Nishter

Lift Stations (Detail)

	1. Garden **Sub-division**							
S. #	Name	Pump Sr. No.	Avg. Running Hours (Per Day)	Pumping Rating (Cfs)	Motor Rating (Kw)	Actual Flow (Cfs)	Design Flow (Cfs)	Design Head (Ft)
1	Garden Town	1	8	8-Cfs	80-Hp	6	8	40
		2	2	6-Cfs	60-Hp	5	6	40
		3	6	4-Cfs	40-Hp	3	4	40
		4	4	6-Cfs	60-Hp	5	6	60
		5	2	2-Cfs	20-Hp	2	2	30
		6	7	13-Cfs	100-Hp	13	13	60
		7	7	13-Cfs	100-Hp	13	13	60

2. Township **Sub-division**								
S. #	Name	Pump Sr. No.	Avg. Running Hours (Per Day)	Pumping Rating (Cfs)	Motor Rating (Hp)	Actual Flow (Cfs)	Design Flow (Cfs)	Design Head (Ft)
1	Satto Kattla Lift Station	1	5		150	20	25	
		2	18		150	20	25	
		3	8		80	7	8	
		4	18		150	20	25	
2	Bahar Colony Lift Station	1	8		80	8	8	
		2	18		40	6	6	

3. Green Town Sub-Division								
Sr No.	Location	Pump Serial No.	Average Running Hours	Pump Rating	Motor Rating Hp	Actual Flow cfs	Design Flow (Cusec)	Design Head (Feet)
1	C-I Disposal Station Sadiq Chowk	1	20	15-Cfs	100	15-Cfs	15-Cfs	30
		2	10	13-Cfs	150	13-Cfs	13-Cfs	30
		3	4	6-Cfs	80	6-Cfs	6-Cfs	30
2	C-II Disposal Station Muslim Chowk Town	1	22	15-Cfs	100	15-Cfs	15-Cfs	30
		2	22	15-Cfs	100	15-Cfs	15-Cfs	30
		3	8	13-Cfs	150	13-Cfs	13-Cfs	30
3	Ameer Chowk Disposal Station	1	12	7.5-Cfs	60	7.5-Cfs	7.5-Cfs	35
		2	12	7.5-Cfs	60	7.5-Cfs	7.5-Cfs	35
		3	4	7.5-Cfs	60	7.5-Cfs	7.5-Cfs	35
		4	4	7.5-Cfs	60	7.5-Cfs	7.5-Cfs	35

4. Industrial Area Sub Division							
Sr No.	Location	Pump Serial No.	Average Running Hours	Pump Rating Hp	Actual Flow (Cusec)	Design Flow (Cusec)	Design Head (Feet)
1	Nishter Colony Old Disposal Station	1	18	-	6	6	25
		2	20	-	4	4	25
2	Hadyara Drain (Rohi Nala)	1	8	-	6	6	30
		2	6	-	6	6	30
3	A-Ii Disposal	1	14	-	6	6	20
4	Chandray Road Lift Station	1	20	-	2	2	20
5	Youhanabad	1	14	-	4	4	30
6	Boostan Colony	1	20	-	4	4	20
		2	8		4	4	20
7	Race Club	1	6		2	2	20
8	Kamahan Disposal Station	1	10		10	10	30
		2			10	10	30
		3	10		6	6	30
		4			6	6	30
		5			4	4	30

Gunj Baksh Town

Lift Stations (Detail)

1. Anarkali subdivision								
Sr No	Location	Pump Serial No.	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Design Flow (Cusec)	Design Head (Feet)
1	Napier Road	1	11	150	150	4	Horizontal	30
2	Mochi Bagh	1	10	60	60	4	Submersible	30
		2	10	50	80	8		30
		3	10	40	40	2		30
		4	10	150	150	16	Horizontal	35
3	Janki Devi	1	10	10	10	1 1/2	Horizontal	30
		2	10	10	10	1 1/2		30
4	Lakshmi Chowk	1	11	150	150	25	Horizontal	30
		2	11	150	150	25		30
		3	11	100	100	10		30
5	Pia Planetarium	1	10	100	100	10	Submersible	35
		2	10	100	100	10		35
		3	10	60	60	6		35
6	Lakshmi Mension B/ Pump	1	11	20	20	1	1	10
7	Ghandi Square B/ Pump	1	11	25	25	1	1	15

2. Islam Pura Sub division								
Sr. No.	Name	Pump Serial No.	Avg. Running Hours (Per Day)	Pump Rating (Hp)	Motor (Hp)	Actial Flow (Cusec)	Design Flow (Cusec)	Design Head (Ft)
1	Fazal Colony Lift station	1	16		20-Kw	2	2-Cfs	30
		2	17		20-Kw	2	2-Cfs	30

3. Ravi Road **Sub-division**								
Sr. No.	Name	Pump Serial No.	Avg. Running Hours (Per Day)	Pump Rating (Hp)	Motor (Hp)	Actual flow (Cusec)	Design Flow (Cusec)	Design Head (Ft)
1	Bagh Munchi Ladha	1	16	988	75	8	10 Cfs	45
		2	16	988	75	8	10 Cfs	45
		3	18	988	120	15	20 Cfs	45
		4	18	988	75	8	10 Cfs	45
		5	17	988	120	15	20 Cfs	45
		6	15	988	115	12	15 Cfs	45
2	Kallay Wali Pully	1	19	1400	40	2	2 Cfs	20
		2	18	1400	60	2	2 Cfs	20
3	Merzi Pura	1	18	1400	40	2	2 Cfs	20
		2	18	1400	60	4	6 Cfs	25
		3	18	1400	20	2	2 Cfs	20

Gulberg Town

Lift Stations (Detail)

1. Mozung **Sub-division**							
Sr.#	Location	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Desiign Flow (Cusec)	Design Head (Feet)
1	Shadman Bridge	20	6-Cfs 6-Cfs 10-Cfs	80 80 100	6-Cfs 6-Cfs 10-Cfs	6-Cfs 6-Cfs 10-Cfs	60
2	Lytton Road	20	6-Cfs 6-Cfs	80 80	6-Cfs 6-Cfs	6-Cfs 6-Cfs	60
3	Shama	20	4-Cfs 6-Cfs	40 60	4-Cfs 6-Cfs	4-Cfs 6-Cfs	60 75
4	Choburgi	12	2-Cfs 4-Cfs	20 40	2-Cfs 4-Cfs	2-Cfs 4-Cfs	60

2. Shimla Hill Sub-division								
Sr No	Location	Pump Serial No.	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Desiign Flow (Cusec)	Design Head (Feet)
1	Muhammad Nagar	1	12	60	60	6	6	35
2	Ghazi Muhallah	1	10	20	20	2	2	30
		2	6	40	40	4	4	30
		3	0	60	60	6	6	30
3	Larex Colony	1	12	20	20	2	2	20
		2	8	60	60	6	6	45
		3	0	50	50	2	2	45
4	Bird Market Disposal	1	8	100	100	10	10	48
		2	8	100	100	10	10	48
		3	3	175	175	20	20	48

3. Gulberg **Sub-division**								
S.#	Location	Pump Serial No.	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Desiign Flow (Cusec)	Design Head (Feet)
1	Zafar Ali Road	1	8	60	60	7	8	20
2	Sharif Colony	1	8	60	60	7	8	20
		2	6	20	20	6	6	20
3	Q-Block Disposal	1	8	150	150	25	25	25
		2	2	40	40	8	8	25
4	G-Block	1	5	150	150	22	25	40
		2	5	150	150	22	25	40
		3	5	175	175	25	25	Submersible
		4	5	80	80	8	8	Submersible
5	Gurumanget A-I Block	1	14	150	150	15	15	40
		2	12	150	150	25	25	40
		3	8	150	150	15	15	40
6	Makkah Colony	1	20	60	60	8	8	40
		2	20	60	60	8	8	40
		3	6	150	150	25	25	40
7	Center Point	1	16	60	60	8	8	40
		2	8	45	45	6	6	40
8	Liber Car Parking	1	0	45	45	8	8	40
		2	0	45	45	8	8	40
9	Nawaz Sharif Colony	1	6	15	15	1	1	Submersible
		2	6	15	15	1	1	Submersible
10	I.T Park	1	6	150	150	25	25	30
		2	6	150	150	25	25	30
		3	6	100	100	10	10	Submersible
11	Kalma Chowk	1	6	40	40	4	4	Submersible
		2	6	40	40	4	4	Submersible
		3	6	40	40	4	4	Submersible

RAVI TOWN

Lift Stations (Detail)

1. City Sub-division						
Sr.#	Location	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Desiign Flow (Cusec)
1	Peco Badami Bagh	14	6+1 Cfs	60+20	6+1 Cfs	6+1 Cfs
	Vegetable Market	15	2-Cfs	150	2-Cfs	2-Cfs
2	Forest Colony	22	10+10 +6+6+ 6cfs	100+ 100+80+ 80+80	10+10+6 +6+6cfs	10+10+6+6 +6cfs
3	Sabzi Mandi	15	4+4+4 +2 Cfs	4+4+40	4+4+4+2 0 Cfs	6+6+ 6+6 Cfs
5	Track Stand Ravi Road	12	4+4+2 +2 Cfs	40+40+2 0+20	4+4+2+2 Cfs	4+4+2+2+ Cfs

2. Data Nagar Subdivision							
Sr. No	Pump Serial No. / Name	Avg. Running Hours (Per Day)	Pump Rating (Hp)	Motor Rating (Hp)	Actual Flow (Cusec)	Design Flow (Cusec)	Design Head (Ft)
1	Peco Road Lift Station	14	1460	80+ 60+60	4+4+4	6+6+6	27 Feet
2	Ali Pura Disposal Station	14	1460	60+30 +20	4+3+2	6+4+2	20-Feet

3. Shadbagh Subdivsion							
Sr.#	Location	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (If Measure d) (Cusec)	Desiign Flow (Cusec)	Design Head (Feet)
There is no Lift Station in Shadbagh							

4. Farakhabad Sub-division							
Sr. #	Location	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Desiign Flow (Cusec)	Design Head (Feet)
1	Faisal Park	24 Hours	4+2+1	80+20+10	5	7	40
3	Fazal Park (B-Ii-10)	24 Hours	2+4+4+4	20+40+80+60	11	14	30

5. Misrishah Sub-division							
Sr.#	Location	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (If Measured) (Cusec)	Desiign Flow (Cusec)	Design Head (Feet)
1	Kachu Pura (B-Ii-10)	12	4+2	60+20	4+2	4+2	15
2	Faiz Bagh (B-Ii-10)	16	4+2	60+20	4+2	4+2	15
3	Domoria Pul (B-Ii-10)	15	4+4+5	50+50+60	4+4+5	4+4+5	35

6. Shahdara Sub-division								
Sr.#	Location	Pump Serial No.	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (If Measured) (Cusec)	Desiign Flow (Cusec)	Design Head (Feet)
1	Barket Town (B-Ii-10)	1,2,3	16,16,16,	4,4,2	20,60,60,	7	2,4,4	40,40,40
2	Maqbara More (B-Ii-10)	1	14	2	20	2	2	30
3	Shahdara Town (B-Ii-12)	1,2,3,4,5	24	6,6,6,6,13	80,80,80,80,150	37	37	40
4	Saeed Park (B-Ii-10)	1,2,3	14	2,4,6	20,40,80	12	12	40,40,40
5	Dheer Disposal	1	12	6	80	6	6	40

ALLAMA IQBAL TOWN

Lift Stations (Detail)

1. Sabzazar Subdivision								
	Location	Pump Serial No.	Average Running (Hours)	Pump Rating (Cfs)	Motor Rating (Hp)	Actual Flow (Cfs.)	Design Flow (Cfs).	Design Head (Ft.)
1	Douban Pura (Lift Station)	06/01	12	6	60	4.8	6	35
		06/02	11	6	60	4.8	6	35
		06/03	8	6	60	4.8	6	35
2	Babu Sabu Drainage Station	25/01	-	25 Cfs.	150	18	25	40
		25/02	-	25 Cfs.	150	18	25	40
		25/03	-	25 Cfs.	150	18	25	40
		25/04	-	25 Cfs.	150	18	25	40
		25/05	-	25 Cfs.	150	18	25	40
		25/06	-	25 Cfs.	150	18	25	40
		25/07	-	25 Cfs.	150	18	25	40
3	D - Block (Lift Station)	06/01	9	06 Cfs.	60	4.8	6	30
		06/02	10					
4	Shah Fareed (Lift Station)	06/01	12	06 Cfs.	60	4.8	6	30
		06/02	12					

2. Johar Town subdivision								
S. #	Name	Pump Sr. No.	Avg. Running Hours (Per Day)	Pumping Rating (Cfs)	Motor Rating (Kw)	Actual Flow (Cfs)	Design Flow (Cfs)	Design Head (Ft)
1	Shoukat Khanam	1	14	12	75	10	12	40
		2	14	8	75	6.5	8	35
		3	12	8	75	6.5	8	35
		4	12	8	75	6.5	8	35
		5	12	12	45	9	12	40
		6	14	12	75	10	12	40
		7	12	25	112	20	25	55
2	Bheer Village	1	10	6	141	4	6	30
		2	10	6	30	4	6	30
		3	10	10	40	9	10	40
3	Ali Razabad	1	8	6	30	6	6	35
		2	8	6	30	6	6	35
		3	6	6	30	6	6	35

3. Mustafa Town subdivision								
Sr no	Location	Pump Serial No.	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Design Flow (Cusec)	Design Head (Feet)
1	Main Market Mustafa Town	1	10			4		
		2				4		
		3				4		
2	Azam Garden		12	40		4		

4. Ichra Sub-division								
Sr no	Location	Pump Serial No.	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Design Flow (Cusec)	Design Head (Feet)
1	Rasool Park	1	18	80		6	45	10
		2		80		6	45	10
		3		80		8	45	35
		4		115		25	45	35
		5		_			45	25
2	Shah Kamal	1	19	80		6	45	25
		2		60		6	45	25
3	Ichra More	1	18	80		6		25
		2		80		6		25

5. AIT Subdivision								
Sr no	Name	Pump Serial No.	Aver. Running Hours	Pump Rating Hp	Motor Rating (Hp)	Actual Flow (Cusec)	Design Flow (Cusec)	Design Head (Feet)
1	AIT Lift station		20		20, 30	864000 G /Day	1,1	20

6. Samnabad Subdivision
There is no Lift Station in Samnabad Subdivision

Annex-1

Drainage Directorate

Primary Drains:

Total No. of Primary Drains: 6 Nos

Total length of Primary Drains: 55.70 Km

Secondary Drains:

Total No. of Secondary Drains: 12 Nos

Total length of Secondary Drains: 38.56 Km

Sludge Carriers:

Total No. of Sludge Carriers: 07 Nos

Total length of Sludge Carriers: 23.64 Km

Road Side/Tertiary Drains:

Total No. of Road Side/Tertiary Drains: 67 Nos

Total length of Road Side/Tertiary Drains: 366.05

Disposal Station:

Total: 1 No at North Drainage Division with 3 pumps of 6cfs

Infrastructure at a glance

No of Towns: 6 No. Served population =6.5 Million Water production=435MGD

Tube wells detail:

Town	S& ABT	Ravi	GBT	Gulberg	Nishter	AIT	Total
4 cfs	48	64	53	27	35	60	286
2 cfs	39	41	31	38	33	23	205
Total	87	105	83	65	68	83	491

Major Disposal Station details:

Town	S& ABT	Ravi	GBT	Gulberg	Nishter	AIT	Total
No of DS	1	4	4	0	2	1	12
Design Capacity cfs	224	589	930	0	236	240	2219

Lift Stations detail:

Town	S& ABT	Ravi	GBT	Gulberg	Nishter	AIT	Drainage	Total
No of LS	13	16	11	19	14	13	1	86

Length of water supply Line & sewerage Network:

	Total (KM)
W/S	5544.721
Sewerage	4214.980

No of Generators

Town	S& ABT	Ravi	GBT	Gulberg	Nishter	AIT	Total	O&M figures
	38	36	33	32	20	30	189	194

No of Filtration plants

Town	S& ABT	Ravi	GBT	Gulberg	Nishter	AIT	Total
No.	36	N.A	N.A	N.A	9	19	N.A

Total means Data is Sum Up that was collected by P&E for each town.
O&M figures means the figure which O&M is showing in its presentations.

Shalimar & Aziz Bhatti Town

No of Sub-divisions: 5 No.

Tube wells detail:

Subdivision	Bhagbanpura	Fatehgarh	Mughalpura	Mustafabad	Tajpura	Total
4 cfs	16	11	10	4	7	48
2 cfs	2	5	15	7	10	39
Total	18	16	25	11	17	87

Major Disposal Station details:

Subdivision	Bhagbanpura	Fatehgarh	Mughalpura	Mustafabad	Tajpura	Total
Name of D/S	Mehmood booti	Nill	Nill	Nill	Nill	1
Capacity cfs	224	Nill	Nill	Nill	Nill	224 cfs

Lift Stations detail:

Subdivision	Bhagbanpura	Fatehgarh	Mughalpura	Mustafabad	Tajpura	Total
No of L/S	2	Nill	5	2	4	13

Length of water supply Line & sewerage Network :

	Total (KM)
W/S	838.581
Sewerage	581.050

No of Generators

Subdivision	Bhagbanpura	Fatehgarh	Mughalpura	Mustafabad	Tajpura	Total
	10	6	8	4	10	38

No of Filtration plants

Subdivision	Bhagbanpura	Fatehgarh	Mughalpura	Mustafabad	Tajpura	Total
No. of FP						36

Ravi Town

No of Sub-divisions: 6 No.

Tubewells detail :

Subdivision	Shahdara	Shadbagh	Misrishah	Farakhabad	DataNagar	City	Total
4 cfs	6	5	5	8	11	19	64
2 cfs	5	6	15	5	3	7	41
Total	11	21	20	13	14	26	105

Disposal Station details :

Subdivision	Shahdara	Shadbagh	Misrishah	Farakhabad	DataNagar	City	Total
Name of DS	Nill	i)Shadbagh, ii)khokarRd	Nill	Farakhabad	Nill	Bhatti	4
Capacity cfs	Nill	i)240,ii)168	Nill	181	Nill	100	589

Lift Stations detail:

Subdivision	Shahdara	Shadbagh	Misrishah	Farakhabad	DataNagar	City	Total
No of L/S	5	nill	3	2	2	4	16

Length of water supply Line & sewerage Network :

Subdivision	Total (KM)
W/S	996.710
Sewerage	953.600

No of Generators

Subdivision	Shahdara	Shadbagh	Misrishah	Farakhabad	DataNagar	City	Total
	6	4	4	6	5	11	36

No of Filtration Plants

Subdivision	Shahdara	Shadbagh	Misrishah	Farakhabad	DataNagar	City	Total
	5	N.A	N.A	N.A	4	N.A	N.A

Nishter Town

No of Sub-divisions: 4 No.

Tubewells detail :

Subdivision	Township	Garden	Green	Industrial	Total
4 cfs	8	7	9	11	35
2 cfs	4	6	18	5	33
Total	12	13	27	16	68

Disposal Station details :

Subdivision	Township	Garden	Green	Industrial	Total
Name of D/S	LMP	Nill	Nill	Nishter	2
Capacity cfs	125	Nill	Nill	111	236

Lift Stations detail:

Subdivision	Township	Garden	Green	Industrial	Total
No of L/S	2	1	3	8	14

Length of water supply Line & sewerage Network :

	Total (km)
W/S	1310
Sewerage	546.900

No of Generators

Subdivision	Township	Garden	Green	Industrial	Total
	2	6	3	9	20

No of Filtration Plant

Subdivision	Township	Garden	Green	Industrial	Total
	4	2	2	1	9

Gulberg Town

No of Sub-divisions: 3 No.

