

7-2 Allocation Plan for Surface Water & Groundwater

(1/2)

Service Area	Daily Water Demand in 2015			Existing Capacity including under construction			Evaluation results in 2009	Present conditions in 2009			Case-1 Allocate surface water by ratio of groundwater abstraction in May 2009			Case-2 Allocate surface water by ratio of water demand increase				Case-3 Allocate surface water to water deficit			
	Population Served	Average daily demand (m ³)	Maximum daily demand (m ³)	Abstraction (m ³ /day)	Capacity of Reservoir			Safe yield (m ³ /day)	Daily abstraction (m ³ /day)	Ratio	Surface water (m ³)	Groundwater required (m ³)	No. of wells required	Demand increase (m ³)	Ratio	Surface water (m ³)	Groundwater required (m ³)	No. of wells required	Water Deficit (m ³)	Ratio	Surface water (m ³)
					Present capacity (m ³)	Retention time to maximum daily demand in 2015 (hour)															
(1) Abbottabad TMA (urban)	77,310	9,973	11,469	6,247	6,066	12.7	1,296	6,246.7	0.512	9,318.4	2,150.6	4	5,222.3	0.280	5,707.1	5,761.9	18	10,173	0.554	10,758.9	
(2) Nawansher Service Unit (urban)	30,606	3,948	4,540	3,836	843	4.5	3,836	3240.0	0.266	4,833.2	-293.2	0	1,300.0	0.070	1,420.7	3,119.3	0	704	0.038	744.5	
(3) Sheikhu Bandi	19,430	2,312	2,659	1,132	455	4.1	1,132	357.4	0.029	533.1	2,125.9	4	2,301.6	0.123	2,515.3	143.7	0	1,527	0.083	1,614.9	
(4) Salhad	23,194	2,760	3,174	890	591	4.5	890	530.0	0.043	790.6	2,383.4	6	2,644.0	0.142	2,889.5	284.5	0	2,284	0.124	2,415.5	
(5) Mirpur	14,208	1,691	1,945	924	136	1.7	924	272.6	0.022	406.6	1,538.4	3	1,672.4	0.090	1,827.7	117.3	0	1,021	0.056	1,079.8	
(6) Jhangi UC	51,605	6,142	7,065	7,095	1,385		4,648	1,548.5	0.127	1,398.0	5,667.0		5,516.5	0.296	2,919.8	4,145.2		2,657	0.145	666.3	
(i) Derawanda	10,738	1,278	1,470	1,020	227	3.7	933	159.3	0.013	237.6	1,232.4	2	1,310.7	0.070	1,432.4	37.6	0	537	0.029	567.9	
(ii) Jhangi	5,415	644	741	933	227	7.4	933	362.5	0.030	540.8	200.2	0	378.5	0.020	413.6	327.4	0	0	0	0.0	
(iii) Lama Maira	4,937	588	676	743	227	8.1	458	280.8	0.023	0.0	676.0	1	395.2	0.021	0	676.0	1	218	0.012	0.0	
(iv) Banda Ghazan	4,016	478	550	527	159	6.9	527	181.8	0.015	271.2	278.8	0	368.2	0.020	402.4	147.6	0	23	0.001	24.3	
(v) Banda Dilazak	6,195	737	848	778	182	5.2	778	233.6	0.019	348.5	499.5	0	614.4	0.033	671.4	176.6	0	70	0.004	74.0	
(vi) Band Phugwarian	5,576	664	764	1331	227	7.1	812	121.0	0.010	0.0	764.0	0	643.0	0.034	0	764.0	0	0	0	0.0	
(vii) Dobathar	14,728	1,753	2,016	1763	136	1.6	207	209.5	0.017	0.0	2,016.0	4	1,806.5	0.097	0	2,016.0	4	1,809	0	0.0	
Total	216,353	26,826 310	30,852 357	20,124 233	9,476	7.4	12,726 147	12,195.2 141	1.000	17,280.0	13,572.0	24	18,656.8	1.000	17,280.0	13,572.0	23	18,366	1.000	17,280.0	

