatives from the States ought to be assembled at the Aral Sea Basin level with clearly defined responsibilities, and supported by legislation and regulations. This could ensure that decisions on broad, sustainable water resources and energy management and development, agricultural reform, and ecological improvement are made in the best interests of the basin as a whole, and ensure the essential coordination, implementation and enforcement of those decisions in the States.

3. The numerous river basin agencies throughout the world have been established fundamentally in accordance with one of three models – a River Basin Authority, a River Basin Coordinating Committee or Council, or a River Basin Commission. The respective features of the three models follow.

River Basin Authority

- This type of agency performs all of the water and water-related resource management functions within a river basin.
- It is a large multi-disciplinary agency or organisation responsible for both regulation and operation and management functions.
- It is used where there is a large, long-term development project to be undertaken, often with many facets or components.
- Usually the existing agencies or departments within the States or provinces in the basin would be weak or ineffective to justify using this model (an example was the establishment of the Tennessee Valley Authority in the USA some 60 years ago).
- This is the 'strongest' or most powerful intervention in basin management.

River Basin Coordinating Committee or Council

- This model normally comprises the heads of all relevant ministries, agencies, or departments, with a small supporting secretariat.
- It essentially coordinates high-level policy and strategy matters and have no role in daily operation or management.
- This arrangement is often used in 'developed' countries where most development is completed, where water trading and other economic instruments are in place, and the water sector is in a stable or mature situation.
- This is the 'softest' or 'weakest' intervention in the overall management of a river basin.

River Basin Commission

- This model sits between the River Basin Authority and the River Basin Coordinating Council in terms of influence within a river basin.
- It deals mostly with policy and strategy formulation, developing standards and quality control procedures, endorsing operating criteria, undertaking long-term planning, and ensuring data and information are suitable basin-wide.
- Some operating functions may exist for very major works or for inter-State boundary issues, but most operation and management issues remain with the individual countries within the basin.
- A feature of this model is that it is a 'partnership' between the commission and the countries within the basin.
- This model, or variations of it, are being used more frequently in the present era when all key stakeholders in a basin need to be involved in major policy decisions.

4. Each of these models is contingent on the availability of good data monitoring networks (surface and groundwater, water quantity and quality, as well as other natural resources data) which are represented basin-wide, and collection, processing and storage systems are adequate, and the information is available to all stakeholders. Hydrologic and socio-economic models must also be available to support and test the impact of any new policies or management and development proposals.

Potential Future Arrangements

River Basin Commission

5. For the longer term it is suggested that the existing institutions would gradually move towards the model of the River Basin Commission as the most appropriate institutional model for the Aral Sea Basin. At present there is no single regional authority in the basin at a high enough level to ensure complete, unequivocal jurisdiction over the water, energy, and environment sectors, or one that can balance the diverse objectives and problems. The absence of such a regional organisation enables the project interests of one sector or one or two countries to dominate the decision-making process in a way that may not necessarily be in the best interests of the basin as a whole.

6. Establishment of a River Basin Commission, by effectively broadening, strengthening, and re-focusing ICWC and IFAS, would build on the cooperation, collaboration and experience developed since 1992. It would be a logical continuation and expansion of the existing arrangements, be consistent with the central Asian social systems that rely heavily on personal relationships, and would allow for negotiation and bargaining.

7. Establishment of a River Basin Commission would:

- expedite work towards achieving sustainable resource management and development;
- avoid project duplication and confusion;

- ensure efficient and effective resource allocation annually;
- create a strong, internationally-recognised organisation; and
- maximise the potential financial assistance available from the international donor community.

8. The move towards a River Basin Commission, as an institutional framework model to be attained in the long term (possibly over a decade), would be a logical evolution of the existing IFAS arrangements. It would be achieved by effectively adding the energy sector to broaden and strengthen the mandate, responsibilities and capabilities of the existing arrangements involving IFAS, ICWC, CSD and the Energy Council.

Composition of a Commission

9. It is suggested that a Commission could consist of four components as shown in Figure 3:

- a **Council** of the Prime Ministers or Vice Prime Ministers with the responsibility for policy and decisions, supported by
- a **Joint Committee,** consisting of the three ministers from each of the States responsible for water, energy and the environment, charged with the responsibility for making recommendations to Council and implementing the Council's decisions; through
- a permanent **Secretariat,** with staff appropriately qualified in water resources, agriculture, energy, environment, law, hydrometeorology, etc. drawn from the various regional and State agencies, together with donor experts from the international community, which would be responsible for administration and technical advice; and
- the **BVOs**, with appropriately qualified staff, which would be responsible for the operation, maintenance and monitoring of the water supply and distribution infrastructure under the jurisdiction of the Commission.