Tubewells detail :

Subdivision	Mozung	Gulberg	Shimlahill	Total
4 cfs	7	11	9	27
2 cfs	19	14	5	38
Total	26	25	14	65

Disposal Station details :

Subdivision	Mozung	Gulberg	Shimlahill	Total
Name of D/S	Nill	Nill	Nill	Nill
Capacity cfs	Nill	Nill	Nill	Nill

Lift Stations detail:

Subdivision	Mozung	Gulberg	Shimlahill	Total
No of L/S	4	11	4	19

Length of water supply Line & sewerage Network :

Subdivision	Total(km)
W/S	509.380
Sewerage	593.680

No of Generators

Subdivision	Mozung	Gulberg	Shimlahill	Total
	16	10	6	32

No of Filtration plants

Subdivision	Mozung	Gulberg	Shimlahill	Total
		3		

Gunj Buksh Town

No of Sub-divisions: 3 No.

Tubewells detail :

Subdivision	Anarkali	Ravi	Islampura	Total
4 cfs	10	21	21	52
2 cfs	10	14	7	31
Total	20	35	28	83

Disposal Station details :

Subdivision	Anarkali	Ravi	Islampura	Total
Name of D/S	Nill	i) MOF-I ii)MOF-II iii)MOF-III	Gulshan Ravi	4
Capacity cfs	Nill	i)181, ii)102, iii)87	560	930

Lift Stations detail:

Subdivision	Anarkali	Ravi	Islampura	Total
No of L/S	7	3	1	11

Length of water supply Line & sewerage Network :

Subdivision	Total
W/S	888.160
Sewerage	761.050

No of Generators

Subdivision	Anarkali	Ravi	Islampura	Total
	10	13	10	33

No of Filtration Plants

Subdivision	Anarkali	Ravi	Islampura	Total
	N.A	6	2	N.A

Allama Iqbal Town

No of Sub-divisions: No.

Tubewells detail :

Subdivision	Samnabad	Sabzazar	Johartown	Mustafa	Ichra	AIT	Total
4 cfs	14	5	12	1	13	15	60
2 cfs	1	9	3	0	7	3	23
Total	15	14	15	1	20	18	83

Disposal Station details :

Subdivision	Samnabad	Sabzazar	Johartown	Mustafa	Ichra	AIT	Total
Name of D/S	Nill	Multan Rd	Nill	Nill	Nill	Nill	1
Capacity	Nill	240	Nill	Nill	Nill	Nill	240

Lift Stations detail:

Subdivision	Samnabad	Sabzazar	Johartown	Mustafa	Ichra	AIT	Total
No of L/S	Nill	4	3	2	3	1	13

Length of water supply Line & sewerage Network :

	Total
W/S	1001.890
Sewerage	778.700

No of Generators

Subdivision	Samnabad	Sabzazar	Johartown	Mustafa	Ichra	AIT	Total
50 KVA	5	6	5	0	10	4	30

No of Filtration Plants

Subdivision	Samnabad	Sabzazar	Johartown	Mustafa	Ichra	AIT	Total
	4	3	3	1	6	2	19

DETAIL OF NON-DEVELOPMENT BUDGET (EXPENDITURE)

(Rs. In million)

SR. NO	A/C. Code	Description	2014-15 Budget Estimates	2014-15 Revised Estimates	2015-16 Budget Estimates
1	2	3	4	5	6
	320	REPAIR AND MAINTENENCE:			
15	321	R & M - DISPOSAL STATIONS' BLDGS.	17.000	15.410	15.000
16	321-A	R & M - T/WELL CHAMBERS/RESERVIORS	14.400	11.430	15.000
17	322	R & M - TUBEWELLS	129.600	112.798	129.600
18	322-A	REPLACEMENT OF T/WELL MACHINERY	14.400	10.490	15.000
19	322-B	DRILLING & BORING OF TUBEWELLS	50.000	41.721	50.000
20	323	R & M - PUMPING STATIONS	70.000	43.529	50.000
21	323-A	DEWATERING	15.000	12.403	12.000
22	323-B	REPL./REHAB. OF D/STATION MACHINERY	15.000	6.620	10.000
23	324	R & M - MOBILE EQUIP./MISC. MACHINERY	50.000	37.884	45.000
24	324-A	R & M - GENERATORS	100.000	27.500	60.000
25	326	R & M - METERS / INSTALLATION OF METER CHARGES	5.000	-	15.000
26	327	R & M - WATER SUPPLY LINES	50.000	75.190	85.000
27	328	R & M - SEWER LINES	140.000	176.798	155.000
28	328-A	R & M - DRAINS	40.000	36.530	40.000
29	328-B	SEASONAL STAFF	50.000	50.000	50.000
30	328-C	ARBORICULTURE	1.500	0.500	1.000
31	328-D	DESILTING OF DRAINS / SEWER	15.000	10.973	15.000
32	329	OTHERS- PY LIABILITIES, ETC.	423.000	258.102	150.000
		SUB TOTAL:	1,199.900	927.878	912.600
	330	MATERIAL & STORES:			
33	331	MATERIAL FOR R & M	85.000	83.624	85.000
34	333	CHLORINATION	100.000	34.411	100.000
		SUB TOTAL:	185.000	118.035	185.000
		TOTAL REPAIR & MAINTENANCE	1,384.900	1,045.913	1,097.600

DETAIL OF NON-DEVELOPMENT BUDGET (EXPENDITURE)

(Rs. In million)

SR. NO.	A/C. Code	Description	2013-14 Budget Estimates	2013-14 Revised Estimates	2014-15 Budget Estimates
1	2	3	4	5	6
	320	REPAIR AND MAINTENENCE:			
15	321	R & M - DISPOSAL STATIONS' BLDGS.	14.400	12.752	17.000
16	321-A	R & M - T/WELL CHAMBERS/RESERVIORS	14.400	9.843	14.400
17	322	R & M - TUBEWELLS	129.600	84.500	129.600
18	322-A	REPLACEMENT OF T/WELL MACHINERY	14.400	1.146	14.400
19	322-B	DRILLING & BORING OF TUBEWELLS	50.000	4.750	50.000
20	323	R & M - PUMPING STATIONS	84.000	47.800	70.000
21	323-A	DEWATERING	21.600	5.400	15.000
22	323-B	REPL./REHAB. OF D/STATION MACHINERY	7.200	4.567	15.000
23	324	R & M - MOBILE EQUIP./MISC. MACHINERY	50.400	32.700	50.000
24	324-A	R & M - GENERATORS / HIRING 09 GENERATORS ON RENT	180.000	21.300	100.000
25	326	R & M - METERS	7.200	0.170	5.000
26	327	R & M - WATER SUPPLY LINES	72.000	35.103	50.000
27	328	R & M - SEWER LINES	144.000	125.000	140.000
28	328-A	R & M - DRAINS	57.600	13.770	40.000
29	328-B	SEASONAL STAFF	90.000	23.000	50.000
30	328-C	ARBORICULTURE	1.200	-	1.500
31	328-D	DESILTING OF DRAINS / SEWER	14.400	1.768	15.000
32	329	OTHERS- PY LIABILITIES, ETC.	90.000	56.500	423.000
		SUB TOTAL:	1,042.400	480.069	1,199.900
		EXPENDITURE AGAINST PCGIP FUNDS:			
33	327	R & M - WATER SUPPLY LINES	-	36.672	117.505
34	328-A	R & M - DRAINS	-	9.230	143.550
35	331	MATERIAL FOR R & M	-	14.922	156.678
		SUB TOTAL:	-	60.824	417.733
	330	MATERIAL & STORES:			
36	331	MATERIAL FOR R & M	120.000	51.828	85.000
37	333	CHLORINATION	96.000	22.452	100.000
		SUB TOTAL:	216.000	74.280	185.000
		TOTAL REPAIR & MAINENANCE	1,258.400	615.173	1,802.633

DETAIL OF NON-DEVELOPMENT BUDGET (RECEIPTS)

(Rs. in million)

Sr. No.	A/C. Code	Description	2012-13 Budget Estimates	2012-13 Revised Estimates	2013-14 Budget Estimates
1	2	3	4	5	6
18	531	III. UIP TAX SHARE:	520.000	926.469	850.000
19	531-A	IV. EEPs, PCGIP (WORLD BANK)	-	-	385.000
		IV. MISCELLANEOUS INCOME :			
20	591	MARK-UP INCOME	78.000	85.000	90.000
21	554-571	OTHERS:			
i	554	Ferrule shifting fee	0.010	0.010	0.010
ii	555	Re-opening fee	0.100	0.100	0.100
iii	557	Sale of Book-lets	0.090	0.090	0.090
iv	558	Sale of Tender Forms	10.000	4.375	10.000
v	559	Sale of Scrap	17.500	7.009	10.000
vi	561	Fines to consumers	0.500	0.500	0.500
vii	562	Fines to Contractors	0.150	1.002	0.150
viii	563	Rent	4.500	6.376	6.400
ix	565	Enlistment/Renewal fee	1.300	5.206	5.400
x	566	Change of name	0.050	0.050	0.050
xi	569	Miscellaneous:Disc. Fee, Staff loans, etc.	1.500	0.727	1.500
xii	570	** 15% Collection charges of S/Fee (Est.100 M)	15.000	14.550	15.000
xiii	571	Departmental Charges on deposit works	10.000	8.000	10.000
		Total Others	60.700	47.995	59.200
22		TOTAL MISC. INCOME: (20+21)	138.700	132.995	149.200
23		RECEIPTS FOR THE YEAR:- (17..19+22)	3,758.700	3,308.537	4,602.200
24		GRANT BY THE GOVERNMENT :			
	i	- SUBSIDY FOR LESCO POWER BILLS	1,730.000	2,151.000	2,200.000
	ii	- SUBSIDY FOR POL	-	27.811	-
		TOTAL :	1,730.000	2,178.811	2,200.000
25		TOTAL RECEIPTS :- (23+25)	5,488.700	5,487.348	6,802.200
26		BALANCE BROUGHT FORWARD	(1,511.230)	684.433	185.206
27		GRAND TOTAL (25+26)	3,977.470	6,171.781	6,987.406

: WASA is collecting Sanitation fee w.e.f.1st July'2003 on behalf of District Government for SWM on which 15% deduction is made on account of collection harges as admissible. The Budget estimates FY: 2012-13 was set to Rs. 100.000 millions out of which Rs.97.000 millions has been collected on behalf of WM.The 15% charges calculated against total collection is Rs. 14.550 millions, which is considered as income of WASA. The Budget estimates FY: 2013-14 re set at Rs. 100.000 million on which 15% i.e. Rs. 15.000 million is estimated FY: 2013-14 as income of WASA

WASA
RAWALPINDI

Questionnaire

Water Supply Business

For WASA Rawalpindi

Japan International Corporation Agency

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Questionnaire on the Water Supply Business
Questionnaire 1: Information of WASA in Punjab Province

1. City information 都市の情報

1-1. Name of water supply organization that performs water supply service 水道事業者名称

Water and Sanitation Agency, Rawalpindi

1-2. Name of city that performs water supply service 水道事業を行う都市の名称

Rawalpindi excluding Cantonment, Bahria Town, DHA and Private Housing Schemes

1-3. Population of water service area (person) 給水都市の人口(人)

2011	2012	2013	2014
1,072,409	1,097,095	1,613,573	1,650,330

1-4. City area (km^2) 都市の面積(km^2)

Total area	Water supply area
872 km^2	276km^2

1-5. Number of service connection (number of water meter) 給水(契約)戸数(戸、水道メータ数)

2011	2012	2013	2014
D -> 83,742 C -> 8,204	85,185 8402	102,620 8903	105,529 9,126

1-6. Population served by water supply as percentage of total population (%) 水道普及率(%)

2011	2012	2013	2014
90	90	80	84

2. Water resource / Water treatment 水源／浄水

2-1. Water resource (m^3/day) 水源(m^3/日)

Surface (River / Dam)	Groundwater	Seawater	Other
23 + 6 = 29MGD	39MGD	N/A	N/A

2-2. Method of water intaken 取水方式

Surface Water from Rawal Dam and Khanpur Dam. Ground Water from 362 Tube wells

2-3. Number and capacity of Water Treatment Plant (WTP) (number, m^3) 浄水場数と処理能力(箇所、m^3)

Number of WTP	Total capacity (m^3/day)
1	28 MGD

No.	WTP Name	Built year	Capacity	Treatment volume (average)
1	Rawal Lake	1912	28 MGD	m^3/day

2-4. Name and dosing rate of coagulant (mg/L) 凝集剤名称および注入率(mg/L)

Name of coagulant	Dosing rate of coagulant (mg/L)
Alum	8 mg/L

2-5. Type of sedimentation and filtration 沈殿・ろ過の種類

Type of sedimentation	Circular and Rectangular
Type of filtration	Rapid, Single media

2-6. Filtration speed rate (m/day) ろ過速度(m/day)

Slow sand filter	Rapid sand filter
N/A	110-130 G/ft^2/hr

2-7. Name and dosing rate of disinfection (mg/L) 消毒剤名称および注入率(mg/L)

Name of disinfection	Dosing rate of disinfection (mg/L)
Chlorine	1-2 mg/L

2-8. Number and capacity of distribution reservoir (number, m^3) 配水池数と容量(箇所、m^3)

Number	Total capacity (m)	Minimum reservoir (m^3)	Maximum reservoir (m^3)
36 (OHR)	2.77 MG	1,000 G	0.3 MG

2-9. Production cost of water treatment (PHP/m^3) 造水コスト(PHP/m^3)

Ground Water (Per Thousand Gallons) - Rs. 25-30 Surface Water (Per Thousand Gallons) – Rs. 8(Rawal Dam), Rs. 35 (Khanpur Dam)	USD/m^3

2-10. Number of items of water quality inspection (number) 水質検査項目数(数)

Everyday	Every week	Every month	Every year
16			
6-10 (Rawal Lake WTTP)	4 days at least		

2-11. Hour of water suspension and supply turbidity water (times, hour/year) 断水・濁水時間(時間/年)

	Number of times	Total hours
Water suspension	N/A	N/A
Supply turbidity water	N/A	N/A

2-12. Describe the problem about water treatment 浄水処理の問題点の記述

1. Mixing of waste water into surface water due to settlements at the upstream of Rawal Dam
2. Plant age is about 50 years so Repair and Maintenance of some section is required

3. Organization 組織体制

3-1. Total number of KCWN staff member (person) 職員数(人)

2011	2012	2013	2014
1069	1068	1153	1183

3-2. Total number of engineer staff member (person) 技術職員数(人)

2011	2012	2013	2014
24	25	24	21

3-3. Proportion of staff member according to staff's age (%) 職員年齢構成(%)

10's – 20's	30's	40's	50's –
Nil %	25 %	60 %	15 %

3-4. Proportion of staff member's business experience of water supply (%) 職員経験年数構成 (%)

– 5 years	5 – 10 years	10 – 20 years	20 – 30 years	30 years –
5%	10 %	10 %	30 %	15 %

3-5. Hour of staff's training (times/person, hour/year/person) 職員研修時間(回/人、時間/人)

	Inner training (exclude OJT)		Outsourcing	
	Times/person	Total hour/person	Times/person	Total hour/person
Engineer	No Organized training is occurring			
Exclude engineer				

4. Water tariff 水道料金

4-1. Price and consumption of domestic and commercial use (PHP, m^3, average per month)

家事・業務用水道料金・使用水量(PHP/m^3:平均額)

	Price	Average Consumption
Domestic use	Tariff attached	N/D m^3/month
Commercial use	(Annexure 1.1)	N/D m^3/month

4-2. Collection frequency (month) 水道料金徴収間隔(月)

2 □onths

4-3. Collection rate of □ater charge (□) 水道料金徴収率(%)

Domestic use	Commercial use
□□ □	□□ □

4-4. Descri□e/Attach the □ater tariff ta□le 水道料金表の記載

□ ater Tariff attached as an annexure to this document (Annexure 1.1)

□emar□s□

□ □oney exchange rate□1 □□ Dollar (□□D) □ _____ Pa□istani rupee (P□□) on April 2□1□

□ □f no data□ans□er is □N/D□□else if no ans□er or non-applica□le□ans□er is □N/A□

Questionnaire on the Water Supply Business

Questionnaire 2: Leakage Prevention Work of WASA

1. Organization 組織

1-1. Name of organi□ation for lea□age prevention 漏水対策を担当する組織名称

□ea□age repairing is □eing done □y each □D□ of his region

1-2. Num□er of person in organi□ation (person) 漏水対策を担当する組織の人員数(人)

2□11	2□12	2□13	2□14
35	35	45	45

1-3. Annual training time for lea□age prevention (person□person x hours)

漏水対策に関する年間研修時間(人×時間)

	2□13	2□14
Person	Nil	
Person □ □ours		

2. Leakage Detection 漏水調査

2-1. Num□er of lea□age survey team (num□er) 調査チーム数(数)

2□11	2□12	2□13	2□14
12	12	15	15

2-2. Num□er of person in one survey team (person) 1チーム当りの人数(人)

2-3

2-3. Num□er of days of lea□age survey (person x days / year) 年間漏水調査日数(人×日／年)

2□11	2□12	2□13	2□14
Every day			

2-4. Num□er of hours of average lea□age survey (person x hours / month) 調査平均時間(人×時間／月)

□ffice hour

2-□. □ength of lea□age survey (□m / year) 年間漏水調査延長(km／年)

2□11	2□12	2□13	2□14
2□□ □m	2□□ □m	3□□ □m	3□□ □m

2-□. Num□er of surface lea□age detection (num□er / year) 年間地上漏水発見数(箇所／年)

2□11	2□12	2□13	2□14
1,975	1,801	975	640

2-□. Num□er of underground lea□age detection (num□er / year) 年間地下漏水発見数(箇所／年)

2□11	2□12	2□13	2□14
Nil	Nil	Nil	Nil

2-□. □rea□do□n of num□er of underground lea□age detection □y Acoustic rod□□ea□age detector□ Correlative lea□detector□and other in 2□11 (num□er)

地下漏水発見数の内訳：音聴棒、漏水探知機、相関式探知機、その他

Acoustic rod	□ea□age detector	Correlative lea□detector	□ther
N/A	N/A	N/A	N/A

2-□. Num□er of reparation of lea□age site (num□er / year) 年間漏水箇所修理数(箇所)

2□11	2□12	2□13	2□14
All the registered complaints are rectified as soon as possible			

2-1□. Average time to repair from lea□age detection and the longest hours (hour)

漏水発見から修理までに要する平均時間(時間)

Average	□ongest
1 day	□days

2-11. Num□er of lea□age reports from pu□lic (num□er) 市民からの漏水の通報数(数)

2□11	2□12	2□13	2□14
880	801	680	225

2-12. □ave you done □inimum Night □lo□ □easure method□ 夜間最小流量測定を行ったことがあるか？

No

3. Equipment of Leakage Detection 漏水調査機材

3-1. Num□er of Acoustic rod/□ar and Amplified acoustic rod (num□er)

単純アンプ内蔵型/アンプ内蔵型音聴棒の本数(数)

Acoustic rod/□ar	Amplified acoustic rod
N/A	N/A

3-2. Num□er of set of Correlative lea□detector (num□er) 相関式漏水探知機のセット数(数)

N/A

3-3. Num□er of set of □ea□□one detector or □ea□noise correlator (num□er)

音圧式漏水探知機のセット数(数)

N/A

3-4. Num□er of sensor of □ea□ □one detector or □ea□noise correlator (num□er)

音圧式漏水探知機のセンサー数(数)

N/A

3-□. Num□er of □etal pipe locator (num□er) 金属管探査機の台数(数)

N/A

3-□. Num□er of □esin pipe locator (num□er) 樹脂管探査機の台数(数)

N/A

3-□. Num□er of Distance measuring equipment (num□er) 距離測定装置の台数(数)

N/A

3-□. Num□er of □ ater meter measuring for □N□□ (num□er) 夜間最小流量測定用水量メータの台数(数)

N/A

3-□. Num□er of vehicles used for lea□age survey (num□er) 漏水対策に用いる車両台数(台)