Appendix 7-37

Service Area	In case 2004 BD plan					New plan (1 of Case 3)					New plan (2 of Case 3)					New plan (3 of Case 3)				
	Water source		Capacity of reservoir			Water source		Capacity of reservoir			Water source		Capacity of reservoir			Water source		Capacity of reservoir		
	Surface water system (m ³ /day)	Groundwater system (m ³ /day)	Groundwater required (m ³ /day)	Additional capacity (m ³)	Retention time (hour)	Surface water system (m ³ /day)	Groundwater system (m ³ /day)	Groundwater required (m ³ /day)	Additional capacity (m ³)	Retention time (hour)	Surface water system (m ³ /day)	Groundwater system (m ³ /day)	Groundwater required (m ³ /day)	Additional capacity (m ³)	Retention time (hour)	Surface water system (m ³ /day)	Groundwater system (m ³ /day)	Groundwater required (m ³ /day)	Additional capacity (m ³)	Retention time (hour)
(1) Abbottabad TMA (urban)	11,469	0	0	-1,364	9.8	11,469	0	0	-1,364	9.8	10,510	959	0	-455	11.7	11,469	0	0	-1,364	9.8
(2) Nawansher Service Unit (urban)	1,309	3,231	0	340	6.3	704	3,836	0	340	6.3	704	3,836	0	340	6.3	704	3,836	0	340	6.3
(3) Shekhul Bandi	2,296	363	0	130	5.3	1,527	1,132	0	130	5.3	1,527	1,132	0	130	5.3	1,527	1,132	0	130	5.3
(4) Salhad	2,647	527	0	180	5.8	2,284	890	0	180	5.8	2,284	890	0	180	5.8	2,284	890	0	180	5.8
(5) Mirpur	1,669	276	0	620	9.3	1,021	924	0	350	6.0	1,021	924	0	350	6.0	243	924	778	350	6.0
(6) Jhangi UC	2,676	3,619	770	1,280		848	4,408	1,809	620		848	4,408	1,809	620		848	4,408	1,809	620	
(i) Derawanda	1,314	156	0	220	7.3	537	933	0	220	7.3	537	933	0	220	7.3	537	933	0	220	7.3
(ii) Jhangi	378	363	0		7.4	0	741	0		7.4	0	741	0		7.4	0	741	0		7.4
(iii) Lama Maira	0	285	391	110	12.0	218	458	0	8.1	218	458	0	8.1	218	458	0	218	458	0	8.1
(iv) Banda Ghazan	369	181	0	530	30.1	23	527	0	100	11.3	23	527	0	100	11.3	23	527	0	100	11.3
(v) Banda Dilazak	615	233	0		5.2	70	778	0		5.2	70	778	0		5.2	70	778	0		5.2
(vi) Band Phugwarian	0	639	125	120	10.9	0	764	0	0	7.1	0	764	0	0	7.1	0	764	0	0	7.1
(vii) Dobahtar	0	1,762	254	300	5.2	0	207	1,809	300	5.2	0	207	1,809	300	5.2	0	207	1,809	300	5.2
Total	22,066	8,016	770	2,550	9.4	17,853	11,190	1,809	1,620	8.6	16,894	12,149	1,809	1,620	8.6	17,075	11,190	2,587	1,620	8.6
	255	93	9			207	130	21			196	141	21			198	130	30		

7-3 Questionnaire on Socio & Economic Conditions

Due to the change in project design year, an interview survey was conducted with objectives to review the target water supply service population and water demand projections. Results at this stage are reported.

Survey Area: 3 areas of Abbottabad, Nawanser and U/C
 Survey Duration: 22 April to 12 May 2009 (21 days)
 Sample Number: Abbottabad, n=136; U/C, n=102; Nawansher, n=47

(1) Basic Information such as household member count and income

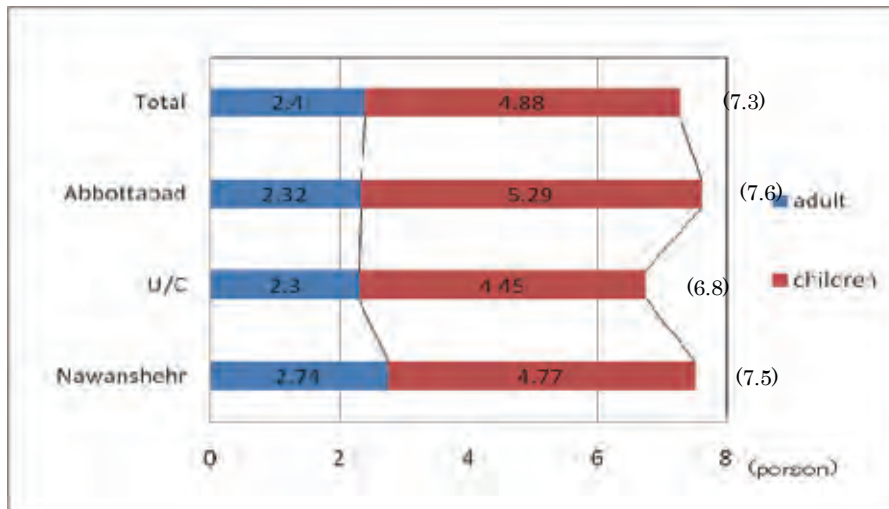


Fig-1. Household Member Count (Abbottabad, n=135; U/C n=102; Nawansher, n=47)

From respondents, the average composition of households is 7.1 persons and this breaks down into 4.6 adults and 2.5 children. According to the 1998 District Census Report of Abbottabad, the per household composition is 6.6 persons.