OPTION FOR A LONG TERM ARAL SEA BASIN INSTITUTIONAL ARRANGEMENT

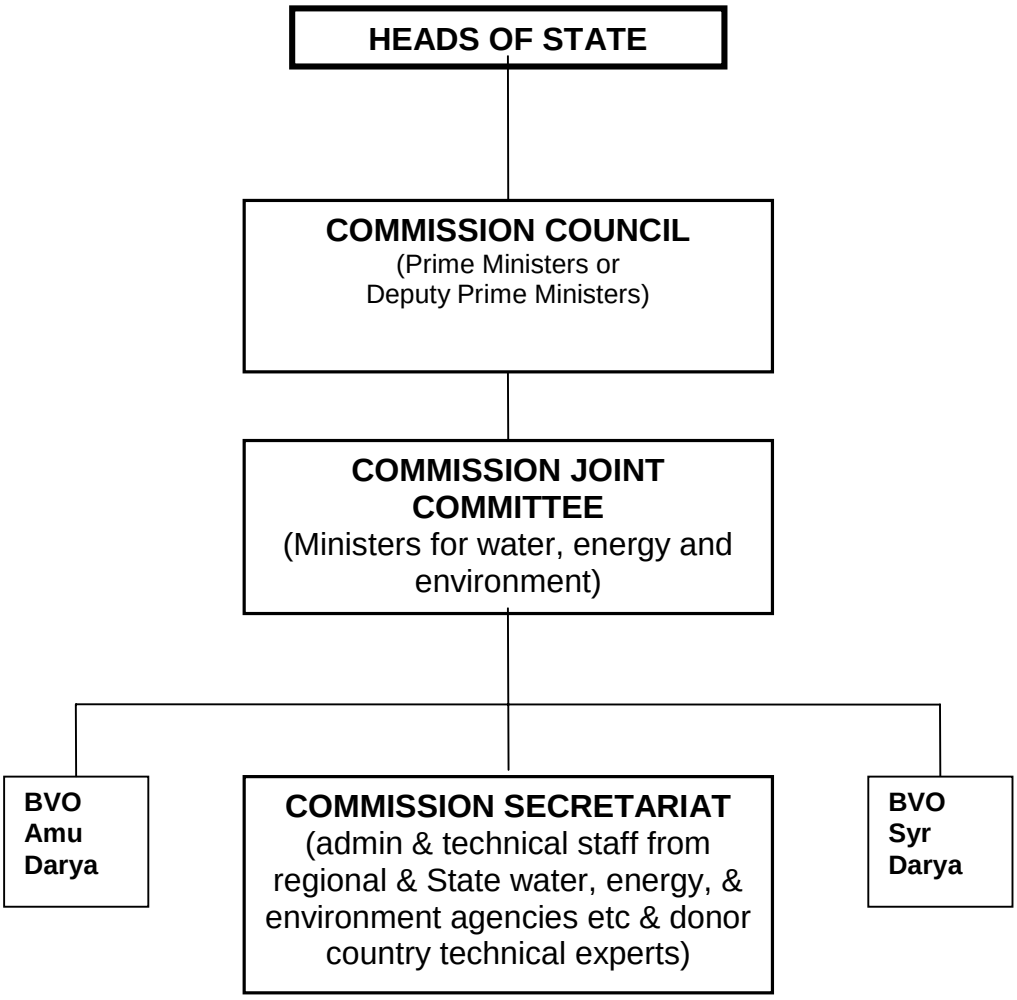

Figure 3

10. In addition to broadening and strengthening the mandate of IFAS, and making it more representative of the key stakeholders, this arrangement would provide a much simpler decision-making and administrative structure by reducing the number of primary bodies from ten to five. By combining the functions of the ICWC and CSD secretariats and SICs into one body, a much more integrated approach to basin management would be achieved.

Responsibilities of a Commission

11. The responsibilities of a Commission could include:

- Determining broad water resources allocations (surface and groundwater) for the States in accordance with the UN/ECE 'Convention on the Protection and Use of Transboundary Watercourses and International Lakes', Helsinki, 1992.

Amongst other things, this Convention confirm that each basin State is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of the basin.