N/A

3-1□. Name of other lea□age detector その他の漏水探知機

N/A

4. Water Distribution Analysis 配水量分析

Data in this ta□le is 2□___. 下表のデータは 20___年の水量。

□ystem □nput □olime 配水量 24□□2□□ □□	Authori□ed Consumption 認定使用水量 □□-□□□	□evenue □ ater 有収水量	□illed Authori□ed Consumption 請求消費量	□illed □etered Consumption (incuding □ater exported) 検針による料金徴収	N/A □
				□illed Non-metered Consumption 検針に拠らない料金徴収	□□-□□□
		Non-□evenue □ ater (N□□) 無収水量	□n□illed Authori□ed Consumption 非請求消費量	□n□illed □etered Consumption 請求せず(検針あり・調停)	N/A □
				□n□illed Non-metered Consumption 請求せず(検針なし・事業用)	N/D □
	□ ater □osses 損失水量 4□-4□□		Apparent □osses 商業的(見かけ)損失量	□nauthori□ed Consumption 不正規消費(盗水・不明水)	2□ □
				□etering □naccuracies 水道メーター検針エラー	N/A □
			□eal □osses 実質損失量	□ea□age on Transmission and/or Disri□ution □ains 総配水管からの漏水	N/D □
				□ea□age and □verflo□s at □tilities □trage Tan□s 貯水槽からの溢水、漏水	N/D □
				□ea□age on □ervice Connections up to Customers□□eters 戸別メータまでの給水管からの漏水	N/D □

4-11. Distri□uted □ ater (□□□) 年間総配水量

2□11	2□12	2□13	2□14
20,805	21,535	24,090	24,820

4-12. □ ater tariff (□evenue □ ater) (m^3 / year) 水道料金対象水量(有収水量)(m^3/年)

2□11	2□12	2□13	2□14
11□3□□	11,820	13,469	14,117

4-13. □ther (□evenue □ ater) (m^3 / year) その他の徴収料金対象水量(有収水量)(m^3/年)

2□11	2□12	2□13	2□14
N/A	N/A	N/A	N/A

4-14. □ eter loss (Non-□evenue □ ater) (m^3 / year) 水道メータ損失水量(無収水量)(m^3/年)

2□11	2□12	2□13	2□14
N/A			

4-1□. □tolen □ater (Non-□evenue □ ater) (m^3 / year) 盗水損失水量(無収水量)(m^3/年)

2□11	2□12	2□13	2□14
1,632	1,792	1,780	1,745

4-1□. □npaid □ater (Non-□evenue □ ater) (m^3 / year) 未納水量(無収水量)(m^3/年)

2□11	2□12	2□13	2□14
2□332	2,499	3,038	3,277

4-1□. □ea□age □ater (Non-□evenue □ ater) (m^3 / year) 漏水量(無収水量)(m^3/年)

2□11	2□12	2□13	2□14
□□4□□	5,372	5,803	5,621

4-1□. □ ater□or□s usage volume (Non-□evenue □ ater) (m^3 / year) 水道工事使用水量(無収水量)(m^3/年)

2□11	2□12	2□13	2□14
□.□	0.6	0.7	0.7

4-1□. □n□no□n □ater (Non-□evenue □ ater) (m^3 / year) 不明水量(無収水量) (m^3/年)

2□11	2□12	2□13	2□14
m^3	m^3	m^3	□□.3 m^3

4-2□. □ther (Non-□evenue □ ater) (m^3 / year) その他の無収水量(m^3/年)

2□11	2□12	2□13	2□14
N/A	N/A	N/A	N/A

5. DMA / Leakage Survey Scale DMA/漏水調査メッシュ

□-1. To ma□e up meshes or □loc□s for lea□ detection. (□f ma□e up meshes or □loc□s□D□A is replaced □ith the meshes or □loc□s.)

漏水調査用のブロックやメッシュを構成しているか(構成している場合は、以下のDMAは読み替える)

N/A

□-2. Num□er of D□A □loc□(num□er) DMAブロック数(数)

N/A

□-3. Num□er of connection in D□A (connection) □Average of all D□A / □inimum / □aximum□

DMA内給水戸数(戸)[全ブロックの平均/最小/最大]

Average N/A	□inimum	□aximum

□-4. Num□er of □ourly □actor in D□A □Average of all D□A / □inimum / □aximum□

DMA内時系数(ー)[全ブロックの平均/最小/最大]

Average N/A	□inimum	□aximum

□-□. □ ater supply average volume in D□A (m^3 / day) □Average of all D□A / □inimum / □aximum□

DMA内日平均給水量(m^3)[全ブロックの平均/最小/最大]

Average N/A	□inimum m^3	□aximum m^3

□-□. □ ater supply maximum volume in D□A (m^3 / day) □Average of all D□A / □inimum / □aximum□

DMA内日最大給水量(m^3)[全ブロックの平均/最小/最大]

Average N/A	□inimum m^3	□aximum m^3

□-□. □ ater pressure in D□A (□Pa) □Average of all D□A / □inimum / □aximum□

DMA内給水圧(MPa)[全ブロックの平均/最小/最大]

Average N/A	□inimum □Pa	□aximum □Pa

□-□. Num□er of valves formed D□A area (num□er) □Average of all D□A / □inimum / □aximum□

DMAを構成する(区切る)仕切弁数(数)[全ブロックの平均/最小/最大]

Average N/A	□inimum	□aximum

□-□. Num□er of valves in D□A (num□er) □Average of all D□A / □inimum / □aximum□

DMA内仕切弁数(数)[全ブロックの平均/最小/最大]

Average N/A	□inimum	□aximum

□-1□. Num□er of hydrant in D□A (num□er) □Average of all D□A / □inimum / □aximum□

DMA内消火栓数(数)[全ブロックの平均/最小/最大]

Average N/A	□inimum	□aximum

□-11. □i□e of mesh (□f ma□e up meshes or □loc□s) (□m x □m)

漏水調査用メッシュがある場合、メッシュの大きさ(km×km)

N/A □m x □m

□-12. Num□er of valve in distri□ution net□or□(num□er) 総仕切弁数(数)

N/D

□-13. Num□er of hydrant in distri□ution net□or□(num□er) 総消火栓数(数)

N/A

□-14. Num□er of another valve in distri□ution net□or□(num□er) その他の調整弁等の総数(数)

N/A

□-1□. Num□er of □ater suspension (num□er / year) 年間断水回数(数／年)

N/A num□er / year

□-1□. The total num□er of connection of □ater suspension (connection / year) 年間断水のべ戸数(戸／年)

N/A connection / year

□-1□. □ ater suspension time per one time (hour / time) □Average / □aximum□

断水1回当りの継続時間(時間/回)[平均/最大]

Average N/A hour / time	□aximum hour / time

□-1□. Descri□e the lea□age repair flo□chart 漏水修繕フロー図の記述

Annexure 3.1

6. Distribution pipeline laying 管路布設

□-1. Ne□ installation pipeline length (□m) 新規布設管路延長(km)

2□11	2□12	2□13	2□14
2 □m	2 □m	4 □m	□ □m

□-2. □eplacement pipeline length (□m) 送配水管更新(入替)延長(km)

2□11	2□12	2□13	2□14
12 □m	14 □m	3□ □m	42 □m

□-3. □eha□ilitation pipeline length (□m) 更生管路延長(km)

2□11	2□12	2□13	2□14
N/A □m	N/A □m	N/A □m	N/A □m

□-4. □emoval pipeline length (□m) 撤去管路延長(km)

2□11	2□12	2□13	2□14
N/A □m	N/A □m	N/A □m	N/A □m

□-□. □uspended pipeline length (□m) 休止管路延長(km)

2□11	2□12	2□13	2□14
N/A □m	N/A □m	N/A □m	N/A □m

7. Distribution / Service Pipe material 送配給水管種別

□-1. Ductile □ron Pipe (D□P) length (□m) ダクタイル鉄管(DIP)延長(km)

Distri□ution	3.4□□ □m	□ervice	□m

□-2. Cast □ron Pipe (C□P) length (□m) 鋳鉄管(CIP)延長(km)

Distri□ution	3.□ □m	□ervice	□m

□-3. □teel Pipe (□P) length (□m) 鋼管(SP)延長(km)

Distri□ution	3□ □m	□ervice	□m

□-4. □tainless □teel Pipe (□□□) length (□m) ステンレス鋼管(SUS)延長(km)

Distri□ution	N/A □m	□ervice	□m

□-□. Concrete (□ume) Pipe (□P) length (□m) コンクリート管(HP)延長(km)

Distri□ution	13.□ □m

□-□. As□estos Cement Pipe (ACP) length (□m) アスベスト管(ACP)延長(km)

Distri□ution	22□ □m	□ervice	□m

□-□. Polyvinyl Chloride Pipe (P□C) length (□m) 硬質塩化ビニル管(PVC)延長(km)

Distri□ution	11□ □m	□ervice	□m

□-□. □igh □mpact □inyl Pipe (□□□P) length (□m) 高強度塩化ビニル管(HIVP)延長(km)

Distri□ution	N/A □m	□ervice	□m

□-□. Polyethylene Pipe (P□P) length (□m) ポリエチレン管(PEP)延長(km)

Distri□ution	N/A □m	□ervice	□m

□-1□. □alvani□ed □teel Pipe (□P) length (□m) 亜鉛メッキ鋼管(GP)延長(km)

Distri□ution	2□ □m	□ervice	□m

□-11. □ead Pipe (□P) length (□m) 鉛管(LP)の延長(km)

Distri□ution	N/A □m	□ervice	□m

□-12. Cupper Pipe (CP) length (□m) 銅管(CP)の延長(km)

□ervice	□m

□-13. □ther Pipe length (□m) その他の管の延長(km)

Pipe material name	Distri□ution	□ervice
HDPE	1□□ □m	□m

□-14. Transmission Pipeline length (□m) 送水管延長(km)

2□11	2□12	2□13	2□14
□m	2□ □m	N/D	N/D

□-1□. Distri□ution Pipeline length (□m) 配水管延長(km)

2□11	2□12	2□13	2□14
□m	□m	N/D	N/D

□-1□. □ervice Pipeline length (□m) 給水管延長(km)

2□11	2□12	2□13	2□14
□m	12□ □m	N/D	N/D

8. SCADA/Mapping system 水道情報データ管理／マッピングシステム

□-1. Descri□e the name of digital data filing 電子データ化している業務名

□ □□ □ased system is under development

□-2. Proportion of filing system of □usiness management document (□) 事業文書の管理割合(%)

Paper filing	Digital filing
mostly	□nder preparation

Currently all documents are manually maintained on papers. Consultants are □or□ing on it and after completing the soft□are they □ill hand over it to □ A□A

□-3. Proportion of filing system of □ater facilities□dra□ing (□) 水道工事図面の管理割合(%)

Paper filing	Digital filing
mostly	□nder preparation

9. Water meter and maintenance 水道メータ・修繕

No meter installed so far. (N/A)

□-1. Num□er of installed □ater meter (num□er) 水道メータ設置数(数)

Diameter	13mm	2□mm	2□mm	mm	mm	□ther	Total
Num□er	N/A	N/A	N/A	N/A	N/A	N/A	N/A

□-2. Period of service of □ater meter (year) 水道メータ使用期間(年)

N/A □ear

□-3. Num□er of annual purchase of □ater meter (num□er) 水道メータ年間購入数(数)

2□11	2□12	2□13	2□14
N/A	N/A	N/A	N/A

□-4. Times of usage of maintained expiry □ater meter (times)

満期水道メータの修理後の繰り返し使用回数(回)

N/A

□-□. Num□er of damaged □ater meter (num□er) 破損水道メータ数(数)

2□11	2□12	2□13	2□14
N/A	N/A	N/A	N/A

□-□. Num□er of intentional damaged □ater meter (num□er) 故意に破損された水道メータ数(数)

2□11	2□12	2□13	2□14
N/A	N/A	N/A	N/A

□-□. Descri□e the reason of damaged/□ro□en □ater meter 水道メータの破損理由の記述

N/A

10. Procurement / Stock management 資材調達・資材管理

1□-1. Descri□e the procedure of procurement of □ater supply material 材料調達手段の記述

PP□A (Pu□lic Procurement □egulatory Authority)□□ules□Pun□a□2□14 are follo□ed.
□s. 1 - 1□□□□□ □y comparison of three quotations
□s. 1□□□□1 □2□□□□□□ □y giving advertisement on PP□A □e□site
□s. 2□□□□□1 and a□ove □y giving advertisement on PP□A □e□site and Ne□s Paper
□equest is generated □y relevant □D□ and after follo□ing proper channel it is presented to □D for approval. After Approval from □D□concerned DD follo□ the concerned clause of PP□A □ule for procurement.

1□-2. Descri□e the management of spare parts 予備材料の管理方法

□anagement is done □y each section □y itself.

□emar□s□

□ Transmission pipeline defines the pipeline □et□een □ater treatment plant and distri□ution reservoir□ also □et□een t□o distri□ution reservoirs.

□ D□A defines District □etered Area as same as District □etered □one (D□□).

□ The □ourly □actor defines non-dimension value □hich hourly maximum consumption volume divides hourly average one.

□ □f no data□ans□er is □N/D□□else if no ans□er or non-applica□le□ans□er is □N/A□

□ Pressure unit□

	□Pa	□gf/cm^2	□ar	P□□
□Pa	1	1□.2□	□.□□□	14□.□
□gf/cm^2	□.□□□1	1	□.□□□□	14.22
□ar	□.1□13	1.□33	1	14.□□
P□□	□.□□□□	□.□□□3	□.□□□□	1

Questionnaire on the Water Supply Business
Questionnaire 3: Tube Well

Name of organi□ation□□ A□A □a□alpindi

Please provide data for tube well as follows:

Q1 How many tube well are there in your town?
Answer: 366

Q2 Do you have the inventory of tube well ?
Answer:
Yes.
Annexure A of "Master Plan Study Report B WASA Rawalpindi" and Annexure 3.1

Q3 Do you have information of each tube well regarding well location, installation year, screen depth, maintenance record, operational hours, specification of pumps ?
Answer: Yes.

Location,	Annexure 3.1
Installation year,	Annexure 3.1
Screen depth,	Annexure 3.1
Maintenance record,	Annexure 3.1
Operational hours,	12-14 hours
Specification of pumps	Annexure 3.1

Questionnaire on the Water Supply Business
Questionnaire 4: Sewerage and Drainage

Name of organi□ation□□ ater and □anitation Agency□□a□alpindi

A. Documents or information related to sewerage and drainage system in WASAs

(1) Please provide following maps.

- Location Plan of the City (including Area Boundary)
  (Annexure 4.1)
- Topography and Levels (Page 44 of Master Plan Study Report B WASA Rawalpindi)
- Served and Unserved Areas
  (Annexure 4.2, not separated available but can be see)
- WASA administration Zones Boundary
  (Annexure 4.1)
- Location of Disposal stations (N/A)
  Layout Plan of Existing Sewer System (Annexure 4.2)
- Layout Plan of Existing Drainage System (N/D)
- Existing Drainage Route and Point of Final Disposal (N/D)
- Proposed or planed Sewers and Drainages System (N/D)
- Major Ponding Areas
  (Annexure 4.3 contains the most vulnerable areas in which water remains till the high water level in Drain Lai. When level of drain drops down then water also move to Drain Lai by itself.)

(2) Please provide following rainfall data.

- Rainfall intensity (15, 30, 60 120 minutes, 3,6,9,12 hours duration) (Figure 2,4 and 8 of Master Plan Study Report B WASA Rawalpindi)
- Fitted Intensity Duration Curve (N/D)

B. Organization and finance

(1) Please provide an actual organization chart of WASAs especially Sewers and Drainages cleaning (Engineers, Equipment operators, Sewer man, etc)

Annexure 5.1 & 5.2

(2) Please furnish an annual budget and disbursement in the WASAs and its breakdown for the last 5 years especially Sewers and Drainages cleanings.

Annexure 5.□contains the details (Submitted as hard copy)

(□) Please explain the schedule and budget allocation for the implementation of the cleanings (operation□maintenance of the sewage and drainage system).

Annexure 5.□contains the details (Submitted as hard copy)

□. □□ui□ment□□ ac□inery

(1) Please provide a list of equipment□machinery owned by WASAs as tabulated below (type of equipment, model, year of manufacturing, name of manufacturer and country, running hour□km, working condition, maintenance method, present location).

Equipment	□odel (□ain Spec.)	□ear	□anufacturer□ □ountry	Running hour/km	Working Condition	Maintenance method	Location
Wheel Excavator	PC200	1998	Komatsu Japan	6000hr	Under repair	Need overhaul	Motor pool

Annexure 4.4 contains the list of special vehicles

(2) Existing facilities or equipment for maintenance service available at the workshop of WASAs.

(3) Procedure of machine maintenance and process of daily/routine maintenance activity and preparation of activity's record/report.

Fault or abnormality is reported by the driver / supervisor. Relevant Assistant Director reviews the issue and report to the Motor Transport Officer (MTO). He further proceed or solve the issue.

(4) Laws/Regulations of gas emission control for vehicles and construction equipment.

Environmental Protection Agency Act is followed.

(5) Average field working hours per day for Sewers and Drainages cleanings.

8 hours

(6) Current dredging method.

Only for Nala Lai: two excavator + two dump trucks

(7) Current sludge removal work from sewage pipes.

In case of manual work: two worker for manhole + 2 helpers

In case of Mechanical work: One Driver + One Operator + 2 helpers

(8) Record of the accidents of construction equipment/machinery for the last 5 years
(N/A) WASA Rawalpindi outsource the construction work

(9) With regard to disposal stations the following information will be required (refer to Format 1):

N/A

Questionnaire on the Water Supply Business

Questionnaire 5-Rawalpindi

Management, Finance and Organization

Name of organization: __Rawalpindi WASA_

1) Management

Please answer the following questions and provide financial reports in recent three (3) years□current tariff tables and your organi□ation chart to support your answers.

	□uestions	Please write your answers.	Reference document
□ision□ strategy	Existence of a long□term□plan	Answer: □es□ Master Plan 1996 □2016 prepared by Provincial □overnment	
Finance	Revenues:	□ear 2012 actual (913.968)□ 2013 actual (1193.563)□ 2014 actual (1188.288)□ 2015 estimated (1320.657)□ 2016 planning (2187.292)	
	Costs	□ear 2012 actual (849.409)□ 2013 actual (1187.660)□ 2014 actual (1158.943)□ 2015 estimated (1330.372)□ 2016 planning (3029.930)	
	Investment	□ear 2012 actual (30.793)□ 2013 actual (26.580)□ 2014 actual (27.873)□ 2015 estimated (15.148)□2016 planning (□)	
	Main finance sources	What is your main finance source□e.g. water charge collection□ subsidy□ government finance (PC□1)□assistance from donors□ Answer (Water collection Charges)	
Future expansion	What is your future expansion plan□ Master Plan is under preparation by M/S Osmani □ Co. (Pvt.) Ltd. New water treatment plant ( ) New sewage plant ( ) Rehabilitation ( ) How much do you need to implement the above plans□( )		Master Plan Study Report C WASA RWP
Administration and organi□ation	Organi□ation chart	Number of staff in each division by grade (Annexure 5.1)	
	Recruitment	□ear 2012 actual (□)□2013 actual (□)□2014 actual (□)□2015 estimated (25)□2016 planning (50)	
	Retirement	□ear 2012 actual (8)□2013 actual (8)□2014	

		actual (11)□ 2015 estimated (10)□ 2016 planning (15)	
	Communication among divisions	Do you have a regular cross□division meeting (e.g. once a month□once a week)□ Answer ( )	
	Pipe distribution network map	Do you have a pipe distribution network map of your city□ Answer: □es.	
	Inventory List	Do you have a list of inventory□machinery and other fixed assets□ Answer: Partially yes. Study MP Study Report □ contains all available inventories	
	Customer database	Do you have a customer database□ Answer: □es.	
Training	Training program (actual)	What training have you conducted□ Answer (No Organi□ed Trainings are being conducted)	
	Necessary Training in the future	What training do you need in the future□ Answer: (□IS□Integrated Water Resource Management□Technical Trainings for □EN□DD□SDO□AD and SE)	
	□uidelines	Do you have textbooks or guidelines to give a lecture to your staff□ Answer: No.	
	□udget for the training	How much is your annual budget for the training□ Answer ( )	
Relation with customers	Communication with customers	Do you have a regular meeting with customers (e.g. once a month□once a week)□ Answer: □es□No□Comments ( )	
	Complaints from customers	Do you keep recording customer complaints□ Answer: □es.	
Relation with other organi□ations: WASAs□ □overnment□ and donors	Relation with other WASAs□ suppliers	Do you have a regular meeting with other WASAs or suppliers (e.g. once a month□once a week)□ Answer: □es□No□Comments ( )	
	Relation with the State □overnment	Do you have a regular meeting with the State □overnment (e.g. once a month□ once a week)□ Answer: □es□No□Comments ( )	

	Relation with Tehsil Municipal Administrations	Do you provide some training for Tehsil Municipal Administrations□ Answer: No.	