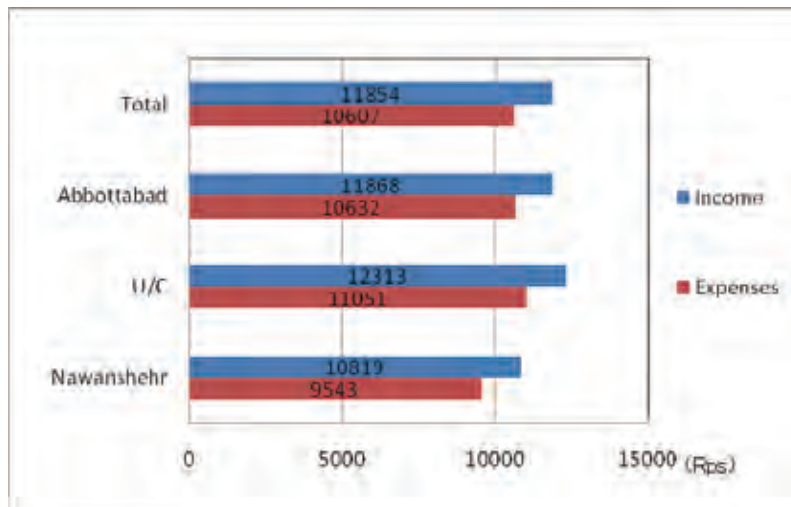


Fig-2 Monthly Household Income and Expenses (Abbottabad, n=136; U/C n=102; Nawansher, n=46)

Monthly household income is about 12,000Rps and expense is 11,000Rps. This becomes about ¥15,000 for income and about ¥13,000 if converted to Japanese Yen (JICA Rate for May 2009 is 1Rps=¥1.210).

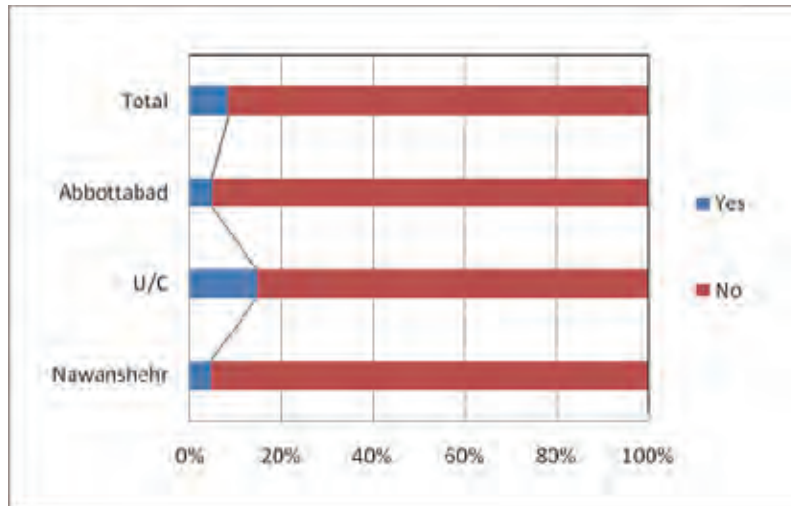


Fig.-3 Availability of Household Private Borehole (Abbottabad, n=136; U/C n=102; Nawanshehr, n=47)

Within the respondents, the number of households possessing their own borehole is about one only.

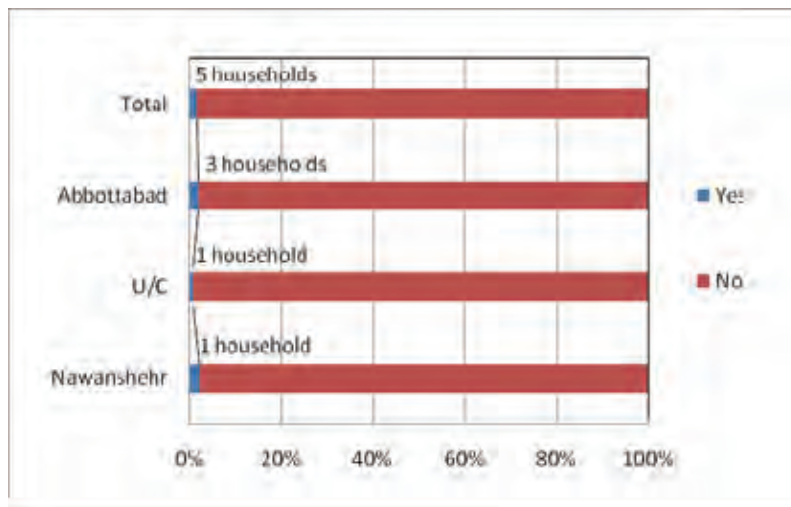


Fig.-4 Condition of Purchasing PET Bottle Drinking Water (Abbottabad, n=136; U/C n=102; Nawanshehr, n=47)

Within the respondents, the number of households which purchase PET bottle drinking water is very low.

(2) Situation in use of existing water supply facilities

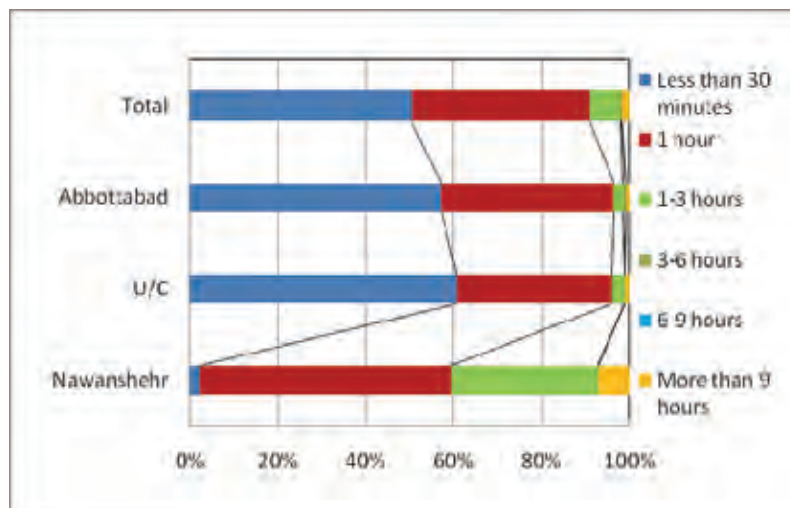


Fig.-5 Area-wise Water Supply Hours (Abbottabad, n=136; U/C n=102; Nawanshehr, n=47)