- Further development of broad policies and programs promoting sustainable water resources management, particularly with respect to:
  - river salinity standards, control mechanisms andmanagement;
  - promotion of increased water use (especially irrigation) efficiency through demand management mechanisms and community/farmer education;
  - environmental demands.
- Preparation and supervision of comprehensive, regional (basin-wide) water and salt management strategies/plans that would provide the basis for guiding agricultural reform and the development and management of major multipurpose projects, and would outline mainstream water quality and environmental conditions etc. It is suggested that these plans would be essential to the preparation of national plans, but would not dictate the ways in which the States should utilise their water allocations.
- Operation, maintenance and monitoring of water supply and distribution infrastructure on the transboundary rivers.

12. It is suggested that a primary responsibility of the Commission would be to ensure that the agreed national water allocations and return flows, and arrangements for intra-regional energy trade and distribution, are honoured in practice; that they are delivered in a manner that meets the requirements of the States and are in the best interests of the Aral Sea Basin as a whole; and that other intra-regional commitments are met. More specifically, the Commission's functions would include policy and planning, standard setting and auditing, coordination and dispute resolution, data collection and compilation, monitoring the national allocations, and public awareness and education.

Management Arrangements for a Commission

13. Irrespective of the degree of support for a Commission, it would probably not be possible in the short-term because of political and economic constraints. For example, some governments do not permit several ministers to leave their posts on the same day, so that the Joint Committee with the suggested composition could not convene. However, it is suggested that a decision to establish a Commission 'in principle' would send a strong signal to the international donor community (World Bank, Asian Development Bank, European Union, USAID, etc.) and assist greatly in the provision of technical and financial support.

14. The Nile Basin Initiative provides a recent clear indicator of available support where nations genuinely want to cooperate. In that case, and despite serious potential conflicts between the ten riparian countries, a multi-track diplomacy approach among the key nations has now resulted in an encouraging level of cooperation. According to the World Bank Development News of 31 July 2001: "the 10 Nile countries have decided to rise above national differences and pursue a common social and economic vision by establishing the Nile Basin Initiative. In June 2001 the international donor community pledged $140 million in grants to

implement a basin-wide program of research, capacity building and technical assistance, and begin detailed planning of investment programs, the first of which is expected to amount to $3 billion."

15. Although establishment of a Commission may be an initiative for the future, it is suggested that the Council Chairman should sit for a two-year term and that the position should rotate according to the alphabetical listing of the member States. The Council would convene at least two regular sessions every year, and might convene special sessions whenever considered necessary or upon the request of a member State. The Council would also decide the location of the permanent office of the Secretariat and, if necessary, a headquarters agreement would be negotiated and entered into with the host government.

16. It is suggested that the Chairman of the Joint Committee should also sit for a two-year term, and that the position should rotate according to the reverse alphabetical listing of the member States. The Joint Committee would desirably convene at least three regular sessions every year, and convene special sessions whenever considered necessary or upon the request of a member State.

17. The **Secretariat** would be responsible for providing technical advice and administrative support services to the Council and the Joint Committee, and be under the supervision of the Joint Committee. More specifically, it would assist the Joint Committee in implementation, evaluation and management of programs, projects and activities; maintain databases; formulate an annual work program; prepare other plans and program documents; and undertake such studies and assessments as might be required.

18. The Secretariat would operate under the direction of a Chief Executive Officer (CEO) appointed by Council. It is suggested that consideration be given to recruiting the initial CEO on a five-year term from outside the States following world-wide advertisement of the position. The position of Deputy CEO could rotate among the States on a two-year term consistent with that of the Joint Committee Chairman, and the five key division directors could be appointed from each of the States.

19. Although it is expected that a significant number of the Secretariat staff would be drawn from the SIC-ICWC and SIC-CSD, it is suggested that other staff from riparian countries with specific expertise in water resources, agriculture, energy, environment, law, hydrometeorology etc. be recruited on the basis of technical competence, and the number of posts assigned on an equitable basis among the member republics. It is suggested that staff be recruited for no more than two three-year terms, except as otherwise decided by the Joint Committee.