□) □ **ate□□□□□□**

The I□NET is International □enchmarking Network for Water and Sanitation Utilities□issued by the World □ank. I would appreciate if you answer the following questions□in reference to the data as of year 2010 on the web or data from the JICA report in July 2014.

□uestions	□ear 2006 data	□ear 2009 data	Source	Please write current situations.
Rawalpindi population	946□000	1□250□000	I□NET	1□500□000□0□60□000
Coverage with water service	61.73□	90□ (1□125□00)	I□NET	85□
Coverage with sewerage	34.99□	35.04□	I□NET	40□
Water treatment capacity (m3/day)			N/A	□□ □ □ □
Actual average treatment volume (m3/day)			N/A	N/D
Number of connections		90□000	I□NET	115□000
Network length (km)		1□150 km	I□NET	1200km (approximate)
Water production	295.55 lpcd	228.92lpcd	I□NET	40□pcd
Total water consumption	152.00 lpcd	150.99 lpcd	I□NET	N/D
Residential consumption		87.67 lpcd	I□NET	N/D
Losses in m3/km of the network a day	79.71 m3/km	76.24 m3/km	I□NET	N/D
Losses in □ (Non Revenue Water)	48.57□	34.04□	I□NET	30 □40 □
Revenues□US□□ Rs per M3 sold	0.10 □	0.05 □	I□NET	65□70□
Costs□US□per M3 sold	0.15 □	0.09 □	I□NET	
Operation cost coverage	0.68	0.61	I□NET	
Revenue collection ratio	173.57□ (2007)□ 155.14□ (2008)	176.28□	I□NET	
Labor costs vs. operation costs		19□	I□NET	
Electrical energy costs vs. operation costs		37□	I□NET	40 □50 □

Contracted or service costs vs. operation costs		45□	I□NET	
Total staff number		1□282 staff (2011)	JICA	1□282
Staff per 1□000 connections		13.9 staff per 1□000 connections (2011)	JICA	11
Water supply hours a day		8 hours a day (2011)	JICA	2□4
Water meter installation ratio		N/A	JICA	□ero
Average monthly tariff		135 Rs (2011)	JICA	
Revenue collection ratio		67□ (2011)	JICA	65□75□
New connection installation fee		2□500 Rs (2011)	JICA	
Annual costs per a connection (Rs)		200 Rs (2011)	JICA	
Annual Complaints		10□220 complaints (2011)	JICA	Online Complaint System + manual complaints in each regional office by phone or by visiting office

□) □e□age

□uestions	□ear 2011 data	Source	Please write current situations.
Coverage with sewage	35□	JICA	40□
Sewage capacity (m3/day)		N/A	
Actual average sewage volume (m3/day)		N/A	
Sewage network length (km)	250 km	JICA	250km (Approximate)
Drainage network length (km)	N/A	JICA	
Drainage pump stations	□ero	JICA	□ero
Sewage plants	□ero□ One (Under planning)	JICA	NO WWT facility

Thank you for your answers.

List of Annexures

Rawalpindi

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Annex-1

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WATER AND SANITATION AGENCY (RDA) RAWALPINDI

NOTIFICATION

MD/DG/RDA/Tariff 2007-08/206 dated 4.9.09

In exercise of powers conferred in the Rawalpindi Development Authority under section 27(I)(ii) of the Punjab Development of Cities Act. 1976 (Act No.XIX of 1976) the rates and fees in respect of its water supply and sewerage operations as fixed w.e.f 01.07.2006 vide Punjab Gazette Notification No.L-7532 dated 09.03.2007 are modified / revised with previous consent of the Govt. as under w.e.f next Quarter after date of issuance of notification.

WATER TARIFF RATES

	Categories	Existing rates	New rates
A.	BULK WATER SUPPLY	RATE/1000 GALLONS	RATE/1000 GALLONS
1	Military Engineering Services (MES)	17.00	17.00
2.	National Institute of Health (NIH)	11.00	11.00
3.	National Agricultural Research Council (NARC)	17.00	17.00
B.	DOMESTIC METERED SUPPLY	RATE/1000 GALLONS	RATE/1000 GALLONS
1	Upto 5000	21.00	30.00
2.	5001-1000	29.00	40.00
3.	10001-15000	35.00	50.00
4	15001-20000	43.00	60.00
5.	Over 20000	50.00	70.00

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C.	COMMERCIAL CONNECTIONS METERD	RATE/1000 GALLONS	RATE/1000 GALLONS
	Consumption Slab (gallons)		
1	Up to 5000	29.00	50.00
2	5001-10000	35.00	65.00
3	10001-2000	50.00	80.00
4	Over 20,001	56.00	100.00

D.	DOMESTIC CONNECTIONS UN-METERD	Flat rate/mth/connection	Flat rate/mth/connection
1	Up to 5 Marlas	78.00	98.00
2	Above 5 upto 7 Marlas	128.00	160.00
3	Above 7 upto 10 Marlas	176.00	220.00
4	Above 10 Marlas & upto 15 Marlas	200.00	250.00
5	Above 15 Marlas & upto 20 Marlas	300.00	375.00
6	Above 20 Marlas & upto 25 Marlas	500.00	625.00
7	Above 25 Marlas & upto 30 Marlas	550.00	688.00
8	Above 30 Marlas & upto 2 kanal	636.00	795.00
9	More than 2 kanal	706.00	883.00

Note: Above 200 Sq Feet of plot size falling in higher category will be charged in the lower category

	COMMERCIAL CONNECTIONS UN-METERED	Flat rate/mth/connection	Flat rate/mth/connection
1	Petrol Pump / CNG with service station	7063.00	8829.00
2.	Petrol Pump / CNG without service station	1413.00	1766.00
3.	Service Station	5650.00	7063.00
4	Cinema House	2825.00	3531.00
5	Laundry / Dry Cleaners (Small)	706.00	883.00
6.	Laundry / Dry Cleaners (Large)	2000.00	2500.00
7.	Dyers	424.00	530.00
8	Barber Shop with Hamam (up to two hamams)	424.00	530.00
9	Barber Shop with more than two hamams	706.00	883.00
10.	Barber shops without Hamam	213.00	266.00
11	Gents Parlors	1000.00	1250.00
12	Beauty Parlors (In House)	350.00	438.00
13	Beauty Parlors (In Shop)	1000.00	1250.00
14	Bakery, Dairy and Sweet Shops	300.00	375.00
15.	Bakery, Dairy, Sweet and Confectionary with Factories	1500.00	1875.00
16	Bottle Factories, Soda water/Ice cream	1695.00	2119.00

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19	Concrete Pre-casting Pipe Factories / Marble Factories	2825.00	3531.00
20	Other factories / Mills	1500.00	1875.00
21	Other commercial & industrial concern using water for manufacturing/business purposes	848.00	1060.00
22.	Banks	1500.00	1875.00
23.	Plazas		
	(a) Per connected Shop	150.00	188.00
	(b) Per connected Residential flat	175.00	219.00
	(c) Per connected office	250.00	313.00
	(d) Per connected single residential room	125.00	156.00
24	Cattle Farm		
	a Up to 10 cattle	706.00	883.00
	b 11 to 20 cattle	1059.00	1324.00
	c more than 20 cattle	1413.00	1766.00
25	Printing press	283.00	354.00
26	Warehouses / Stockests	495.00	619.00
27.	Traders / Wholesale dealers	530.00	663.00
28	Others Commercial Shops	176.00	220.00
29	Car dealers / Rent a car	494.00	618.00
30	Auto workshops	565.00	706.00
31	Commercial institutions / Organizations / Agencies	700.00	875.00
32.	Snooker Clubs / Video Game shops / Internet clubs	424.00	530.00
33.	Photography / color labs	424.00	530.00
F.	HOTELS/RESTAURANTS UN-METERES	Per room/Per month	Per room/Per month
1	Centrally Air conditioned (per room / per month)	213.00	266.00
2.	Air conditional (per room/per month)	141.00	176.00
3.	Without AC (per room/per moth)	106.00	133.00
4.	Restaurants (Air conditioned)	3000.00	3750.00
5.	Restaurants (Without Air conditioned)	848.00	1060.00
6.	Hotel & Restaurant (common)	Rate of higher category	
7	Tea stalls/ Cafetrias	248.00	310.00
8.	Sarai cum Restaurants (Common	706.00	883.00
9.	Corner food stall	424.00	530.00
10	Small restaurant / refreshment corner	600.00	750.00
11.	Fast food Restaurants	1060.00	1325.00
12.	Marriage Halls (Air conditioned)	3000.00	3750.00
13	Marriage Halls (Without Air conditioned)	2000.00	2500.00

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G.	GOVT. OFFICES/ PRIVATE OFFICES	Flat rate/mth/connection	Flat rate/mth/connection
1	Upto 10 persons	283.00	354.00
2	11 - 25 persons	424.00	530.00
3	26 - 50 persons	565.00	706.00
4	Over 50 persons	848.00	1060.00
5	Post Offices	283.00	354.00
H.	SCHOOL / COLLEGES	Flat rate/mth/connection	Flat rate/mth/connection
1	Primary (Govt./Welfare)	141.00	176.00
2	Primary (Pvt) Fee upto Rs. 500/-	283.00	354.00
3	Primary (Pvt.) Fee above Rs.500/-	1500.00	1875.00
4	Above primary & up to Matric (Govt./Welfare)	213.00	266.00
5	Above primary & up to Matric (Pvt.)	424.00	530.00
(6)	Above primary & up to Matric (Pvt.) Fee above Rs.500/-	3000.00	3750.00
7	College & Universities (Govt)	706.00	883.00
8	College & Universities (Pvt)	5000.00	3750.00
9	Academy / Coaching / Tuition Centers	283.00	354.00
J.	HOSPITALS / NURSING HOMES	Flat rate/mth/connection	Flat rate/mth/connection
1	Non-Commercial/ Charity/ Welfare	141.00	176.00
2	Pvt. Nursing Homes/Hospitals(per bed/per month)	213.00	266.00
3	Homeopathic/Hikmat practitioners/Dispensaries	283.00	354.00
4	Dental / Private Clinics (Consultancy Fee upto Rs. 100/-)	400.00	500.00
5	Medical Center (Specialist)	1500.00	1875.00
6	Private Clinics with Consultancy Fee Above Rs. 100/-	1000.00	1250.00
7	Clinical / Medical / Ultrasound / X-ray Labs	1000.00	1250.00
8	Collection Points of Labs	500.00	625.00
K.	SUPPLY THROUGH WATER TANKERS	PER TANKER	PER TANKER
1	Domestic	300.00	375.00
2	Commercial	500.00	625.00
3	Tanker filling charges (from WASA filling point)	200.00	250.00

Annex-1

Note: -

Change of connection would be allowed only after clearance of all dues in respect of first connection.

M.	MISCELLANEOUS FEES	Domestic	Commercial
1	Disconnection on consumer's request	883.00	1236.00
2.	Ferrule Cleaning fee	173.00	266.00
3.	Ferrule Shifting fee (change of connection)*	883.00	1235.00
4.	Change of Ownership fee	438.00	704.00
5.	Regularization Fee for Illegal Water Connection	New Connection fee along with one year bill of existing category	New Connection fee along with one year bill of existing category
6.	Surcharge on late payment	10%	10%
7.	Miscellaneous charges bill	10.00	10.00
8.	Installment Charges	10.00	10.00

Note:-

Change of connection would be allowed only after clearance of all dues in respect of first connection.

N.	MISCELLANEOUS	Flat Rates /Month	Flat Rates/ Month
1.	Mosques/Religious Buildings/institutions	Free of Cost (EXISTING)	Free of Cost (NEW)
2.	Deserving Widows (Only For Domestic Consumers)	25% Exemption from Total Bill	25% Exemption from Total Bill
3.	Bus stand /Wagon stand/ Coach stand	706.00	883.00
4.	Commercial Business without WASA connection but utilized WASA water through Filtration Plant / Water Point	-	50% of actual category
5.	Tube wells (Aquifers charges)	6000.00	7500.00
6.	Shallow Well/ open well /hand pump) for Domestic only	141.00	176.00
7.	Public Toilets (Per Seat)	706.00	883.00
8.	Nurseries	706.00	883.00
9.	Public Parks	1413.00	1766.00
10.	Vegetable /Fruit farms	1413.00	1766.00
11.	Libraries	141.00	176.00
12.	Hatchery /Poultry Farms	706.00	883.00
13.	Social welfare org/ institutions per '5" Connection	141.00	176.00
14.	Hostels (upto 10 rooms)	1000.00	1250.00
15.	Hostels (More than 10 rooms)	1500.00	1875.00
16.	Cooking / Catering Shops	750.00	938.00
17.	Bore hole (Aquifer Charges) Below 8" (For commercial / More than 01 kanal residential)	625.00	781.00
18.	a N.O.C fee for installation of private Tubewell (Bore hole more than 8")	-	16000.00 (one time only)
	b N.O.C fee for private commercial boring les than 8"	-	5000.00 (one time only)

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SEWERAGE TARIFF RATES

S.No	CATEGORY	FLAT RATE PER MONTH
1	Sewerage rate	50% of water rate of respective consumer categories except for commercial categories of "petrol pump with service station" and, "only service station" in which monthly sewerage rate would be Rs 1500 & 1000 respectively
2.	Connection Fee	ONCE ONLY
	(a) Domestic	
	Plot up to 10 marlas	300.00
	Plot More than 10 Marlas	500.00
	(b) Commercials	2500 00
3	Suckers Machine Charges	1500.00 per hour

Notes:-

1 For domestic/ non –commercials connection ferrule size of not more than ½" dia is allowed

2 For existing ferrules bigger than ½" dia, in the commercials tariff categories the rates charged will be as under

a) For ¾" dia ferrule — Double the rate of 1/2" dia ferrule for respective consumer category

b) For 1" dia ferrule — Four times the rate of ½" dia ferrule for respective consumer category

3. Extraction of water from ground water in WASA's Controlled area through private tubewell installation is not allowed except in exceptional circumstances with prior permission of Managing Director ,WASA on payment of monthly aquifer charges besides initial charges under an agreement with WASA on specified terms and conditions.

4. Treated water from WASA system shall not be used for watering to vegetable/ fruit farms/ gardens and other wasteful uses.

5. Making water connection from WASA system without approval of WASA is unauthorized and an offence. Such cases shall be treated as theft of water and shall be liable to punishment under the law The plumber/ persons found instrument in making or having connivance such illegal connection shall be proceeded against under the law.

6. Restoration of connection disconnected due to default of the consumers or due to offence as mentioned at Sr No "5" above, shall be allowed after fulfilling all the formalities as prescribed for a new connection with full recovery of arrears, surcharges and fine etc.

7. Installation of suction pump/donkey pump directly on WASA's water supply lines is an offence and offenders in such cases shall be liable to be proceeded under law and to fine which shall not be less than four times the actual water bill. The water pumps so recovered and removed by WASA enforcement staff shall be confiscated without any right of returning to the defaulters.

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8. New individual connection installation for commercial/residential/Plazas/Flats may be provided on individual ownership bases. In case of multiple owners of building either connection would be allotted to first owner or multiple connections would be provided accordingly to number of owners.
9. The water & Sewerage rates for domestic connections are applicable upto two storey buildings. Consumer will be required to pay ½ of basics rate for every additional storey.
10. Change of water connection from one to the other WASA line, if available in the street / road, would only be allowed after clearance of up data dues in respect of water and sewerage charges on account of the first connection.
11. No new water connection would be installed in the premises already having a water connection under default for domestic/ commercial consumers.
12. Disconnection made due to default of the consumer, the water bill of each quarter/ session for the period of disconnection will have to be paid by the consumer along with the fine decided/ imposed by the Senior Special Magistrate, WASA/RDA.
13. In case of non-payment of water bill after due date, late fee (surcharges) would be charged @ 10% of current / due amount.
14. Any complaint regarding water supply /sewerage and non-delivery of bill in the past would not be considered as a valid reason for non-payment of bill.
15. In case of change /transfer of ownership, it is the sole responsibility of the new owner to make sure that there is no pending liability in respect of water and sewerage charges thereon from the original owner otherwise the new owner shall be responsible for clearance of all upto date dues of respective premises.
16. Challan for New Sewerage Connection/Re-connection will be issued by the Sewerage Directorate and after Installation of Sewerage Connection, the data record will be communicated to Revenue Directorate.
17. Full Sewerage rates would be charged in case consumer has laid down a private sewerage line and connected it to WASA sewerage network.

25/7/09

(Muhammad Makeen Shahbaz)
Director General
Rawalpindi Development Authority
Rawalpindi

3.11.16. SOP for Leak Detection and Repair

Annex 2.1

Purpose

This SOP describes the steps to be taken by the RWASA to reduce water leakage. It outlines the procedure to be deployed by the staff to detect and repair leaks within the transmission lines, distribution lines and in the customer service lines.

Responsibility/Accountability

The Zonal Assistant Director at the RWASA is responsible leak detection and repair.

Procedure

Procedure for Leak Detection:

1- The Zonal Assistant Director establishes a mechanism to encourage the general public to report leaks.
2- The Zonal Assistant Director forms a leak detection team comprising Technicians, Meter Readers and zones Sub Engineer.
3- The Zonal Assistant Director confirms the leaks reported by the general public, customers or press, by using the leak detection team.
4- The Zonal Assistant Director inspects bulk meter readings of established leaks and sends leak detection team to verify.
5- The team detects underground leaks when and where appropriate.
6- The team records every leak in the Leak Detection Form and Leak Office Register on daily basis.

Procedures for Leak Repair:

For pipes up to 80 mm, the Sub Engineer:

1- Sub Engineer Prepares a Job Card.
2- Visits the site and with help of Technician exposes the leaking pipe.
3- Assesses the leak and with approval of the Zonal Assistant Director requisitions the materials required.
4- Repairs the leak and flushes the pipeline.
5- Completes the Job Card and submits to the Zonal Assistant Director for endorsement and records.

Leakage repair instruction for pipes (80 – 200) mm, the Sub Engineer:

1- Sub Engineer Prepares a Job Card.
2- Visits the site and with help of technician exposes the leaking pipe.
3- Assesses the leak and with approval of the Zonal Assistant Director requisitions the materials required.
4- Isolates the fault section and drains it.
5- Repairs the leak and flushes the pipeline.
6- Ensures that the water service is restored.

7- Completes the Job Card Form submits it to the Zonal Assistant Director for endorsement and records.

Leakage repair instruction for pipes more than 200 mm, the Technician:

1- Sub Engineer Prepares a Job Card.
2- Visits the site and with help of Technician expose the leaking pipe.
3- Assesses the leak and with approval of the Zonal Assistant Director requisitions the materials required.
4- If the pipe line is a raising main, pump shut down procedures by pump operator must be followed.
5- Isolates the fault section and drains the main pipeline.
6- Fixes the leak, flushes the pipe section and disinfects the pipeline according to applicable standard procedures.
7- .Switches on the pump with the assistance of the Pump Operator according to starting procedures.
8- Ensures that the water service is restored.
9- Completes the Job Card Form signs and submits it to the Zonal Assistant Director for endorsement and records.

Pipe manufacturer's recommendations should be followed during execution of the works.

Performance Indicators

Performance Indicators are the measures which communicate that the procedure is being followed and is working.