The water supply time of areas other than Nawanshehr is less one hour for over 90% of the area. The time differs between respondents, but most receive water from 6 a.m. to 9 a.m. Also, when comparing Nawanshehr with other areas, the supply hours are relatively assured for Nawanshehr.

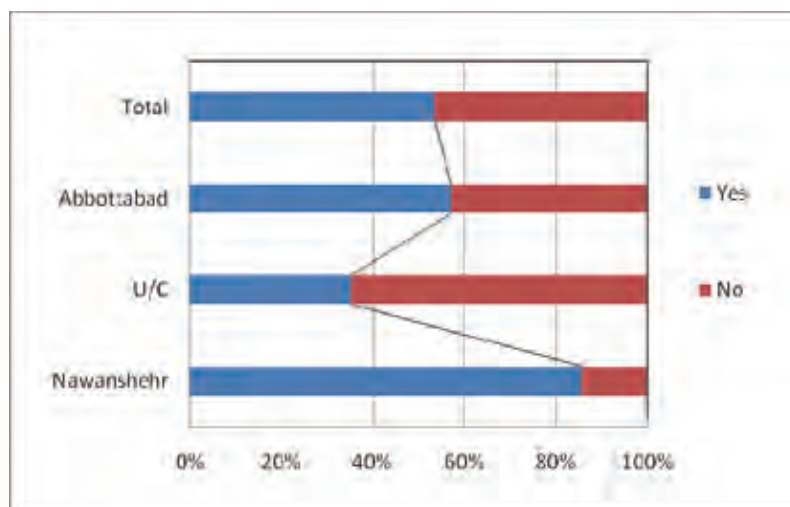


Fig.-6 Area-wise Water Pressure (Abbottabad, n=136; U/C n=102; Nawanshehr, n=47)

The percentage of respondents who replied that the water pressure at the taps is sufficient is 54%. Also, for Nawanshehr, this figure is 86% which is higher than other areas. Since the urban area formation of Nawanshehr is relatively well organized, lowering of the water pressure is probably restrained due to regional development.

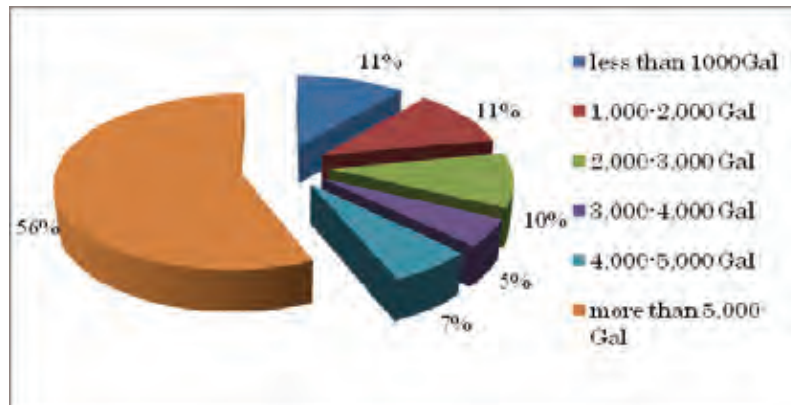


Fig.-7 Monthly Household Water Use (n=285)

For over half of the households, the monthly amount of water used by households is over 5,000Gal (1Gal=4.546ℓ) and if converted to SI units, over 23m³. In consideration that there are 7 persons per household, half of the respondents are using over 109ℓ per person per day.

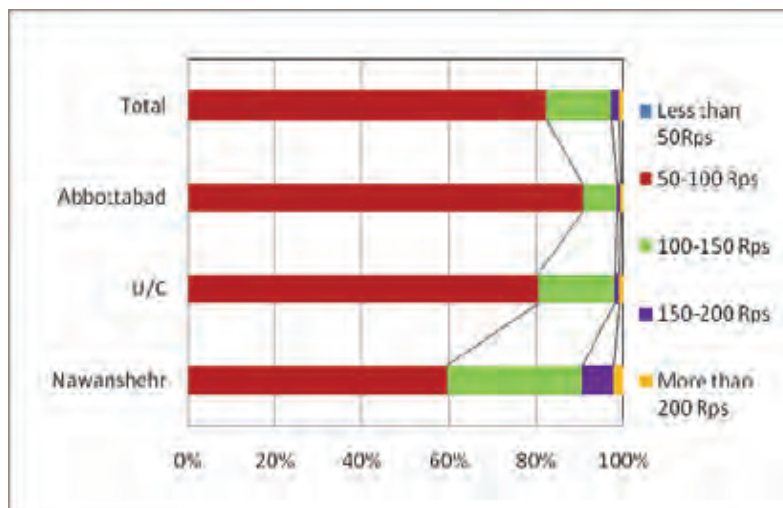


Fig.-8 Monthly Payment (Abbottabad, n=136; U/C n=102; Nawansher, n=47)