20. The **BVOs** would continue to operate, but possibly with a wider mandate. Whilst they have, at least nominally, the responsibility for operating the transboundary rivers, they do not operate any of the key reservoirs nor do they have any power to enforce reservoir operations. In the Syr Darya Basin for example, operation of the Naryn-Syr Darya Cascade (Toktogul, Kurpsay, Tashkumir, Shamalaysay and Uchkurgam), Andijan, Kayrakum, Farkhad, Charvak and Chardara is undertaken by various agencies from Kyrgyzstan, Uzbekistan, Tajikistan and Kazakhstan, and the BVO effectively operates as a monitoring organisation.

21. In the case of the Amu Darya, the situation is currently less constrained, with Turkmenistan and Uzbekistan having a water-sharing agreement in place. However, the future development of Tadjikistan's vast water resources, and those generated in Afghanistan, both of which are largely unregulated, could affect other countries, which suggests that it may be advantageous to develop a basin agreement to ensure sustainable development.

22. For the future, the operational management options for the BVOs could include:

- maintaining their existing monitoring roles (which would not assist in working towards the goal for sustainable water resources management);
- leaving the day-to-day operation and maintenance responsibility for the reservoirs as outlined previously to the various State agencies, although subject to the direction of the BVOs with respect to diversions in each river reach (e.g. in the Syr Darya system the river reaches could be: Toktogul to the Karadarya confluence, Andijan to Naryn confluence, Karadarya/Naryn confluence to Kayrakum, Kayrakum to Farkhad, Farkhad to Chirchik confluence, Charvak to Syr Darya confluence, Syr Darya/Chirchik confluence to Chardara, and Chardara to the delta). This option would require that the BVOs be given appropriate funding by the States and the legal authority to enforce penalties for non-compliance.

23. The option of transferring to the BVOs ownership of the major water reservoirs and hydro-generation facilities, together with the mandate to operate them only in accordance with ICWC policy, is not considered a realistic option at this stage. To operate effectively the BVOs need security of funding. They also need the assurance that, not only will they receive all their budgeted funds, but they have the management flexibility to carry out any repairs and maintenance that are urgently required.

National Aral Sea Basin Committees

24. For the long-term it is further suggested that national committees be established in each of the States to assist the Commission Secretariat in providing advice to the Joint Committee to ensure essential communication, coordination and implementation of the Commission's policies, programs and activities. Each national committee would be chaired by a Joint Committee member and would be representative of all water, energy and environment interests, including the Ministry of Finance, and serviced by a permanent office.

APPENDIX 5

INTRODUCTION TO THE MODELS AND DATABASE OF WEMP A1

1. INTRODUCTION

1. The original Project Terms of Reference note that the lack of management tools and efficient information systems and reliable databases has been to date a major constraint to progress in establishing a framework for Basin water management. They state also that models are essential for the planning process as well as for later use in the development and implementation of the policies, strategies, and action programs. Hence, the Project had a major Basin Modelling component.

2. The models are seen as being needed during the planning process to simulate current and future water and salt balances at the planning zone level and at the level of the Amu Darya and the Syr Darya river basins. They are also to be capable of being used later for various purposes including: (i) monitoring water resource conditions, (ii) assessing regional and national projects and actions, and (iii) predicting the outcomes and consequences of various actions.

3. The models are required to have the capability to analyse water use, salinity, the inter-connected groundwater systems, and their economic and ecological impacts in all the planning zones including the specific interactions between rivers and command areas, and between surface water, groundwater and salinity in each zone.

4. The Terms of Reference required a careful evaluation of existing models that might be utilised for the above purposes, to ensure that they:

- are based on proven and appropriate scientific principles,
- can be readily understood and can be readily transferred to local agencies,
- are sufficiently versatile for the various purposes,
- are formulated at an appropriate level of detail,
- provide full simulation of the hydrological and salinity characteristics of transboundary waters.

5. In the early stages of the project it was agreed that the tools to be used in the project would be augmented by appropriate optimisation models. The concurrent expansion of the project scope of work to include energy issues, as far as relevant, resulted in a requirement for the development of an optimisation model integrating the water, agriculture and energy systems of the Basin. After evaluation of existing models, it was concluded that in view of the requirements a new set of modelling tools had to be developed for use in the project and for later use by the project beneficiaries. Essentially two types of models were needed:

- an optimisation model
- a simulation model

2. ARAL SEA BASIN OPTIMISATION MODEL (ASBOM)

6. After discussions with the countries, and in line with the recommendations of the Independent Panel of Experts, the project opted to consider and model the region in five different national modules. In conceptualising the situation the countries can be divided into upstream countries (Kyrgyzstan and Tadjikistan) and downstream countries (Uzbekistan, Kazakhstan and Turkmenistan) distributed within two separate river basins.