The indicators to be used to measure the performance of this SOP are:

a. Job Card Form

b. Materials Requisition Form

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi.
WASA Rawalpindi

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Make	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlorinator	Filtration Plant	Strata Chart	Delivery Pipe Dia (Inch)	Pressure Gauge	Year of Construction	Total Pumping Hours		Flow Meter Values			
																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
Detail List of Tube Wells West Zone, Sector-I UC (1-9)																								
1	73-A	1	Choki Muhallah Ratta Amral	318,642	3,720,477	Submersible	K S B	8,000	300	25	25	Yes	Yes	No				2004	10	80,000				
2	74	1	Near Lai Pull Ratta Amral	318,935	3,720,624	Submersible	K S B	7,000	210	25	50	Yes	Yes	No				1999	8					
3	74-A	1	Chungi Ratta Amral	318,625	3,720,232	Submersible	K S B	6,000	260	30	50	Yes	Yes	Yes				1999	17					
4	74-B	1	Near Railway Police Line Railway Godaam Road Ratta Amral	318,371	2,720,197	Submersible	K S B	8,000	150	30	50	Yes	Yes	Yes				1994	18					
5	74-C	1	Near Street no. 22 Ratta Amral	318,685	3,720,249	Submersible	FLOW PAK			30	50	No	No	No				2014						
6	75	1	Bhusa Godaam	318,347	3,720,814	Submersible	K S B	7,000	260	25	50	Yes	Yes	Yes				1992	10					
7	75-B	1	Near Girls College Melaad Nager Dhoke Ratta	318,441	3,720,835	Submersible	K S B	7,000		25	25	No	No	No				2010	8					
8	75-C	1	Kachi Abadi Bhusa Godaam	318,173	3,720,781	Submersible	FLOW PAK			25	25	No	Yes	No				2014	10					
9	76-A	1	Near Utility Store Melaad Nager Dhoke Ratta	318,547	3,720,745	Submersible	K S B	4,000	270	20	25	No	Yes	No				2004	7					
10	76-B	1	Near Pull Dhoke Ratta	318,625	3,720,591	Submersible	K S B	5,000	250	25	50	No	Yes	Yes				2002	10					
11	77	2	Dhoke Ratta Dispensary	318,603	3,721,013	Submersible	K S B	5,000	260	15	50	Yes	Yes	Yes				1988	12					
12	78	2	Toheedi Road Dhoke Ratta	318,385	3,721,051	Submersible	K S B	6,000	260	25	50	Yes						1988	Abundant					
13	78-A	2	Tanga Stand Dhoke Ratta	318,402	3,720,940	Submersible	K S B	5,000	260	25	50	No	No	No				1997	8					
14	78-B	2	Near scheme No.7 Railway Workshop Road	318,359	3,721,384	Submersible	H M A	5,000	270	20	50	Yes	Yes	No				1997	10					
15	79-A	2				Submersible		5,000	190	20	50							1998	Abundant					
16	79-C	2	Babu Laal Husain Road Dhoke Ratta (Tanki)	318,699	3,721,132	Submersible	MAK	7,000	270	25	Public	No	No	Yes				1998	8					
17	79-D	2	Near Boys High School Babu Laal Husain Road	318,710	3,721,232	Submersible	FLOW PAK			20	25	No	No	No				2012	8					
18	80-B	2	Ahata Zubair Butt Dhoke Ratta	318,572	3,721,322	Submersible	K S B	7,000	260	25	25	Yes	No	No				2005	8					
19	78-C	3	Madni Market Railway Workshop Road	318,536	3,721,396	Submersible	K S B	5,000	190	20	50	No	No	No	No	3	No	1998	10					
20	80-A	3	Near Khajur Wala Medan Hazara Colony	318,289	3,721,685	Submersible	K S B	6,000		20	25	Open	No	Yes	No	4	No	2004	12					
21	81	3	Hazara Colony	318,723	3,721,893	Submersible	K S B	7,000	200	20	50	Yes	Yes	No				1984	10					
22	81-A	3	Umar Abad Hazara Colony	318,850	3,721,940	Submersible	K S B	6,000	260	20	50	Yes	Yes	No				2004	12					
23	81-B	3	Madrasa Usmania Hazara Colony	318,827	3,721,432	Submersible	FLOW PAK			20	50	No	No	No				2007	6					
24	81-C	3	Ahata Manzir Hazara Colony	318,908	3,721,572	Submersible	K S B			20	50	No	No	No				2012	8					
25	82-A	3	Kiran Road Hazara Colony	318,650	3,721,501	Submersible	FLOW PAK	3,000	270	20	25	No	No	No				2007	12					
26	82-B	3	Near Pulli Hazara Colony	318,751	3,721,993	Submersible	FLOW PAK	5,000		20	50	Yes	No	No				2014	10					

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Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Make	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlorinator	Filtration Plant	Strata Chart	Delivery Pipe Dia (Inch)	Pressure Gauge	Year of Construction	Total Pumping Hours		Flow Meter Values			
																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
27	83	4				Submersible	K S B	4,000	170	25	50							1988	Abundant					
28	83-A	4	Boring Road (Tanki)	318,075	3,722,228	Submersible	MAK	5,000	280	25	25	Yes	Yes	Yes	No	3	No	2008	9					
29	84	4				Submersible	K S B	5,000	190	25	50							1984	Abundant					
30	84-A	4				Submersible		6,000	260	20	25							2005	16					
31	84-B	4	Khawaja Abad	318,619	3,722,093	Submersible	K S B	7,000		25	50	Open	No	No	No	3	No	2010	10					
32	84-C	4	Muhallah Farooqia Girls School Dhoke Mangtal	318,178	3,722,051	Submersible	FLOW PAK	4,000		25	50	Open	No	Yes	No	4	No	2013	10					
33	84-D	4	Muhallah Khatekan Dhoke Mangtal	318,207	3,722,209	Submersible	K S B	7,000		30	50	Open	No	No	No	4	No	1998	10					
34	85	4				Submersible	K S B	7,000	160	25	50							1992	Abundant					
35	85-A	4	Near Pull Boring Road	318,177	3,722,230	Submersible	K S B	7,000	180	30	50	Yes	Yes	No	No	4	No	1998	9					
36	87	5	Aalim Abad Dhoke Hasuu	317,404	3,722,259	Submersible	K S B	6,000	260	25	50	Yes	Yes	Yes	No	4	No	1990	10					
37	87-B	5	Near Graveyard Aalim Abad Dhoke Hasuu	317,488	3,722,230	Submersible	K S B	7,000	260	25	50	Yes	Yes	Yes	No	4	No	2007	10					
38	87-C	5	Aalim Abad Dhoke Hasuu	317,386	3,722,339	Submersible	K S B			25	50	No	No	No	No	3	No	2014	10					
39	88	5	Model Colony Dhoke Hasuu	318,004	3,722,500	Submersible	K S B	6,000	180	25	50	Yes	Yes	Yes	No	4	Yes	1991	5					
40	88-A	5	Mehar Abad Dhoke Hasuu	317,955	3,722,530	Submersible	FLOW PAK			30	50	Yes	No	No	No	3	No	2013	8					
41	89-A	5	Dhoke Darzian Dhoke Hasuu	317,650	3,722,420	Submersible	Mak	6,000	180	25	25	Yes	Yes	Yes	No	4	Yes	1999	14					
42	86	6	Gulshan Data Dhoke Hasuu	317,315	3,722,620	Submersible	FLOW PAK	6,000	170	30	50	Yes	Yes	Yes	Yes	4	Yes	1985	12					
43	87-A	6	Waqeel Abad Dhoke Hasuu	317,228	3,722,749	Submersible	H M A	5,000	260	25	50	Yes	Yes	Yes	Yes	4	Yes	1999	8					
44	89	6	Gulshan Fatima Dhoke Hasuu	317,153	3,722,908	Submersible	K S B	6,000	180	25	50	Yes	Yes	Yes	No	3	Yes	1988	12					
45	90	6	Near Tawar Aalam Abad Dhoke Hasuu	317,226	3,722,302	Submersible	H M A	7,000	290	20	50	Yes	Yes	Yes	No	6	Yes	1986	10					
46	91-B	7	Awan Colony Perwadai	318,161	3,722,563	Submersible	LOWARA	6,000	270	25	50	No	No	No	No			2007	10					
47	91-C	7	Akab Anarkali Hotel Perwadai	318,323	3,722,697	Submersible	K S B	5,000	270	30	50	No	No	No	No		No	2007	10					
48	92	7	Awan Colony Perwadai	318,118	3,722,738	Submersible	K S B	6,000	170	25	50	Yes	Yes	No	Yes			1995	12					
49	143-A	7	Muslim Abad	318,597	3,722,449	Submersible	K S B	6,000	180	30	50	Yes	Yes	No	No			1997	14					
50	143-B	7	Quaid Abad (Tanki)	318,772	3,722,333	Submersible	K S B	6,000	180	25	50	Yes	Yes	Yes	No			2007	14					
51	143-C	7	Near Chhati Ghali Muslim Abad	318,493	3,722,525	Submersible	LOWARA	6,000	280	30	50	Yes	Yes	No	No			2007	14					
52	91	8	Mehar Colony Perwadai	317,968	3,722,852	Submersible	K S B	6,000	180	25	50	Yes	Yes	Yes	No		Yes	1988	8					
53	91-A	8	Bokra Road Perwadai	318,078	3,722,852	Submersible	K S B	6,000	180	25	50	No	No	Yes	No			1999	9					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
54	92-A	8	Dhoke Awan Street No 1	317,064	3,723,107	Submersible	Abundant																	
55	92-B	8	Street No. 10 Fuji Colony	317,390	3,723,084	Submersible	K S B	5,000	270	25	50	Yes	Yes	Yes		3	Yes	2007	13					
56	92-C	8	Street No. 18 Fuji Colony	317,473	3,722,832	Submersible	KERSELF	7,000	280	20	50	Yes	Yes	No	No	4	No	2007	13					
57	92-D	8	Near Street No.1 Dhoke Awan Fuji Colony	317,022	3,723,137	Submersible	K S B	6,000		25	25	Open	No	No	No	3	No	2014	12					
58	93-B	8	Street No. 29 Fuji Colony	317,867	3,723,082	Submersible	MAK			25	50	No	No	No	No			2012	8					
59	93	9	Fair Barged Perwadai	318,198	3,722,943	Submersible	K S B	6,000	150	20	50	Yes	Yes	Yes	No	3	No	2015	9					
60	93-A	9	Near Muhammadia Shopping Center Perwadia (Moru Wala)	318,093	3,723,088	Submersible	H M A	6,000	280	20	25	Open	No	No	No	4	No	2005	9					
61	94	9	Bus Stand Perwadai (Tanki)	318,494	3,723,069	Submersible	FLOW PAK	6,000	170	25	50	No	No	No	No	4	No	1989	13					
62	94-A	9	Baghish Colony Medan	318,348	3,723,131	Submersible	K S B	7,000	260	25	50	Yes	Yes	Yes	No	3	No	1999	11					
63	95-A	9	Badar Colony	317,838	3,723,465	Submersible	K S B	7,000	260	25	50	Yes	Yes	Yes	Yes	4	No	2002	13					
64	95-B	9	Near Pull Badar Colony	318,104	3,723,744	Submersible	FLOW PAK			25	25	Open	No	No	No	3	Yes	2009						
65	96	9	Near Ghosia Masjid Banghish Colony	318,171	3,723,315	Submersible	FLOW PAK	7,000	200	30	50	Yes	Yes	Yes	Yes	4	Yes	1994	9					
66	96-A	9	Near Imam Bargah Banghish Colony	318,170	3,723,425	Submersible	H M A	6,000	240	25	50	Yes	Yes	No	No	4	No	2005	10					
67	96-B	9	Park Baghish Colony (Tanki)	318,224	3,723,316	Submersible	H M A	6,000	260	20	50	Yes	Yes	No	No	4	No	2005	16					
68	97	9	Zia-up-Haq Colony	318,732	3,722,738	Submersible	FLOW PAK	6,000	160	25	50	Yes	Yes	Yes	Yes	4	No	1986	2					
69	97-A	9	Near Wegen Stand Perwadai	318,532	3,722,788	Submersible	K S B	6,000	270	20	50	Yes	Yes	No	No	4	Yes	2007	9					
70	97-B	9	Islam Pura Perwadai	318,644	3,722,782	Submersible	FLOW PAK			20	50	No	No	No	No	3	No	2013						
Detail List of Tube Wells Khaya Ban-e-Sir Syed Rawalpindi UC (10,11, 12)																								
71	102	10	Sector 2 Akab Awan Market	318,558	3,723,918	Submersible	K S B	5,000	160	20	50		Yes	No				1988	12					
72	102-A	10	Sector 2 Akab Awan Market	318,558	3,723,918	Submersible	K S B	8,000	180	20	50		Yes	No				1996	12					
73	103	10	Sector 3 Near Baraf Khana Chowk	318,945	3,723,203	Turbine	K S B	4,000	160	25	25		Yes	Yes				1980	14					
74	160-A	10	Sector 2 Awan Market	318,477	3,723,708	Submersible	MAK	10,000	280	25	50		No	No				2013	12					
75	164-A	10	Sector 2 Tanki	318,672	3,723,437	Submersible	KSB	7,000	240	30	50		Yes	Yes				2002	12					
76	164-B	10	Sector 2 Melaad Pak	318,550	3,723,485	Submersible	GRU FAS	7,000	180	20	25		Yes	No				2006	12					
77	168	10	Sector 2 Allama Iqbal Park	318,366	3,723,585	Submersible	K S B	8,000	240	25	25		Yes	Yes				1988	12					
78	168-A	10	Sector 2 Disposal No. 2	318,500	3,723,327	Submersible	MAK	8,000	280	25			No	No				2014	5					
79	103-A	11	Sector 3	318,721	3,723,096	Submersible	FLOW PAK	8,000	280	25	50		No	No				2012	12					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
80	103-B	11	Sector 3	319,023	3,723,089	Submersible	FLOW PAK	6,000	280	25	50		No	No				2013	12					
81	162-A	11	Sector B.4 Near Mora Shareef Darbar	319,293	3,722,947	Submersible	KSB	7,000	240	20	50		No	Yes				2005	12					
82	162-B	11	Sector B.4 Near Mora Shareef Darbar	319,218	3,722,924	Submersible	MAK	7,000	280	20	25		Yes	No				2008	12					
83	162-C	11	Sector B.4 Near Mora Shareef Darbar	319,343	3,722,781	Submersible	FLOW PAK	8,000	280	25	50		No	No				2013	12					
84	165-A	11	Sector B.4 Near D.H.O	319,020	3,723,295	Submersible	MAK	7,000	220	20	50		Yes	No				2009	12					
85	166	11	Sector B.4 Ayesha Park	319,278	3,723,109	Submersible	GRU FAS	8,000	180	20	50		Yes	Yes				1994	12					
86	166-A	11	Sector 3 Muslim Park	319,097	3,722,842	Submersible	MAK	6,000	280	30			Yes	Yes				1997	12					
87	166-B	11	Sector 3	319,116	3,722,794	Submersible	K S B			25	50	No	No	No	No	3	No	2015						
88	167-A	11	Sector 3 Muslim Park	318,897	3,722,752	Submersible	KSB	3,000	230	20	50		Yes	Yes				2007	12					
89	167-B	11	Sector 3 Girls School	318,935	3,722,650	Submersible	MAK	3,500	240	25	50		No	No				2013	12					
90	100	12	Khaya Ban-E-Sir Syed	318,703	3,724,138	Submersible	KSB	6,000	180	20			Yes	No				1979	12					
91	100-A	12	Sector A.4 Dhoke Naju	319,135	3,724,349	Submersible	GRU FAS	7,000	250	20	50		Yes	Yes				1999	14					
92	101	12	Sector 1 Near Goal Tanki	318,797	3,724,008	Submersible	KSB	6,000	150	20	50		Yes	No				1993	12					
93	101-A	12	Sector 1 Goal Tanki	318,764	3,723,931	Submersible	KSB	7,000	180	30	50		Yes	Yes				1995	12					
94	104	12	Sector A.4 Service Road	319,014	3,724,325	Submersible	GRU FAS	5,000	180	20	50		Yes	No				1993	12					
95	104-A	12	Sector A.4 Main Town	319,367	3,724,521	Submersible	MAK	7,000	220	20	25		Yes	No				2008	12					
96	104-B	12	Sector A.4 Main Town	319,300	3,723,196	Submersible	MAK	8,000	280	25	50		No	No				2013	12					
97	105	12	Sector A.4 Near Graveyard	319,117	3,723,768	Submersible	KSB	7,000	180	20	50		Yes	Yes				1993	12					
98	105-A	12	Sector A.4 Dhoke Naju	319,296	3,723,663	Submersible	GRU FAS	3,500	180	20	25		Yes	No				2008	12					
99	105-B	12	Sector A.4 Near Noorani Masjid	319,220	3,723,857	Submersible	FLOW PAK	7,000	280	25	50		No	No				2013	12					
100	159-A	12	Sector 01 Near Goal Tanki	318,781	3,723,827	Submersible	FLOW PAK	7,000	280	25	50		No	No				2013	12					
101	163-A	12	Sector A.4 Tanki	319,053	3,723,833	Submersible	GRU FAS	7,500	180	25	25		Yes	No				2008	12					
102	163-B	12	Sector A.4 Near Masjid Shah Najaf	318,985	3,723,947	Submersible	FLOW PAK	8,000	280	25	50		No	No				2013	12					
Detail List of Tube Wells West Zone -II (UC's 13-20)																								
103	1-C	13	New Katarian	319,838	3,724,712	Submersible	H M A	5,000	240	30	50	No	No	No	No			2004	8					
104	2	13	Katarian	319,717	3,724,758	Submersible	KSB	8,000	140	25	50	Yes	Yes	Yes	Yes			1992	10					
105	5	13	Quaid Park	320,157	3,724,820	Turbine	KSB	8,000	140	30	50		Yes	No				1989	7					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
106	6	13	Chishtia abad	320,401	3,724,440	Turbine	KSB	8,000	140	30	50		Yes	No				1990	7					
107	6-A	13	Hunza Colony	320,232	3,724,683	Submersible	G/F	5,000	240	20	50		Yes	No				1996	7					
108	108	13	Holly Family	319,655	3,724,095	Submersible	KSB	5,000	280	20	50	Yes	No	No	Yes	3	No	1998	16					
109	111-B	13	Holy Family	319,704	3,723,691	Submersible	K S B	6,000		25	50	No	No	No	No	3	No	1998	8					
110	169	13	Katarian Market	319,918	3,724,382	Submersible	MAK	8,000	240	30	50	No	No	Yes				2009	10					
111	1	14	Katarian Market	319,987	3,724,438	Submersible	KSB	8,000	140	30	50	Yes	Yes	No	Yes			1987	8					
112	1-A	14	New parian	319,855	3,724,314	Submersible	KSB	7,000	240	30	25	Yes	Yes	No	No			2004	8					
113	1-B	14	Katarian Market	319,908	3,724,471	Submersible	FLOW PAK	5,000	240	20	50	No	No	No	No			2004	8					
114	106	14	Muhallah R Sultan	319,629	3,723,298	Turbine	KSB	8,000	140	30	50	No	No	Yes	No	4	No	1988	15					
115	108-A	14	Holly Family	319,654	3,723,863	Submersible	KSB	5,000	130	25	50	Yes	Yes	No	No	4	No	1988	12					
116	108-B	14	Holly Family Road Ghosia Masjid	319,707	3,724,303	Submersible	FLOW PAK	8,000		30	50	No	No	No	No			2013	8					
117	3	15	Katarian Chungi	319,915	3,724,862	Submersible	KSB	8,000	280	25	50	Yes	Yes	No	Yes			1998	10					
118	4	15	Chenar Park	320,114	3,724,643	Turbine	KSB	7,000	150	25	50	Yes	Yes	Yes	No			1981	12					
119	109	15	TMA Nursery	320,159	3,722,843	Submersible	KSB	7,000	140	25	50	No	No	No	No	3	No	1985	5					
120	109-A	15	TMA Nursery	320,197	3,723,076	Turbine	K S B	7,000		25	50	yes	Yes	No	No	4	No	1975	5					
121	110	15	Jamia Park	320,123	3,722,940	Turbine	KSB	7,000	140	30	50	Yes	No	Yes	No	3	No	1987	8					
122	110-B	15	Dispensary			Submersible	G/F	5,000	240	20	50		Yes	No				2003	7					
123	111	15	Holly Family	320,013	3,723,633	Submersible	KSB	6,000	210	30	50	Yes	No	No	No	3	No	2010	8					
124	111-A	15	RDA R.Sultan	319,953	3,723,331	Submersible	G/F	8,000	240	40	50	Yes	Yes	Yes	No	4	No	1988	9					
125	112-B	15	Safaid Tanki	320,241	3,723,248	turbine	G/F	5,000	240	20	50	Yes	Yes	No	No	4	No	2004	8					
126	107	16	Phagwari	319,114	3,723,409	Submersible	G/F	5,000	280	20	25	Yes	Yes	No	No	4	No	2004	10					
127	107-A	16	Commerce College	319,420	3,723,408	Submersible	KSB	5,000	240	25	50	Yes	Yes	Yes	No	4	No	2004	15					
128	107-B	16	Near Commerce College	319,442	3,723,200	Submersible	K S B	7,000		25	100	No	No	No	No	3	No	2012	14					
129	110-A	16	Abbasia Masjid			Turbine	KSB	7,000	130	60	50		Yes	No				1988	5					
130	147	16	Eid Gah	319,818	3,722,782	Submersible	KSB	5,000	240	25	50		Yes	No				2003	9					
131	147-A	16	Eid Gah	319,595	3,722,570	Submersible	G/F	5,000	240	25	50		Yes	Yes				2003	9					
132	147-B	16	Eid Gah	319,858	3,722,886	Submersible	G/F	5,000	240	25	50		Yes	Yes				2003	9					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
133	12	17	Pindora			Turbine	KSB	6,000	150	30	50		Yes	No				1985	11					
134	13	17	Pindora	320,848	3,724,939	Submersible	KSB	10,000	240	40	50		Yes	No				1985	14					
135	13-A	17	Pindora	321,220	3,724,966	Submersible	G/F	5,000	240	25	50		Yes	No				2001	8					
136	13-B	17	Pindora			Submersible	G/F	5,000	280	25	50			No				2007	8					
137	13-C	17	Benazir Chowk PD			Submersible	G/F	7,000	250	25	50		No	No				2009	7					
138	6-B	18	Milia Park	320,112	3,724,309	Submersible	FLOW PAK	5,000	240	20	50	Yes	Yes	No	No			2010	7					
139	7	18	Pindora Chungi	320,520	3,725,242	Turbine	KSB	8,000	130	30	50		Yes	No				1986	12					
140	7-A	18	Pindora Maka CNG			Submersible	G/F	5,000	280	20	50		Yes	No				2006	10					
141	8	18	Punlic Park	321,439	3,724,865	Submersible	KSB	8,000	140	25	50	No	No	No	No	4	No	2014	7					
142	8-A	18	Double Road	321,465	3,725,142	Submersible	Mak	5,000	280	25	50	No	Yes	No	No	4	Yes	2007	6					
143	10	18	Gulshan Dadan	322,126	3,725,492	Submersible	KSB	9,000	280	25	50	No	No	No	No	3	Yes	1988	10					
144	11	18	Dh. Babu Irfan	321,337	3,725,587	Turbine	KSB	8,000	140	30	50		Yes	Yes				1989	11					
145	11-A	18	Mehmood abad	320,940	3,725,434	Submersible	KSB	7,000	240	30	50		Yes	No				1994	11					
146	11-B	18	IGP Road			Submersible	G/F	5,000	240	20	50							2003	11					
147	14	19	Siddique Chowk	320,472	3,724,377	Turbine	KSB	7,000	160	25	50		Yes	No				1986	9					
148	14-A	19	7Th Road			Submersible	G/F	5,000	240	20	50		No	Yes				2002	8					
149	115-A	19	Degree College	320,442	3,723,685	Submersible	KSB	5,000	240	25	50	No	No	No	No	4	No	2005	6					
150	116	19	Masjid Al Furqan	321,311	3,724,078	Submersible	FLOW PAK	8,000	140	40	50	Yes	Yes	Yes	No			1990	8		Physical Site Condation Does Not Allow to Calculate Flow			
151	116-A	19	D-Block	321,133	3,724,094	Submersible	KSB	5,000	240	40	50	Yes	Yes	No	Yes			2002	9		10500	0.8446	647 , 647	65 R
152	117	19	DSP Office	320,794	3,723,974	Turbine	KSB	11,000	140	40	50	Yes	Yes	Yes	No			1988	8					
153	117-A	19	DSP Office	320,743	3,723,910	Submersible	FLOW PAK	5,000	240	20	50	No	No	No	No			2009	8					
154	119	19	Siddique Chowk			Turbine	KSB	10,000	20	25	W		No	No				1988	15					
155	119-A	19	Muzaffar Masjid	320,561	3,723,976	Submersible	K S B	6,000		25	50	Yes	Yes	Yes	Yes			2011	8					
156	120	19	Siddique Chowk			Turbine	KSB	10,000	20	30	W		No	No				1988	15					
157	124	19	Ali Masjid	320,573	3,723,481	Submersible	KSB	7,000	140	40	50	Yes	Yes	No	No			2011	9					
158	121	20	C Market	321,196	3,723,644	Submersible	KSB	8,000	240	40	Public	No	Yes	No	Yes			1986	13		Physical Site Condation Does Not Allow to Calculate Flow			
159	122	20	C Market	321,141	3,723,503	Submersible	KSB	8,000	240	20	50	Yes	Yes	No	No			1989	12		Physical Site Condation Does Not Allow to Calculate Flow			