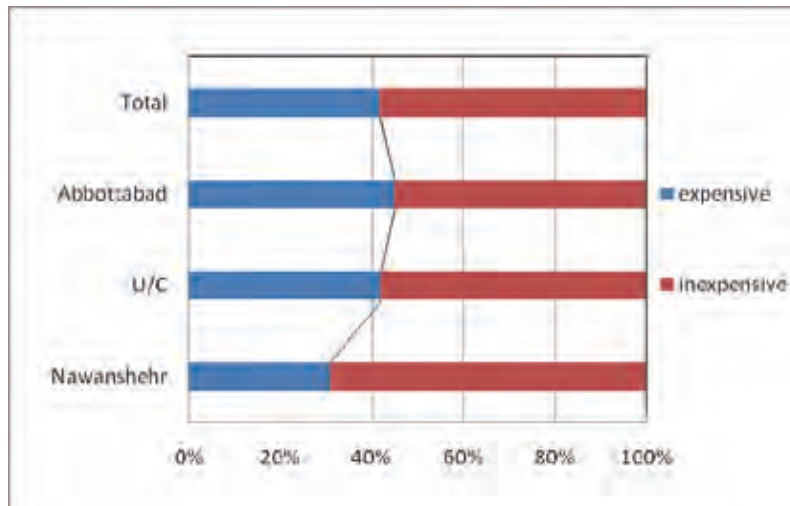


Fig.-9 Comments on Tariff Setting (Abbottabad, n=136; U/C n=102; Nawanshehr, n=47)

Excluding Nawanshehr, over 80% of households are paying 50 to 100Rps. On the other hand, in Nawanshehr, 60% are paying 50 to 100Rps, followed by 30% paying 100 to 150Rps. Also, about 40% of respondents feel the present water tariff is high. From this result, it can be assumed that the presently low water supply service is influencing this response. However, the present water tariff is about 1% of the average income of the area and is kept at a low rate.

(3) Willingness to pay of new tariff system

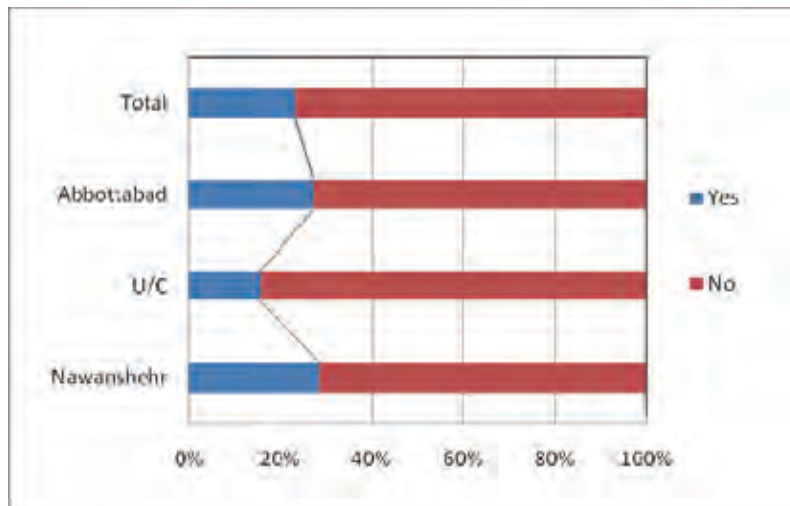


Fig.-10 Willingness to Pay for Rise in Water Fee (Abbottabad, n=136; U/C n=102; Nawanshehr, n=47)

In response to the question on willingness to pay if the present water tariff is changed to a new tariff system, over 70% of the respondents said they do not have the willingness to pay. Since water is supplied for only a few hours in the present water service, taking the step to raise the water fee without improving the service is not realistic. Therefore, raising the price along with the service period of surface water supply is important.

7-4 Environmental Check List

(1/5)

Category	Main Check Items	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits ① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	Environmental Protection Agency of North West Frontier Province has assured that the IEE report approved in 2004 has been valid until May 2010. Both sides agreed that the implementation of the EIA study is not necessary this time. Pakistani side has also assured that the validity of IEE would be extended accordingly when it is necessary before its expiration in May 2010.
	(2) Explanation to the Public ① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?	Pakistan side is planning to set the water tariff based on the amount of the water used by the users. The plan is going to be explained to the users during implementation of the soft component scheme.
2 Mitigation Measures	(1) Air Quality ① Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	There is no risk of air pollution since it is planned to use breaching powder instead of liquid type for the chlorination. Currently, there is no standard regarding the use of bleaching powder in Pakistan. However, like in Japan, appropriate safe measures such as use of mask, glasses, safety wear etc. would be required for the workers in order to prevent direct contact with the powder. Therefore, the same safety measure will be applied.
	(2) Water Quality ① Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	There is no risk of pollution from the effluent because of the use of slow sand filter that does not use chemical matter for the treatment. The back-wash water from the filter will be consisting of inorganic matter such as sand and silt; in addition the washing will be implemented only 3 or 4 times a year. Therefore, pollution due to discharging the effluent into the river is not anticipated.
	(3) Wastes ① Are wastes, such as sludges generated by the facility operations properly treated and disposed of in accordance with the country's standards?	There is no risk of pollution from the sludge because of the use of slow sand filter that does not use chemical matter for the treatment sludge will be extracted from wastewater/basins/drying beds periodically for disposal and they will be transported to the appropriate dumping sites accordance with suitable disposable measures.