7. The upstream countries have large hydropower generation facilities and relatively small thermal power facilities, and the irrigable areas are relatively small. In contrast, the downstream countries have large irrigable areas, large fossil fuel resources available for thermal power generation, and little in the way of hydropower generation capacity. The optimal water use will therefore differ between the upstream countries and the downstream countries.

8. The Aral Sea Basin Optimisation Model (ASBOM) has been developed in accordance with this concept, combining technical, economic, environmental and agronomic aspects into a coherent framework. The model consists of five different national modules, although both the Tadjikistan and the Uzbekistan module contains two segments – one for the Syr Darya basin and one for the Amu Darya basin. Each module consists of Water Network and an Energy Network. The Water Network comprises the river(s) major supply systems and collector drains and the planning zones. The Energy Network contains energy supply nodes that are fed by hydropower and thermal power stations, and energy demand nodes. The interconnection between the two networks comes about from the fact that water released from reservoirs for irrigation purposes generates hydropower, or conversely water released to generate hydropower is used for irrigation or will contribute to the ecology of the wetlands and the Aral Sea itself.

9. Because of the different objectives of the upstream and downstream countries, there is likely to be a considerable difference between countries in the two groupings in terms of the optimum pattern of water releases, and some form of compromise will be required.

10. The ASBOM is a useful tool for evaluating the benefits of various compromise situations, which may include transfers of energy and/or water between countries, or compensation payments to or from individual countries for benefits foregone or gained in particular situations. It provides a useful vehicle for direct energy/water negotiations between the upstream and downstream countries, and help in formulating a general framework in which negotiations can be undertaken.

11. In Appendix 6 a brief introduction to ASBOM is provided. Full documentation of the model, manuals and training material for the use of the models was prepared and has been handed over to the NWGs (see Appendices 3 and 4).

3. RIVER BASIN SIMULATION MODEL (RIBASIM)

12. The main purpose of the simulation model is to evaluate the performance of a defined situation of water use (e.g. current or in future), when such a situation would encounter variations of natural flow over time. It allows to determine if a given water use pattern can be supported by the river flows within acceptable limits of failure or, on the contrary, if such criteria are surpassed to determine where and to what extent water use would have to be adjusted.

13. The river basin simulation software RIBASIM has been used to set up two separate models, one for the Syr Darya and one for the Amu Darya, in order to simulate the water and salt balances. The original version of RIBASIM software was enhanced by the project to have the capability to keep track of salt movements in the system.

14. In view of obtaining consistency between the models and their interaction, the two models comprise the same features as are represented in the optimisation model ASBOM:a network of rivers, main supply canals, collector drains

- reservoirs and diversion weirs
- hydro-power stations
- planning zones
- large lake systems and desert sinks

15. The results from the optimisations carried out in ASBOM serve as input sets for simulation of the performance of scenarios over the long term.

16. Both the optimisation and the simulation models provide the water balance for the basins, countries and planning zones. In addition the simulation model provides the salt concentrations in the surface water system and the salt balance per planning zone.

4. DATABASE

17. Water and salt balance calculations are highly dependent on data of what has been achieved and experienced in the recent past, the trends which can be derived from that, the expectations on what would be needed in future, and the constraints imposed to achieve sustainable resource management.

18. In developing the water and salt balances under various conditions, extensive use has been made of data provided by the National Working Groups. These data relate to the past and to the projections of potential future outlooks for each country as seen by the respective NWGs, following as far as possible frameworks for scenarios set out by the RWG.

19. Data provided by the NWGs relates to:

- Population and its growth forecasts, and foodstuff production requirements,
- Hydrology,
- Agricultural production,
- Water quality (salinity),
- Irrigation areas,
- Condition of irrigation and drainage infrastructure (translated into irrigation efficiencies and return flows) under present conditions and under future improved conditions,
- Current and projected O&M costs,
- Investment requirements needed to achieve higher efficiency of water use and hence to achieve rational water use,
- Current crop yields and potential future higher crop yields as a result of the investments in projects and programs,
- Current and projected future energy production and generation capacities (both thermal and hydro).