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
160	125	20	Muslim H School	320,578	3,722,855	Turbine	KSB	6,000	140	30	50	Yes	Yes	Yes	No	6	No	1986	6					
161	125-A	20	Muslim H School	320,356	3,723,012	Submersible	G/F	5,000	240	20	50	Yes	Yes	No	No	4	Yes	2004	12					
162	126	20	Asghar Mall Sch	320,864	3,722,811	Submersible	KSB	7,000	140	25	50	Yes	Yes	No	No	4	Yes	1988	12					
163	126-A	20	Johar Abad	321,023	3,722,792	Submersible	PEC	7,000	130	25	50	No	No	Yes	No	4	No	1990	7					
164	126-B	20	Asghar Mall Sch	320,933	3,722,672	Submersible	K S B	8,000		25	50	No	No	No	No	3	No	2015	8					
165	127	20	Kali Tanki	320,412	3,723,276	Submersible	HMA	10,000	150	30	200	No	No	No	No	3	No	1985	16					
166	128	20	Kali Tanki	320,349	3,723,343	Submersible	KSB	10,000	130	30	200	No	No	No	No	4	No	1985	16					
167	129	20	Kali Tanki	320,391	3,723,341	Submersible	KSB	10,000	130	30	200	Yes	No	No	No	4	No	1984						
168	129-A	20	Kali Tanki	320,304	3,723,284	Submersible	KSB	12,000	240	40	200	No	No	No	No	4	No	1992	16					
169	130	20	Asghar Mall Sch	320,786	3,722,577	Submersible	KSB	6,000	130	25	30	Yes	Yes	No	Yes	4	No	1988	6					
	Detail List of Tube Wells East Zone -1 + Sohan																							
170	15	21	New DPS Shamas abad	322,265	3,725,147	Submersible	K.S.B	5,000	270	25	50	Yes	Yes	Yes	No			2004	10					
171	15-A	21	Near Blind School Shamasabad	322,476	3,725,094	Submersible	FLOW PAK	5,000	270	25	50	Yes	Yes	Yes	No			2000	10					
172	15-B	21	G Girls College Shamasabad	322,653	3,724,984	Submersible	M.A.K	8,000	180	25	50	No	Yes	No	No			2013	10					
173	15-D	21	Main Bazar Dh. Kala Khan	322,705	3,725,188	Submersible	MAK	5,000	290	25	50	No	No	No	No			2012	8					
174	18	21	Madina Town DH.Kala Khan	322,354	3,725,460	Submersible	M.A.K	7,000	230	25	50	No	No	No	No			1986	7					
175	18-A	21	Near Ohjri Camp	322,367	3,725,542	Submersible	K.S.B	6,000	240	25	50	Yes	No	Yes	No			2003	12					
176	17	21	Near High Way	323,152	3,725,485	Submersible	M.A.K	8,000	290	30	50	Yes	Yes	No	No			1988	12					
177	17-A	21	Awan Colony Dh. Kala Khan	328,821	3,725,506	Submersible	G FOS	5,000	240	25	50	No	No	No	No			2006	8					
178	17-C	21	Near Raja Tajamal House	322,905	3,725,515	Submersible	M.A.K	5,000	290	25	50	No	No	No	No			1986	Abundant					
179	18-B	21	Near Raja Tajamal House	322,930	3,725,544	Submersible	MAK	10,000	180	30	50	Open	No	No	No			2013	10					
180	18-C	21	Gulistan e Jinnah	322,562	3,726,064	Submersible	F/PAK	8,000	180	25	50	No	No	No	No			2013	8					
181	15-C	22	Taxi Stand DH. Kala Khan	322,754	3,724,971	Submersible	F/PAK	8,000	290	25	50	Open	No	No	No			2012	10					
182	16	22	Qayyum abad Dh. Kala Khan	323,003	3,725,034	Submersible	K.S.B	9,000	190	30	50	Yes	Yes	Yes	No			1984	13					
183	16-A	22	Murree Hazara Colony	323,381	3,725,037	Submersible	PECO	8,000	160	30	50	Yes	Yes	Yes	Yes			1988	12					
184	16-B	22	Farooq E Azam Road	323,040	3,724,540	Submersible	M.A.K	8,000	180	30	50	No	No	No	No			2013	7					
185	17-D	22	Jinnah Town Dh. Kala Khan	323,245	3,725,251	Submersible	F/PAK	5,000	290	25	50	No	No	No				2012	12		Physical Site Condation Does Not Allow to Calculate Flow			

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
186	24-C	22	Model Colony Dh. Kala Khan	323,209	3,724,710	Submersible	K.S.B	8,000	240	25	50	Yes	Yes	Yes	No			2005	11					
187	7	23	A-Block Gunj Bakhsh Road	321,993	3,724,375	Submersible	MAK	5,000		25	50	Yes	Yes	Yes	No			2000	9					
188	7-A	23	A-Block Gunj Bakhsh Road	322,039	3,724,332	Submersible	M.A.K	5,000	270	25	50	Yes	Yes	Yes				2000	9					
189	19	23	Kiyani Bazar	322,300	3,724,223	Submersible	G FOS	9,000	240	25	50	No	Yes	No				1996	8					
190	19-B	23	Magistrate Colony	321,991	3,723,739	Submersible	F/PAK	9,000	280	25	50	No	No	No	No			2012	10					
191	20	23	Dh. Piracha OHR	322,182	3,723,906	Submersible	M.A.K	5,000	220	25	50	Yes	Yes	No	No			1990	10					
192	174	23	Dh. Kashmiri an	322,811	3,724,236	Turbine	PECO	8,000	160	30	50	Yes	Yes	Yes	No			1992	12					
193	175	23	Bilal Colony Service Road	322,522	3,724,711	Submersible	K.S.B	9,000	180	30	50	Yes	Yes	No	No			1988	13					
194	175-A	23	Bilal Colony	322,694	3,724,501	Submersible	G FOS	5,000	250	25	50	Yes	Yes	Yes	No			2006	11					
195	17-B	24	Ali Abad	322,685	3,723,872	Submersible	K.S.B	8,000	180	30	50	Yes	Yes	Yes	No			1992	10					
196	23	24	DK PunNoo	322,805	3,723,592	Turbine	K.S.B	8,000	180	25	50	Yes	Yes	Yes	No			1992	9					
197	23-A	24	Dh. Ali Akbar	323,134	3,723,751	Submersible	K.S.B	8,000	270	25	50	No	No	No	No			2013	6					
198	24	24	Ilyas Town Khana Kak	323,295	3,724,240	Submersible	G FOS	5,000		25	50	Yes	Yes	No	Yes			2006	11					
199	24-A	24	Khana Kak	323,645	3,724,185	Submersible	M.A.K	9,000	260	25	50	Yes	Yes	No				1992	14					
200	24-B	24	Ilyas Town Khana Kak	323,649	3,724,122	Submersible	MAK	5,000	230	25	50	Yes	Yes	Yes	No			1992	14					
201	24-D	24	Shair Ahmad Rd Khana kak	323,368	3,723,971	Submersible	FLOW PAK	8,000	180	25	50	No	No	No	No			2013	6					
202	25	24	Khajoor Wali Gali	322,767	3,723,601	Turbine	K.S.B	9,000	170	25	50	Yes	Yes	Yes	No			1993	9					
203	19-A	25	Shaheen Colony	322,161	3,723,702	Submersible	K S B	5,000	290	25	50	No	No	No	No			2010	10					
204	25-A	25	Muhallah Choudrian S/Road	322,535	3,723,815	Submersible	G FOS	5,000	200	25	50	No	No	No	No			2006	11					
205	26	25	Sadiq abad Muhammadi Masjid	322,251	3,723,447	Submersible	G FOS	8,000	180	25	50	Yes	Yes	Yes	Yes			1994	14					
206	26-A	25	Ghazali Road	321,918	3,723,443	Submersible	K S B			25	50	No	No	No	No			2014	10					
207	21	26	A-Block 6th Road	321,859	3,724,037	Submersible	G FOS	5,000		40	100	No	Yes	No	No			2004	12					
208	22	26	A-Block 6th Road	321,841	3,724,049	Turbine	Siemens	8,000		40	100	No	No	No	No			2004	12					
209	35	26	Afandi Colony	321,851	3,722,838	Submersible	F/PAK	6,000		30	50	Yes	Yes	No	No			2006	10					
210	35-A	26	Afandi Colony	321,998	3,722,812	Submersible	G FOS	6,000		30	50	Yes	Yes	Yes	No			2011	10					
211	36	26	C-Block	321,788	3,723,052	Submersible	K.S.B			30	50	Yes	Yes	Yes	Yes			1995	10					
212	36-A	26	Bangreel Masjid	322,228	3,723,258	Submersible	M.A.K			25	50	Yes	Yes	No	No			2004	8					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
213	36-B	26	C-Block D. Kaku Shah	321,585	3,722,811	Submersible	M.A.K			25	50	No	Yes	No	No			2000	10					
214	170	26	Arshi Masjid	321,675	3,723,402	Submersible	M.A.K	6,000		25	50	No	Yes	No	No			2013	12					
215	27	27	Muhammedi colony muslim town	323,371	3,723,092	Submersible	K S B	7,500		25	50	Yes	Yes	Yes	No	4	Yes	1987	16		6040	1.172	808 , 812	70 R
216	27-A	27	Mohammedi colony	323,268	3,723,574	Submersible	F/PAK	5,000		30	50	Yes	Yes	No	No	3	Yes	1986	16		3818	1.4234	761 , 762	65 R
217	28	27	Azher Satti Plat	323,012	3,723,081	Submersible	HMA	6,000		25	50	Yes	Yes	Yes	No	4	Yes	2007	10		5060	0.9716	765 , 766	90 R
218	28-A	27	Haji chowk muslim town	323,160	3,723,153	Submersible	K S B	6,000		25	50	Yes	Yes	No	No	4	No	2013	12		Physical Site Condation Does Not Allow to Calculate Flow			
219	28-B	27	Osmani Masjid Muslim Town	322,952	3,722,790	Submersible	HMA			25	50	No	No	No	No	3	Yes	1998	16		3244	1.197	803 , 805	80
220	29	27	Muslim town behind PAF flates	323,375	3,723,147	Turbine																		
221	29-A	27	Capt Riaz Mehmood	323,084	3,723,042	Submersible	FLOW PAK			25	50	No	No	No	No	3	No	2012	6		3478	1.2793	847 , 850	65 R
222	New-4	27	Yousif colony muslim town	323,232	3,723,932	Submersible	MAK			25	50	No	No	No	No	3	No	2014	7		Physical Site Condation Does Not Allow to Calculate Flow			
223	188	27	Haji chowk muslim town street No.10	322,767	3,722,853	Submersible	K S B			25	50	No	No	No	No	4	No	2008	10		6660	1.288	841 , 842	70
224	31	28	Muslim town streer No.2-B	322,404	3,722,530	Submersible		7,000		25	50	Yes	Yes	Yes				1985	18					
225	31-A	28	Raja qadeer street	322,055	3,722,649	Submersible	K S B	6,000		25	50	Yes	Yes	Yes	No	4	No	2004	10					
226	30	28	Service road muslim town	322,641	3,722,423	Submersible	MAK	5,000		30	50	Yes	Yes	Yes	Yes			1988	15					
227	30-A	28	Front area of azam hotel chaudhery street	322,665	3,722,931	Submersible	F/PAK	6,000		25	50	Yes	No	No	No			2003	12					
228	31-B	28	Gali No. 05	322,569	3,722,666	Submersible	K S B			25	50	No	No	No	No			2013	8					
229	31-C	28	Gali No. 03 Muslim Town(New)	322,512	3,722,864	Submersible				25	50	No	No	No	No			2014	8					
230	32	29	Bahari colony tanki	323,170	3,722,679	Submersible	Vicyoria	5,000		25		Open	Yes	Yes	No	3	No	2014	12		2250	0.834	774 , 778	84
231	32-A	29	Allah wala chowk near chongi No.8 M.Town	323,199	3,722,402	Submersible	K S B	7,000		25	50	Yes	Yes	No	No	4	Yes	2005	14		4730	0.9178	757 , 758	80
232	32-B	29	Behari Colony Park	323,292	3,722,721	Submersible	K S B	6,000		25	50	Open	No	No	No	4	No	2009	10		Physical Site Condation Does Not Allow to Calculate Flow			
233	33-C	29	Khurram Colony	323,040	3,722,264	Submersible	HMA	4,000		20	50	Yes	Yes	Yes	No	4	Yes	2011	14		4590	0.8986	800 , 801	82
234	32-D	29	Khuram Colony Near Zahid KS.	323,148	3,722,128	Submersible	K S B			25	50	Open	No	No	No	3	No	2014	6		4490	1.67	884 , 885	82
235	33	29	Masjid sultan muslim town	323,226	3,722,332	Turbine	K S B	6,000		25	50	Yes	Yes	No	Yes	6	No	1988	11		10800	0.8733	800 , 801	82
236	33-A	29	Khurram colony street No.28	322,941	3,722,096	Submersible		5,000		25	50	Open	No	No	No	4	No	1999	12		Physical Site Condation Does Not Allow to Calculate Flow			
237	34	29	Khurram Colony	322,965	3,722,497	Submersible	Peco			25	50	No	No	No	No	4	No	2013	13		Physical Site Condation Does Not Allow to Calculate Flow			
238	New-5	29	Khurram colony chungi No.8 muslim town	323,043	3,722,321	Submersible																		
239	37	30	Kuri road chah sultan	321,397	3,722,396	Submersible		8,000		25	50	No	No	Yes	No	3	Yes	2009	12					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
240	40	30	Chamrah godam	321,521	3,721,883	Submersible		6,000		20	50	No	Yes	No	Yes	4	No	1988	10					
241	New-20	30	Ammarpura Chowk	321,057	3,722,108	Submersible																		
242	37-A	30	Raja Israr	321,615	3,722,214	Submersible	FLOW PAK	6,000		25	50	No	No	No	No	3	No	2011	11					
243	38	30	Amur Pura	321,081	3,722,127	Submersible		6,000		25	50	No	Yes	No	No	4	Yes	2007	12					
244	38-A	30	Amur Pura	321,249	3,722,153	Submersible	HMA	6,000		25	50	No	No	Yes	No	4	Yes	2011	12					
245	39	31	Bund khana road	321,665	3,722,217	Submersible		7,000		25	50	No	Yes	No	No	3	No	1985	11					
246	39-A	31	Tamasab abad	321,898	3,721,938	Submersible		6,000		20	50	No	Yes	Yes	No	3	No	2006	10					
247	45	31	Hukam Dad Muhallah	321,669	3,721,660	Submersible	K S B	7,000		25	50	Yes	Yes	No	No	4	Yes	2004	12					
248	45-A	31	Dhok hukam dad	321,324	3,721,455	Submersible	DST	6,000		25	50	No	No	Yes	No	4	Yes	2007	10					
249	45-B	31	New Ishtiaq Mirza House	321,580	3,721,425	Submersible	FLOW PAK	6,000		20	50	Open	No	No	No	3	Yes	2012	12					
250	New-18	31		321,340	3,721,435	Submersible																		
251	37-B	31	Lala Israr	321,743	3,722,068	Submersible	MAK	6,000		25	50	No	No	No	No	3	No	2013	4					
252	43	32	Waris Khan Sarfraz Road	320,741	3,721,629	Submersible		6,000		25	50	Yes	Yes	Yes	No	4	No	1988	12					
253	44	32	Dhoke Hukam Daad	321,329	3,721,641	Submersible		5,000		25	50	Yes	Yes	No	No	4	Yes	1986	12					
254	42	32	Ammar pura	321,086	3,721,755	Submersible	K S B	5,000		25	50	No	No	No	No	4	No	2012	12					
255	43-A	32	Zuffar-Ul-Haq Road	320,899	3,721,536	Submersible	K S B	6,000		15	50	Yes	No	Yes	No	3	No	2012	10					
256	43-B	32	Waris Khan Sarfraz Road	320,740	3,721,555	Submersible		6,000		25	50	Open	No	No	No	3	Yes	2013	10					
257	44-A	32	Muhallah New Amar Pura	321,406	3,721,731	Submersible		5,000		25	50	No	No	No	No	3	No	2010	10					
258	1	Sohan	Sohan Village	323,939	3,726,204	Submersible	M.A.K	16,000	130	40	200	Yes	Yes	Yes	No			2012	10					
259	1-A	Sohan	Sohan Village	323,916	3,726,287	Submersible	M.A.K	16,000	150	40	200	Yes	Yes	No	No			2010	6					
260	2	Sohan	Sohan Village	324,009	3,726,080	Submersible	M.A.K	16,000	100	40	200	Yes	Yes	No	No			1973	6					
261	4	Sohan	Sohan Village	323,991	3,726,327	Submersible	TSK	16,000	140	40	200	Yes	Yes	No	No			1973	6					
262	7	Sohan	Sohan Village	324,066	3,725,923	Submersible	TSK	16,000	150	40	50	Yes	Yes	No	No			2000	6					
263	8	Sohan	Sohan Village	324,273	3,725,884	Submersible	TSK	16,000	150	40	50	Yes	Yes	No	No			2000	6					
264	9	Sohan	Sohan Village	324,226	3,725,743	Submersible	TSK	16,000	150	40	50	Yes	Yes	No				2000	6					
265	10	Sohan	Sohan Village	324,179	3,726,097	Submersible	TSK	16,000	150	40	50	Yes	Yes	No	No			2000	6					
266	11	Sohan	Sohan Village	324,245	3,726,094	Submersible	TSK	16,000	150	50	50	Yes	Yes	No	No			2000	6					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
267	12	Sohan	Sohan Village	324,298	3,726,121	Submersible	TSK	16,000	150	40	50	Yes	Yes	No	No			2000	6					
268	5	Sohan	Sohan Village	323,787	3,726,205	No	No	No	No	No	50	Yes	No	No				1973	Abundant					
269	6	Sohan	Sohan Village	323,660	3,726,414	No	No	No	No	No	50	Yes	No	No				1973	Abundant					
	Detail List of Tube Wells Zone East-I, UC (33, 34, 35)																							
270	131	33	Kohati Bazar	320,541	3,722,167	Submersible	MAK	6,000	210	25	50	Yes	Yes	Yes	Yes	3	No	1992	3					
271	131-A	33	Mohallah Feroozpura	320,755	3,722,248			6,000	270	25	50	No	Yes	Yes	No	3	Yes	1988	6					
272	132	33	Kohati Bazar	320,515	3,722,080	Turbine	K S B	7,000	190	25	50	Yes	Yes	Yes	Yes	3	Yes	1999	6					
273	133	33	Banni Chowk	320,244	3,721,878	Submersible	K S B	7,000	320	25	50	No	Yes	Yes	No	3	No	2015	4					
274	133-B	33	Angat Pura Near Sheikh Tikka	320,180	3,722,387	Submersible	K S B	7,000	260	25	50	No	No	No	No	3	No	2012	6					
275	148-B	33	Asghar Mall Road Near Hayat Wali Clinic	320,656	3,722,517	Submersible	K S B	6,000	270	25	50	Open	No	No	No	3	No	2012	4					
276	148	34	Abdul Rauf S/O Shahzada Khan (R) 0300-5209352	320,236	3,722,133	Submersible	K S B	5,000	270	30	50	Yes	Yes	Yes	Yes	3	Yes	1990	6					
277	148-A	34	Mohalla Hari Pura	320,224	3,722,126	Submersible	MAK	5,000	240	25	50	Yes	No	Yes	No	4	Yes	1985	6					
278	154	35	Doshera Ground	319,591	3,722,291	**Abundant**																		
279	154-B	35	Eid Gah Scheme	319,709	3,722,355							Open						2007						
280	154-C	35	Dusra Ground	319,604	3,722,262				370									2007	8					
281	155	35	Imam Bargh Road	319,958	3,722,171				300										4					
282	155-A	35	Janglaat Road	320,100	3,722,129	Submersible	K S B	4,000	240	20	50	Yes	Yes	Yes	No	3	Yes	2004	4					
	Detail List of Tube Wells West Zone, Sector-I UC (35-38)																							
283	71	36	Near Dispensary Mohan Pura	319,337	3,720,386	Submersible	K S B	6,000	250	25	50	Yes	Yes	Yes	No	4	No	1995	4					
284	71-A	36	Arjun Nagar	319,318	3,720,052	Turbine	K S B	6,000	180	30	50	Yes	Yes	No	No	4	No	1998	3					
285	72-A	36	Girls College Mohan Pura	319,253	3,720,615	Submersible	K S B	7,000	260	25	50	Yes	Yes	Yes	Yes	4	No	2001	12					
286	140	37	Gulshan Abad Akaal Garr	319,243	3,721,820	Submersible	K S B	5,000	260	25	50							1991	12					
287	142	37	Murgi Mandi Bhagh Sardraa	319,357	3,722,060	Submersible	KSB	6,000	260	20	50							1995	7					
288	142-A	37	Kashmiri Colony Bhagh Sardraa	319,247	3,721,954	Submersible	FLOW PAK	7,000	270	20	25							2007	6					