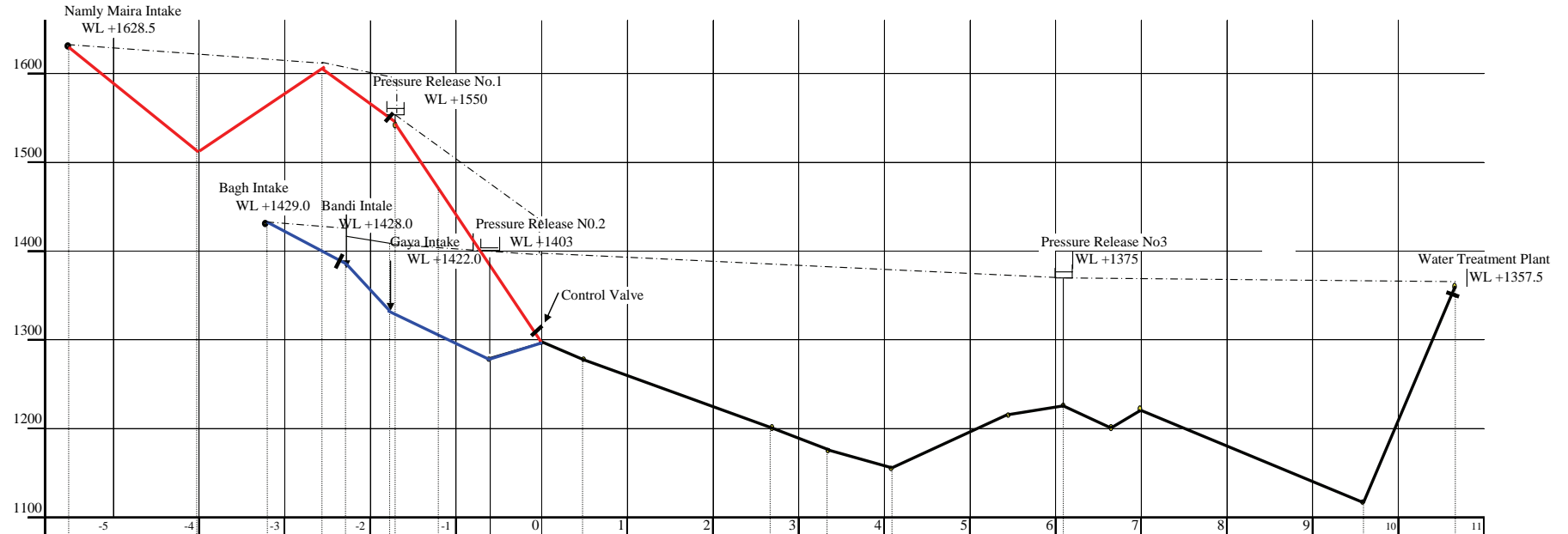
Category		Main Check Items	Confirmation of Environmental Considerations
2 Mitigation Measures	(4) Noise and Vibration	① Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	Problems caused by the noise and the vibration are not anticipated since similar water abstraction facilities have already been in operation around the area.
	(5) Subsidence	① In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	Subsidence may occur if a large volume of ground water is extracted. Therefore, extraction of the groundwater from the tubewells should be implemented with appropriate pumping rate. In addition, the groundwater level of the tubewells should be monitored periodically.
3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	None of the proposed project sites is located in protected areas. Therefore, the project will not affect any protected areas.
	(2) Ecosystem	① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? ④ Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	None of the project sites encompass primeval forests, tropical rain forests, ecologically valuable habitats or protected habitats of endangered species. Therefore, significant ecological impacts are not anticipated.

Category	Main Check Items	Confirmation of Environmental Considerations	
4 Social Environment	(1) Resettlement	<p>① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?</p> <p>② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement?</p> <p>③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?</p> <p>④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples?</p> <p>⑤ Are agreements with the affected persons obtained prior to resettlement?</p> <p>⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan?</p> <p>⑦ Is a plan developed to monitor the impacts of resettlement?</p>	<p>None of project sites encompass involuntary resettlement. Construction of the project will require acquisition of at least 3 ha land out of the vacant lot of 118 ha reserved for the project. In total the project will affect none of households. The total cost for implementation of the land acquisition will be borne by Pakistani side. Land acquisition shall be done by full replacement cost as per the laws of Provincial/Federal government.</p>
	(2) Living and Livelihood	<p>① Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary?</p> <p>② Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?</p>	<p>The proposed water supply project will not adversely affect the living conditions of inhabitants. The conflicts over water usage between Abbottabad district and Haripur district have already been settled owing to the recommendation of Peshawar High Court with coordination by North-West Frontier Province and agreement on the project by the Governor of Haripur district.</p>
	(3) Heritage	<p>① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?</p>	<p>There are no archeological, historical, cultural, and religious heritages around the proposed project sites.</p>
	(4) Landscape	<p>① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?</p>	<p>All the facilities will not affect the view of their surrounding environments from a distant.</p>