20. During Phase III of the project, the RWG made an in-depth analysis of the current irrigation and drainage practices in Central Asia, and their impacts on agricultural production and soil salinisation. That study, entitled ‘Water Losses and Development Strategies’, then analysed a large number of options for improvement of on-farm water management, for various farm types and for the various regions in the Aral Sea Basin. Typical packages of improvement measures were put together for each area, and the economic feasibility of each package was assessed using crop and farm budgets developed specifically for those areas. The results of this work were also summarised in Chapter 8 of Regional Report No.2.

21. The data used in the analyses of current and future water and salt balances hence covers a wide range of issues, and the database has become a rich and vast source of information. The RWG has reviewed the NWG data and has made adjustments where needed to arrive at consistent data sets, which subsequently were checked by the NWG experts.

5. USE OF THE MODELS

22. The models presented above can be used for two main tasks:

- to calculate water and salt balances in the Aral Sea Basin;
- to provide numerical background for a framework for Basin water and salt management.

23. Once the optimum land use has been established in the various Planning Zones with the ASBOM model, the simulation model is used to calculate water and salt balances for different scenarios. The input water demands are derived from the scenario assumptions regarding extent of irrigation, water quality, cropping patterns etc. The simulation models RIBASIM will calculate the water and salt balances in the system, and the energy generated, over the 40-year flow sequence from 1960 to 2000. From this it will be possible to establish how often the system fails, and whether the frequency of failure would be acceptable within the constraints of the scenario. The runs can be used also to manually optimise operating rule curves for the various reservoirs.

24. Apart from the two main tasks, the models could also be used to a certain extent for operational analyses. That is, they could provide answers for very short-term 'what-if' analyses.

25. The main outputs from the computer models - subject to various scenarios – are, per planning zone and so per country:

- optimal land use (cropping pattern)
- crop yields;
- irrigation water requirements;
- hydro and thermal power generated.

26. The ASBOM optimisation model calculates the optimal water use in relation to hydropower and land use in each country. Calculation starts with the upstream countries, and then proceeds to the downstream countries. The model calculates in the following order:

- Kyrgyzstan;
- Uzbekistan and Tadjikistan;
- Kazakhstan or Turkmenistan.

27. It should be understood that apart from structural data input into the models (data about river capacities, reservoirs, diversion, etc.) there are a number of data that depend on decisions, measures that are going to be taken in the future. For these so-called scenarios have been developed for a time horizon of 25 years. Thus the models will mainly deal with the situation as it is assumed to exist in 25 years time based on various scenarios.

28. The scenarios are, in principle, different for each country and will have an impact on the situation in each planning zone, the smallest spatial and economic unit used in the model studies.

29. The river basins may see further development, i.e. additional reservoirs/HPPs and TPPs. The ASBOM and RIBASIM models have the capability to simply activate the main additional reservoirs and power stations.

30. The models have been developed by the Regional Working Group with assistance from the National Working Groups. It is of importance that the water management organisations in the countries will continue to use the models for their own purposes and in view of the regional work on water and energy cooperation.

31. The Consultant therefore designed a training course for experts from the five countries who will be charged with future model use. The participants in the training were selected by the National Working Group Team Leaders on the basis of criteria provided by the International Consultant. In addition, SIC-ICWC, BVO Amu Darya and BVO Syr Darya were invited to participate as well.

32. Before the training, the Consultant developed manuals for the models and software as far as specifically required for the Aral Sea basin models. This material was translated into Russian. Furthermore, tutorials were developed specifically for the training course.

33. The training has taken place from 9 to 13 December 2002 with the participation of 13 experts coming from all the organisations invited. During this intensive one-week course, the participants were able to familiarise themselves with the two software packages, to develop small models themselves and to familiarise with the Project models ASBOM and RIBASIM.

34. It was realised that a one-week training course for the use of the models provides a good introduction to the models but that follow-up training would be needed. Therefore the International Consultant's modelling expert will visit each national team in order to work together with the experts who participated in the training. This allows them penetrate deeper in the models, and learn individually more specific details of interest in modules related to their country. This follow-up training in the countries was executed. It will be beneficial for future work in regional water and energy issues that a coordinated approach would be adopted to further strengthen the database and model use. To this end a one-year program has been drafted, which should be considered for inclusion in ASBP-2.

35. The set of software licences in use by the Consultant will be handed over to the Client of the Project and should be made available for use by parties who may have an interest in doing so and have been authorised by EC-IFAS to have access to the models. For example the models can be used during the Aral Sea Basin Program-2 which is currently being formulated.

36. In case modifications would be needed in the models, the EC-IFAS has to ensure that such modifications are consistently carried out in the six sets of the models