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																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
289	143	37	Safdar Abad Girls High School	318,909	3,721,995	Submersible	FLOW PAK	7,000	190	20	50	Yes	Yes	No				1986	8					
290	144-A	37	Near Nullah Lai Safdar Abad	319,081	3,722,015	Submersible	FLOW PAK			20	50	No	No	No				2013	6					
291	145	37				Submersible	K S B	5,000	250	20	50							1988	Abundant					
292	145-A	37	Zayarat Buduh Shah Bhagh Sardraa	319,315	3,722,134	Submersible																		
293	146	37	shagufta Colony Dhoke Dalal	319,067	3,722,380	Turbine	K S B	6,000	190	25	50	Yes	Yes	No				1989	10					
294	146-A	37	Near Graveyard Dhoke Dalal	319,349	3,722,521	Submersible	K S B	7,000	260	20	50	Yes	Yes	No				2007	8					
295	72-B	38	Sagri Scheme Akab Nawlti Cinema	319,103	3,720,879	Submersible	FLOW PAK	6,000	260	20	25	Yes	Yes	No				2007	6					
296	140-A	38	Tire Bazar Near Khursheed Cinema	319,558	3,721,400	Submersible	PECO	5,000	190	30	25							1999	4					
297	140-B	38	Near Police Station Gang Mandi	319,123	3,721,401	Submersible	K S B	6,000	270	20	50							2007	8					
298	141	38	Ghaznawi Road Bhagh Sardraa	319,525	3,721,729	Submersible	K S B	6,000	170	40	50							1989	12					
299	141-A	38	Near Nullah Lai Muhallah Akaal Garr	319,101	3,721,838	Submersible																		
	Detail List of Tube Wells Zone East-I, UC (39-46)																							
300	135-A	39	Committee Chowk					3,500		25									6					
301	136-A	39	Chatia Hatia	320,218	3,721,160	Submersible	K S B	5,000	240	25	50	No	Yes	Yes				2003	12					
302	151	39	Bhabra Bazar	320,244	3,721,351	Submersible	K S B	6,000	260	25	50	No	Yes	Yes				1986	12					
303	152-A	39	Landa Bazar	320,081	3,721,131	Submersible	K S B	6,000	260	20	50	No	No	No				2005	12					
304	137-A	40	Klam Bazar	319,814	3,721,441	Submersible	K S B	7,000	260	25	20	No	No	No	No	3	No	2005	18					
305	138-A	40	Prona Qalia	319,814	3,721,441	Submersible	K S B	2,000	250	25	25	Yes	No	Yes	No	3	No	1999	4					
306	138-B	40	Bhabra Bazar	320,073	3,721,426	Submersible	K S B	7,000	280	25	25	No	No	No				2008	16					
307	152	40	Lal Havailee	319,862	3,721,200	Submersible	K S B	5,000		20	25	No	Yes	No	No	3	Yes	1984	12					
308	152-B	40	Mission School Raja Bazar	319,750	3,721,035	Submersible	FLOW PAK	6,500	280	25	50	Yes	No	No	No	4	Yes	2010	7					
309	133-A	41	Said Pur Gate	320,182	3,721,854	Submersible	K S B	7,000		25	25	No	No	No	No	4	No	1998	10					
310	150	41	Shah Nazar Pull	319,842	3,721,684	Submersible	MAK	7,000	260	25	50	No	Yes	Yes	No	4	Yes	1988	11					
311	150-A	41	Mohallah Naharia	320,084	3,721,735	Submersible	HMA	6,000	260	20	25	Open	Yes	Yes	No	4	Yes	2010	4					
312	46	42	Millat Colony	320,889	3,721,129	Submersible	K S B	6,000	260	25	50	Yes	Yes	Yes				1988	14					
313	46-B	42	Zafar UL Haq Road	320,599	3,721,231	Submersible	K S B	6,000	260	25	50	No	Yes	Yes				2007	12					
314	50-A	42	Rawal Hotal	320,728	3,720,919	Submersible	K S B	7,000	220	25	25	No	No	Yes				2015	8					
315	52-A	42	Umer Road	320,772	3,720,533	Submersible	K S B	6,000	250	25	25	No	No	No				1990	16					
316	56-A	42	Dh. Elahi Bakhsh	320,901	3,720,713	Submersible	K S B	5,000	240	25	50	Yes	Yes	No				2001	12					
317	56-B	42	Shah De Talian	320,624	3,720,633	Submersible	K S B	7,000	270	25	50	No	No	No				2005	12					

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi.
WASA Rawalpindi

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Make	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlorinator	Filtration Plant	Strata Chart	Delivery Pipe Dia (Inch)	Pressure Gauge	Year of Construction	Total Pumping Hours		Flow Meter Values			
																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
318	47-A	43	Qasim Abad	321,166	3,721,022	Submersible	FLOW PAK	6,000	240	20	50	No	No	No				2010	16					
319	48-A	43	Talab Tailian	321,022	3,721,317	Submersible	K S B	8,000	250	25	50	Yes	Yes	Yes				1992	14					
320	51	43	National Town Dhoke Khaba	321,668	3,721,001	Submersible	MAK	6,000	250	30	50	Yes	Yes	No	Yes	3	Yes	1985	10					
321	51-A	43	National Town Dhoke Khaba	321,592	3,720,815	Submersible	K S B	6,000	270	25	50	Yes	Yes	No	No	3	No	2007	10					
322	53	43	Qasim Abad	321,712	3,721,233	Submersible	K S B	6,000	300	25	50	Yes	Yes	No	Yes	3	No	1988	12					
323	53-A	43	Qasim Abad	321,392	3,721,261	Submersible	K S B	6,000	290	25	50	Yes	Yes	Yes	Yes	3	No	2005	12					
324	54-B	43	Gullberg Town	321,691	3,720,615	Submersible	K S B	5,000		25	25	Open	No	No	No	4	No	2007	5					
325	47	44	Zeenat Sikandria School	321,071	3,720,980	Submersible	K S B	4,000	240	25	50	Yes	Yes	Yes				1988	14					
326	50-B	44	Bilal Masjid Umer Road	320,914	3,720,883	Submersible	K S B	4,000		25	50	No	No	No				2007	8					
327	52	44	Dhoke Elahi Bakhsh	321,032	3,720,410	Submersible	K S B	6,000	270	25	25	No	Yes	Yes				2014	14					
328	52-B	44	Bilal Masjid Umer Road	321,072	3,720,283	Submersible	K S B	6,000	270	25	50	No	No	No				2012	14					
329	54	44	Dhoke Farman Ali	321,499	3,720,372	Submersible	Abundant	5,000	290	25	50	Yes	Yes	No	Yes	3	No	1990	Abundant					
330	54-A	44	Dhoke Farman Ali	321,582	3,720,581	Submersible	K S B	6,000	270	25	25	Open	No	No	No	4	No	2007	15					
331	54-C	44	Fazal Abad Gali No.3	321,364	3,721,507	Submersible	FLOW PAK	7,000	270	25	50	No	No	No	No	3	No	2012	15					
332	58	45	Ariya Mohalla	321,012	3,720,204	Submersible	K S B	7,000	240	30	50	Yes	Yes	Yes				1995	14					
333	58-B	45	Islamia High School	320,665	3,719,950	Submersible	K S B	8,000	260	25	50	Yes	No	No	No	3	No	2008	4					
334	60	45	Ghalla Godam	321,147	3,719,727			6,000	300	25									10					
335	60-A	45	Nighat Abad	321,119	3,719,308			6,000	260	25									12					
336	60-B	45	Moti Mehal	320,678	3,719,638			5,000	260	25									12					
337	60-C	45	Milad Chowk Chaman Zar Colony	320,912	3,719,387			6,000	280	25									8					
338	61	45	Hakeem Abid	321,438	3,720,167			6,000	270	25									12					
339	61-A	45	Muslim Colony	321,167	3,720,055			7,000	260	25									12					
340	61-B	45	Muslim Colony	321,327	3,719,975			6,000	270	25									10					
341	61-C	45	Javed Colony Tipu Road					6,000	270	25									10					
342	67	45	Civil Line	320,736	3,718,341	Submersible	K S B	6,000	280	30	50	Open	No	No	No	3	Yes	2014	8					

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi.
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Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Make	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlorinator	Filtration Plant	Strata Chart	Delivery Pipe Dia (Inch)	Pressure Gauge	Year of Construction	Total Pumping Hours		Flow Meter Values			
																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
343	67-A	45	New Civil Line	320,658	3,718,691	Submersible	K S B	6,000	270	25	50	No	No	No	No	3	No	2012	10					
344	62	46	Complaint Office Liaquat Bagh					8,000		25														
345	62-A	46	Opp . Garden College Liaqat Road	320,281	3,720,290	Submersible	K S B	7,000		25	50	Open	No	Yes	No	4	Yes	2001	16					
346	64	46	Near TMA Office Liaquat Road	320,152	3,720,336	Submersible	MAK	6,000	260	25	50	Yes	Yes	Yes	Yes	4	Yes	1983	18					
347	64-A	46	DAV College Road	320,115	3,720,670	Submersible	HMA	7,000	290	20	50	No	Yes	Yes	No	4	No	1999	14					
348	64-B	46	Near Moti Masjid Liaquat Road	319,937	3,720,577	Submersible	K S B	6,000	240	25	25	Yes	Yes	Yes	No	4	No	2004	13					
349	64-C	46	College Chowk	320,206	3,720,773	Submersible	K S B	7,000	290	20	25	No	No	Yes	No	4	No	2012	12					
350	69	46	Chachi Mohallah Tanki	320,366	3,720,805	Submersible	K S B	7,000	260	25	100	Yes	Yes	Yes	Yes	4	No	1994	12					
351	69-A	46	Muree Road	320,521	3,720,479	Submersible	K S B	6,000	300	25	50	Yes	Yes	Yes	No	4	Yes	2007	16					
352	70	46	Fowara Chowk	319,624	3,720,847	Submersible	HMA	7,000		25	50	No	No	No	No	4	No	1992	14					
353	70-A	46	Usman Pura	319,622	3,720,561	Submersible	K S B	7,000	270	25	50	Yes	Yes	Yes	No	4	No	1992	10					
354	70-D	46	Nia Mohallah	320,022	3,720,859	Submersible	K S B	7,000	290	20	50	No	No	Yes	No	4	No	2012	12					
LIST OF TUBEWELLS IN NEWLY ADDED UC'S																								
355	Nil	74	Nemat Muhallah Haroon Chowk Shakrial	323,366	3,723,717	Submersible				15	50	Yes	No	Yes	No	4	No	2007	12		5975	1.1625	738 , 739	77
356	Nil	75	Muhallah Islam Nagar Near Al-Ghani Service Station	324,356	3,723,432	Submersible				25	30	Steel Cage	No	No	No	4	Yes	2004	14		6455	1.25	789 , 793	64
357	Nil	75	Said Pur Town Shakrial	324,307	3,723,507	Submersible	Siemens			15	25	Yes	No	No	Yes	4	Yes	2003	13		Physical Site Condation Does Not Allow to Calculate Flow			
358	Nil	76	AlNoor Colony Sector-I Satti CNG	324,042	3,722,542	Submersible				30	50	Steel Cage	No	No	No	4	No	2007	10		8250	1.6	783 , 784	89
359	Nil	76	Abdullah Masjid Street Gali No.2	324,265	3,722,784	Submersible				30	25	Steel Cage	No	No	No	4	Yes	2013	12		Physical Site Condation Does Not Allow to Calculate Flow			
360	Nil	76	Raja Town Tarali Adda	324,399	3,722,745	Turbine	Siemens			30	25	No	No	No	No	4	No	2010	13		Physical Site Condation Does Not Allow to Calculate Flow			
361	Nil	76	Masjid Saida Ayisha Anwar Colony	324,433	3,722,876	Submersible				30	50	Yes	No	No	No	4	Yes	2006	13		6996	1.35	793 , 792	82
362	Nil	76	Wasa Complaint Office AlNoor Colony	324,227	3,722,474	Turbine	K S B			30	50	Yes	No	Yes	No	6	No	1993	16		9100	1.71	728 , 729	72
363	Nil	76	Mir Pur Housing Scheme III AlNoor Colony	324,465	3,722,452	Submersible	K S B			30	50	Yes	No	No	Yes	4	No	2004	12		8335	1.625	741 , 742	90
364	Nil	76	Pir Jamsheed Colony Jandad Town	324,542	3,722,181	Turbine				30	50	Yes	No	No	No	4	No	1994	16		9020	0.72	788 , 789	79
365	Nil	77	New Abadi Dhoke Ganghal Graveyard	324,844	3,721,597	Submersible	Siemens			20	25	No	No	No	No	3	No	2004	16		2690	1.96	806 , 808	76
366	Nil	77	Dhoke Lalihal	325,295	3,721,046	Submersible	HMA			20	50	Yes	No	No	No	4	Yes	1999	8		5900	1.14	767 , 768	88
367	Nil	77	Azeem Town Dhoke Lalihal	325,469	3,721,002	Submersible				30	50	Yes	No	No	No	4	No	1989	4		2690	1.96	806 , 808	76
368	Nil	77	Gulzar e Qaid	326,131	3,719,502	Turbine	Siemens			25	25	Steel Cage	No	No	No	4	No	2006	16					
369	Nil	78	Shaheen Town	325,629	3,720,675	Submersible				25	25	Yes	No	No	No	4	No	2005	16					