Category		Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(5) Ethnic Minorities and Indigenous Peoples	<p>① Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples?</p> <p>② Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?</p>	There are no minorities or indigenous people living around the proposed project sites. Therefore, the proposed project will not adversely affect any minorities or indigenous people.
5 Others	(1) Impacts during Construction	<p>① Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?</p> <p>② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts?</p> <p>③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?</p> <p>④ If necessary is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?</p>	<p>① During the construction, water will be sprayed on the road to settle the dust. Daily and periodical inspection of the construction machines will be conducted in order to reduce the exhaust gases, noise and vibrations. The contractors will also take appropriate measures for the disposing the wastes. Soil erosion would be minimized by constructing appropriate concrete-made drainage and fully compacting road. The back-wash water from the filter will be consisting of inorganic matter such as sand and silt .Therefore, the effluent will not cause water contamination.</p> <p>② The proposed projects will not adversely affect the natural environment.</p> <p>③ Annoyance to the general public living in the vicinity by transporting materials for the construction would be minimized through informing the date and time in advance.</p> <p>④ The contractor will prepare safety action plan and will provide safety training especially to the workers.</p>
	(2) Monitoring	<p>① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts?</p> <p>② Are the items, methods and frequencies included in the monitoring program judged to be appropriate?</p> <p>③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)?</p> <p>④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?</p>	If the projects sites are not arranged by the proponent even after the E/N and G/A, the proponent should inform the update status to JICA every month. If the project sites are arranged, the proponent should submit copies of the contract to JICA.

Category		Main Check Items	Confirmation of Environmental Considerations
6 Note	Note on Using Environmental Checklist	① If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	None

Hydraulic Profile of Raw Water Main



Appendix 7-50

Length	Bagh System	5.1	3.23	5	2.30	6a	0.60	7	0.00	0.43	Murree System	2.53	3.34	4.03	6.14	9.50	10.88
	Namly System	1	5.58	2	4.04	2a	2.58	3	1.89	3a	1.84	7	0.00	7a			
GL	Bagh System	+ 1629	+ 1429	+ 1385	+ 1334	+ 1203	+ 1296	+ 1278	+ 1200	+ 1175	+ 1154	+ 1222	+ 1117	+ 1355			
	Namly System	+ 1510	+ 1607	+ 1545	+ 1545	+ 1296	+ 1296										
Diameter	Bagh System		Φ250	Φ250	Φ350	Φ350			Murree System	Φ450		Φ500					
	Namly System	Φ250	Φ250	Φ200	Φ150												
Dynamic WL	Bagh System	+ 1429.2	+ 1423.7	+ 1417.4	+ 1407.9	+ 1399.0	+ 1399.0	+ 1371.7									
	Namly System	+ 1620.6	+ 1612.6	+ 1601.4	+ 1599.4	+ 1439.3	+ 1399.0										

2) Treated Water Transmission Main

Hydraulic Analysis of Treated Water Transmission Main

Node		Flow rate m ³ /s	GL/WL m	Dynamic WL m	Dynamic Head m	Static Head m
No.	Location					
0	WTP	0.1954	+ 1,350	+ 1,349.4		
1			+ 1,169	+ 1,344.3	175.3	180.4
2	at branch of Sheikhl Bandi		+ 1,173	+ 1,341.2	168.2	176.4
2a	Sheikhl Bandi Reservoir	0.0177	+ 1,237	+ 1,268.8	31.8	112.4
3-1	at branch of Aram Bagh		+ 1,185	+ 1,335.7	150.7	164.4
3a'	Aram Bagh Existing Reservoir		+ 1,201	+ 1,328.8	127.8	148.4
3a	Khola Kehal Existing Reservoir	0.0367	+ 1,315	+ 1,327.9	12.9	34.4
3-2	at branch of Kunj Ground		+ 1,200	+ 1,325.4	125.4	149.4
3b	Kunj Qadeem Existing Reservoir	0.0318	+ 1,263	+ 1,325.1	62.1	86.4
4	at branch of Jinnah		+ 1,202	+ 1,323.9	121.9	147.4
3-3	Jail Existing Reservoir	0.0531	+ 1,272	+ 1,320.0	48.0	77.4
5-1	at branch of Salhad		+ 1,225	+ 1,315.6	90.6	124.4
5a	Salhad New Reservoir	0.0132	+ 1,306	+ 1,314.4	8.4	43.4
5-2	Salhad Existing Transmission Main Connection	0.0132	+ 1,303	+ 1,312.2	9.2	46.4
6-1			+ 1,195	+ 1,334.7	139.7	154.4
6-2	at branch of Nawan Shahr Existing Elevated Tank		+ 1,182	+ 1,334.6	152.6	167.4
6-3	at branch of Nawan Shahr New Reservoir		+ 1,231	+ 1,333.2	102.2	118.4
6a	Nawan Shahr New Reservoir	0.0049	+ 1,316	+ 1,332.6	16.6	33.4
6b	Nawan Shahr Existing Tank	0.0024	+ 1,233	+ 1,334.2	101.2	116.4
6c	Nawan Shahr Existing Elevated Tank	0.0008	+ 1,240	+ 1,334.6	94.6	109.4
7			+ 1,192	+ 1,316.4	124.4	157.4
8	at branch of Derawandah		+ 1,190	+ 1,316.0	126.0	159.4
8a	Derawandah New Reservoir	0.0062	+ 1,290	+ 1,313.9	23.9	59.4
9			+ 1,201	+ 1,312.8	111.8	148.4
9a	Mirpur New Reservoir	0.0118	+ 1,262	+ 1,306.4	44.4	87.4
10			+ 1,182	+ 1,309.3	127.3	167.4
10a	Banda Ghazan New Reservoir	0.0036	+ 1,267	+ 1,305.0	38.0	82.4

Pipeline		Length of pipe m	Flow rate m ³ /s	Diameter mm	Coefficient of roughness	Velocity m/s	Hydraulic Gradient m	Loss of Head m	Remarks
Node	Node								
0	- 1	2320	0.1954	500	120	1.00	0.0022	5.1	
1	- 2	670	0.1657	400	120	1.32	0.0047	3.1	
2	- 2a	800	0.0177	100	100	2.25	0.0905	72.4	
2	- 3-1	1440	0.1480	400	120	1.18	0.0038	5.5	
3-1	- 3a'	200	0.0367	150	120	2.08	0.0346	6.9	
3a'	- 3a	500	0.0367	300	100	0.52	0.0017	0.9	
3-1	- 3-2	1120	0.1113	300	120	1.57	0.0092	10.3	
3-2	- 3b	30	0.0318	200	100	1.01	0.0092	0.3	
3-2	- 4	300	0.0795	300	120	1.12	0.0049	1.5	
4	- 3-3	230	0.0531	200	120	1.69	0.0169	3.9	
4	- 5-1	1800	0.0264	200	120	0.84	0.0046	8.3	
5-1	- 5a	240	0.0132	150	120	0.75	0.0052	1.2	
5-1	- 5-2	660	0.0132	150	120	0.75	0.0052	3.4	
1	- 6-1	1650	0.0297	200	120	0.95	0.0058	9.6	
6-1	- 6-2	50	0.0081	150	120	0.46	0.0021	0.1	
6-2	- 6-3	800	0.0073	150	120	0.41	0.0017	1.4	
6-3	- 6b	230	0.0024	100	120	0.31	0.0016	0.4	
6-3	- 6a	740	0.0049	150	120	0.28	0.0008	0.6	
6-2	- 6c	20	0.0008	100	120	0.10	0.0002	0.0	
6-1	- 7	5710	0.0216	200	120	0.69	0.0032	18.3	
7	- 8	180	0.018	200	120	0.57	0.0023	0.4	
8	- 9	750	0.0118	150	120	0.67	0.0042	3.2	
9	- 9a	1520	0.0118	150	120	0.67	0.0042	6.4	
8	- 8a	1640	0.0062	150	120	0.35	0.0013	2.1	
7	- 10	2090	0.0036	100	120	0.46	0.0034	7.1	
10	- 10a	1270	0.0036	100	120	0.46	0.0034	4.3	

Hydraulic Analysis of Water Transmission Main in Dobathar System

Node		Flow rate	GL	Dynamic WL	Dinamic Head	Static Head
No.	Location	m ³ /s	m	m	m	m
11	New Tubewell (No.2)	0.006	+ 1,199	+ 1513.7	+ 315	+ 236
12	New Tubewell (No.3)	0.006	+ 1,197	+ 1509.3	+ 312	+ 238
13-1			+ 1,194	+ 1506.2	+ 312	+ 241
15			+ 1,196	+ 1505.4	+ 309	+ 239
16	Existing Tubewell	0.0024	+ 1,209	+ 1487.0	+ 278	+ 226
17	Reservoir		+ 1,435	+ 1,445	+ 10	+ 0
14	New Tubewell (No.5)	0.006	+ 1,192	+ 1509.5	+ 318	+ 243
13	New Tubewell (No.4)	0.0029	+ 1,192	+ 1506.9	+ 315	+ 243

Pipeline		Length of pipe	Flow rate	Diameter	Coefficient of	Velocity	Hydraulic Gradient	Loss of Head	Remarks
Node	Node	m	m ³ /s	mm		m/s	m	m	
11	- 12	500	0.006	100	120	0.760	0.0087	4.4	
12	- 13-1	710	0.012	150	120	0.680	0.0044	3.1	
13-1	- 15	130	0.0149	150	120	0.840	0.0065	0.8	
15	- 16	1510	0.0209	150	120	1.180	0.0122	18.4	
16	- 17	2400	0.0233	150	110	1.320	0.0175	42.0	
14	- 15	470	0.006	100	120	0.760	0.0087	4.1	
13	- 13-1	300	0.0029	100	120	0.370	0.0023	0.7	