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi.
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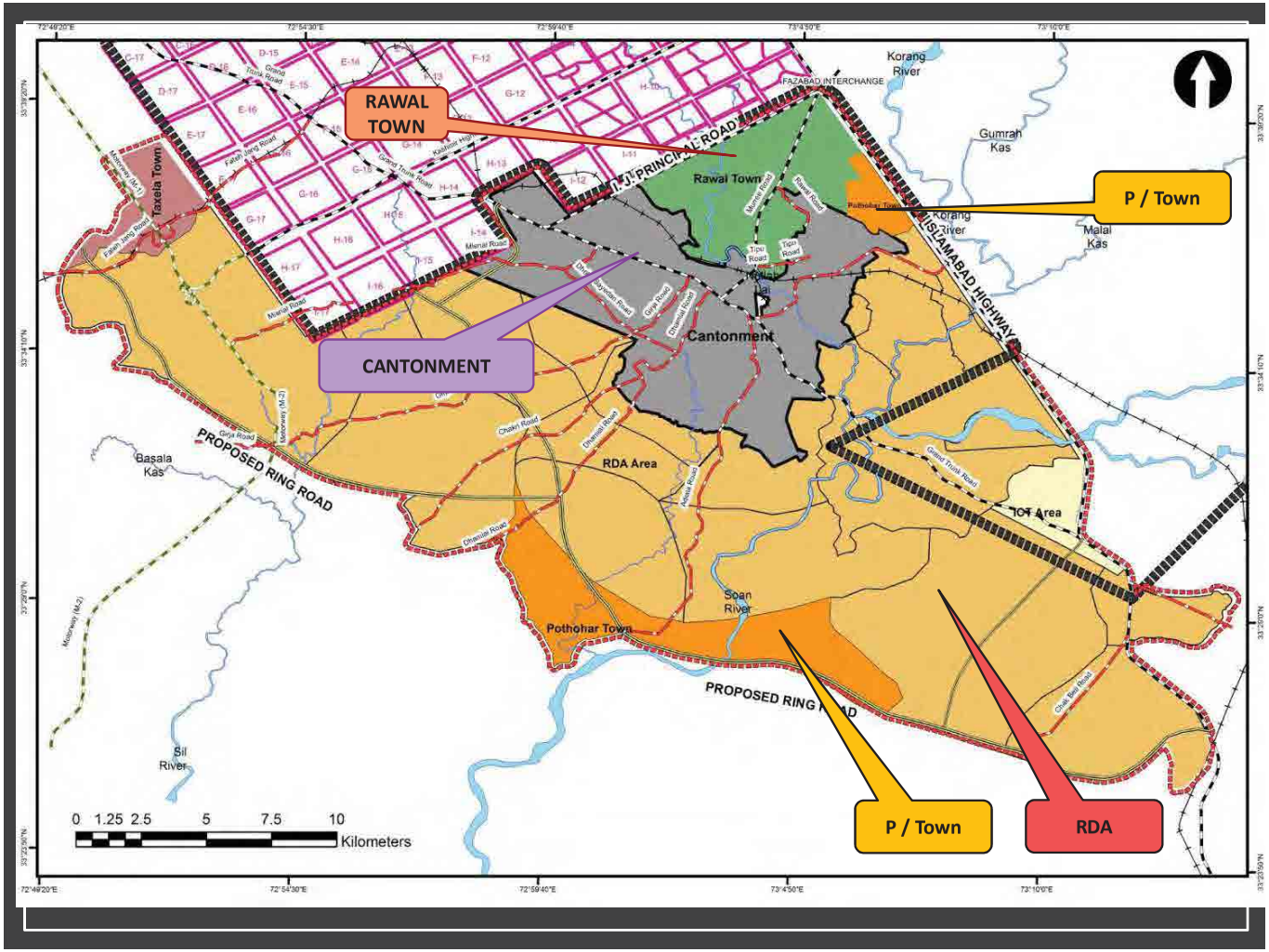
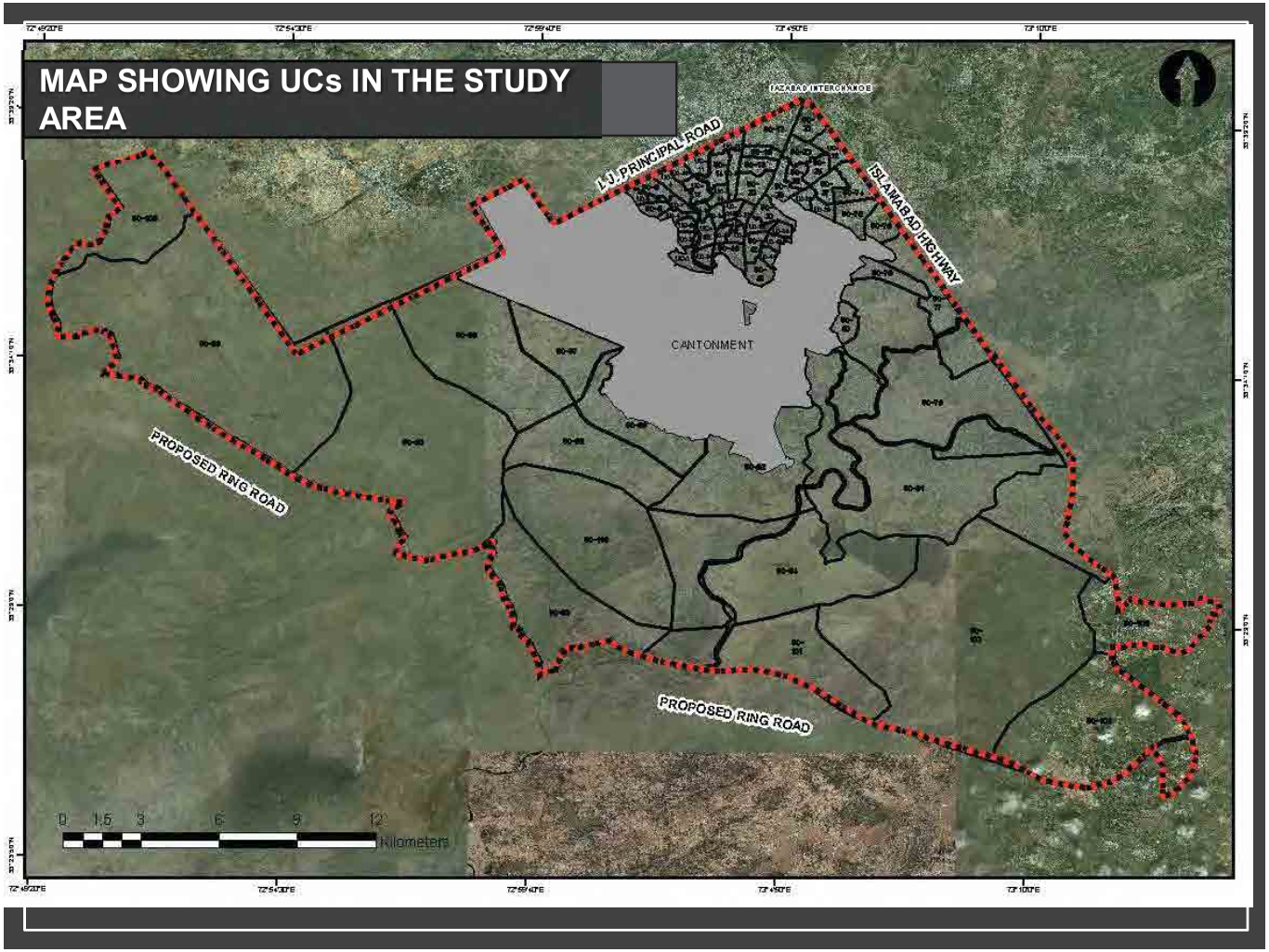
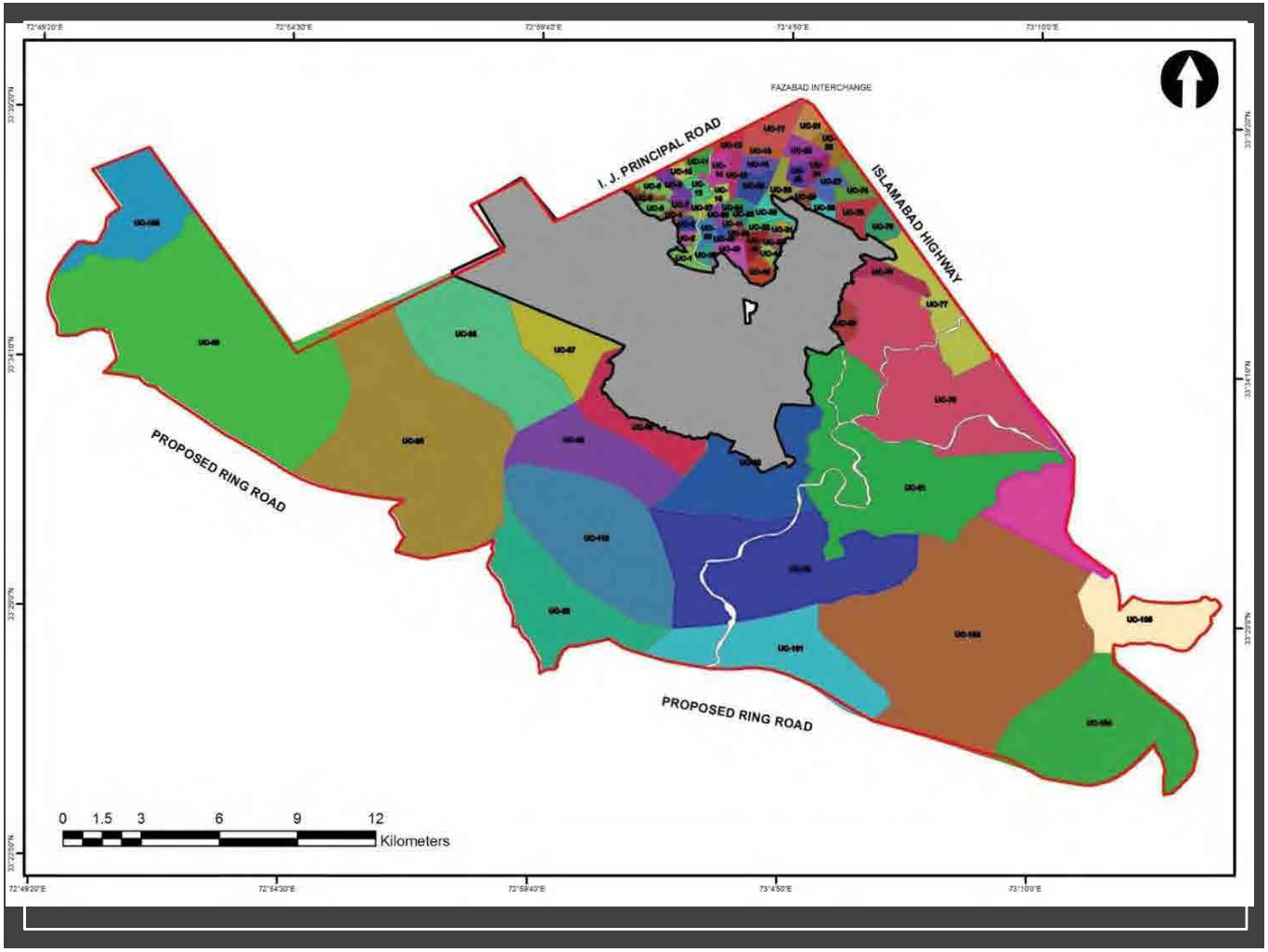
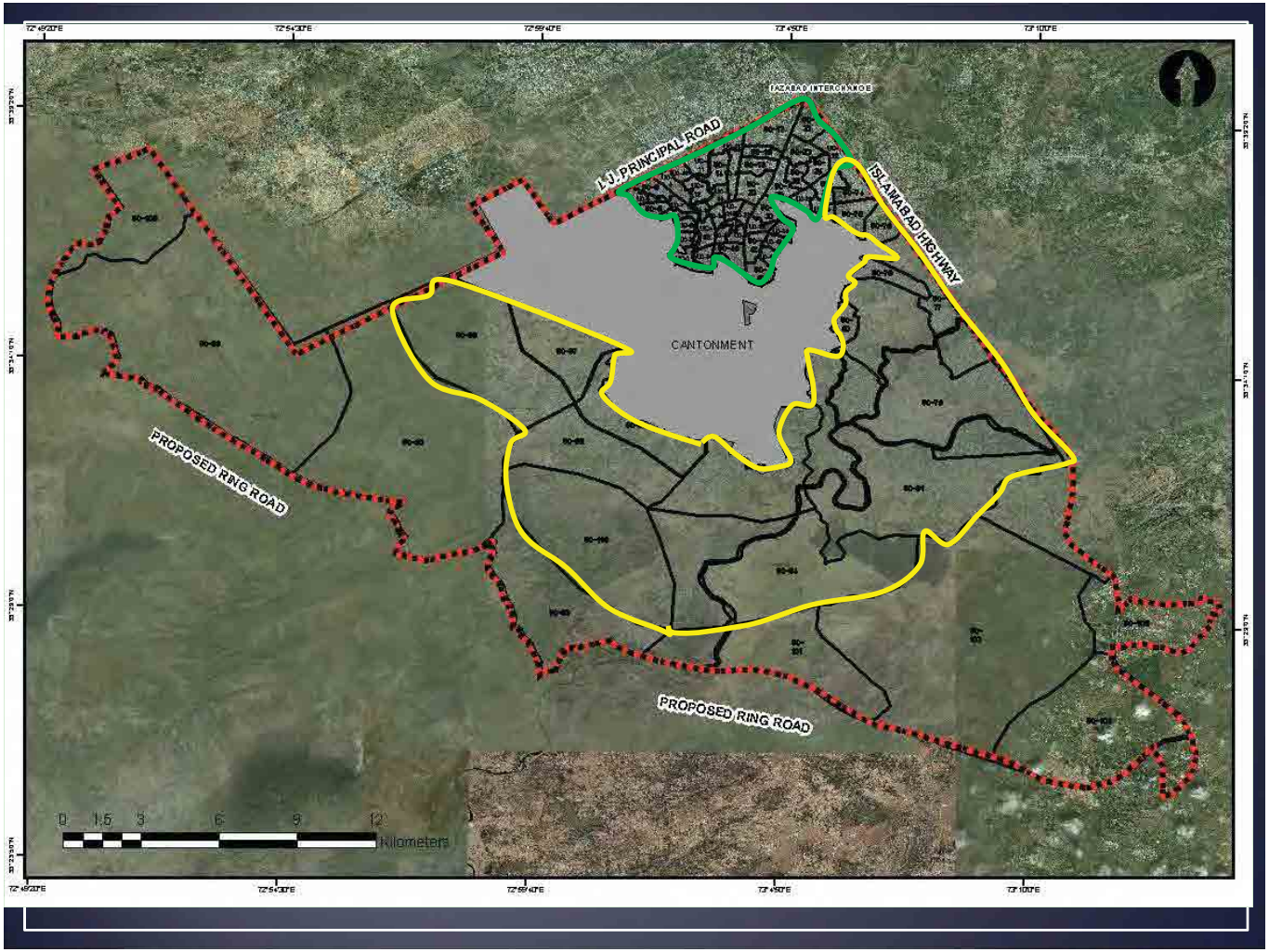
Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Make	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlorinator	Filtration Plant	Strata Chart	Delivery Pipe Dia (Inch)	Pressure Gauge	Year of Construction	Total Pumping Hours		Flow Meter Values			
																					Discharge (Gln/Hour)	Velocity (m/sec)	Signal Strength Value (S)	Signal Quality (Q)
370	Nil	78	Gangal West	325,506	3,720,625	Submersible				20	25	Yes	No	No	No	4	No	2006	16					
371	Nil	78	Chaklala Scheme	324,364	3,719,654	Submersible	HMA			20	50	Yes	No	No	Yes	4	Yes	2007	16					
372	Nil	79	Ghosia Colony	324,573	3,719,285	Submersible					25	Yes	No	No	No	3	Yes	2009						
373	Nil	79	New Afzal Town Gali No.02	324,189	3,718,357	Submersible				25	25	No	No	No	No	3	No	2007	16					
374	Nil	ISB	Gouri Town Phase III Gali No 2	326,258	3,721,248	Submersible				25	25	Yes	No	No	No	4	Yes	2006	16					
375	Nil	ISB	Gangal East	326,151	3,721,121	Turbine	Siemens			50	100	Yes	Yes	No	No	6	Yes	2002	16					
376	Nil	ISB	Gangal East-II	366,086	3,721,219	Submersible					100	Yes	No	No	No	6	No	2004						


RAWAL TOWN
P / Town
CANTONMENT
RDA
Rawal Town
Cantonment
RDA Area
IOT Area
Pothohar Town
Taxela Town
Korang River
Gumrah Kas
Malal Kas
Basala Kas
Soan River
Sil River
I.J. PRINCIPAL ROAD
ISLAMABAD HIGHWAY
PROPOSED RING ROAD
FAZABAD INTERCHANGE
0 1.25 2.5 5 7.5 10
Kilometers


MAP SHOWING UCs IN THE STUDY AREA
FAZAAD INTERCHANGE
I.J. PRINCIPAL ROAD
ISLAMABAD HIGHWAY
CANTONMENT
PROPOSED RING ROAD
PROPOSED RING ROAD
0 1.5 3 6 9 12
Kilometers


FAZABAD INTERCHANGE
I. J. PRINCIPAL ROAD
ISLAMABAD HIGHWAY
PROPOSED RING ROAD
PROPOSED RING ROAD
0 1.5 3 6 9 12
Kilometers


L.J. PRINCIPAL ROAD
ISLAMABAD HIGHWAY
CANTONMENT
PROPOSED RING ROAD
PROPOSED RING ROAD
0 1.5 3 6 9 12
Kilometers

Annex - 4.1

Dhoke Najju
Zia-ul-Haq Colony
New Phagwari
Mohallah Raja Sultan
Dhoke Ratta
Ratta Amral
Gawal Mandi
RWASA Office
Javed Colony,
Tipu Road
Chamanzar Colony
Image © 2007 DigitalGlobe
2000 m
Google

MOST VULNERABLE AREAS OF RAWALPINDI

- [illegible]e following low la[illegible]ing [illegible] [illegible]lo[illegible]e to [illegible]ai N[illegible]lla[illegible] area[illegible] of Rawalpindi [illegible]it[illegible] are [illegible]n[illegible][illegible]all[illegible] affe[illegible]ted [illegible] t[illegible]e [illegible]ai N[illegible]lla[illegible] flood[illegible] re[illegible]lting in lo[illegible] of [illegible]man life[illegible] livestock, and property etc.
  - Dhoke Najju
  - Zia ul Haq Colony
  - Dhoke Ratta
  - Ratta Amral
  - Javed Colony, Chamanzar, Tipu Road
  - New Phagwari
  - Mohallah Raja Sultan
  - Dhoke Ellahi Bakhash

SPECIAL VEHICLES WITH RWASA

	MACHINERY	Qty
1.	Jetting Machine	05 Nos.
2.	Sucker Machine	06 No.
3.	Tractor Sucker Machine	01 No.
4.	Tractor Trolley	02 Nos.
5.	Trolley Mounted sewer Roding machine	04 No.
6.	Dewatering sets	05 No.
7.	Water Bouzers	24 Nos

ORGANIZATION CHART- WASA, RDA

Managing Director

Grade 20	= 1
Grade 18	= 1
Grade 17	= 4
Grade 16	= 1
Grade 14	= 2
Grade 11	= 2
Grade 7	= 1
Staff (1 to 5)	= 5

Deputy Managing Director

Grade 19	= 1
Grade 17	= 2
Grade 14	= 2
Grade 11	= 3
Grade 10	= 1
Grade 9	= 1
Staff (1 to 5)	= 3

Director (A&F)

Grade 19	= 2
Grade 18	= 2
Grade 17	= 6
Grade 16	= 4
Grade 14	= 8
Grade 11	= 3
Grade 9	= 5
Grade 7	= 6
Grade 6	= 2
Staff (1 to 5)	= 19

Director (Revenue)

Grade 19	= 1
Grade 18	= 2
Grade 17	= 2
Grade 14	= 2
Grade 11	= 6
Grade 9	= 16
Grade 7	= 3
Grade 6	= 2
Staff (1 to 5)	= 34

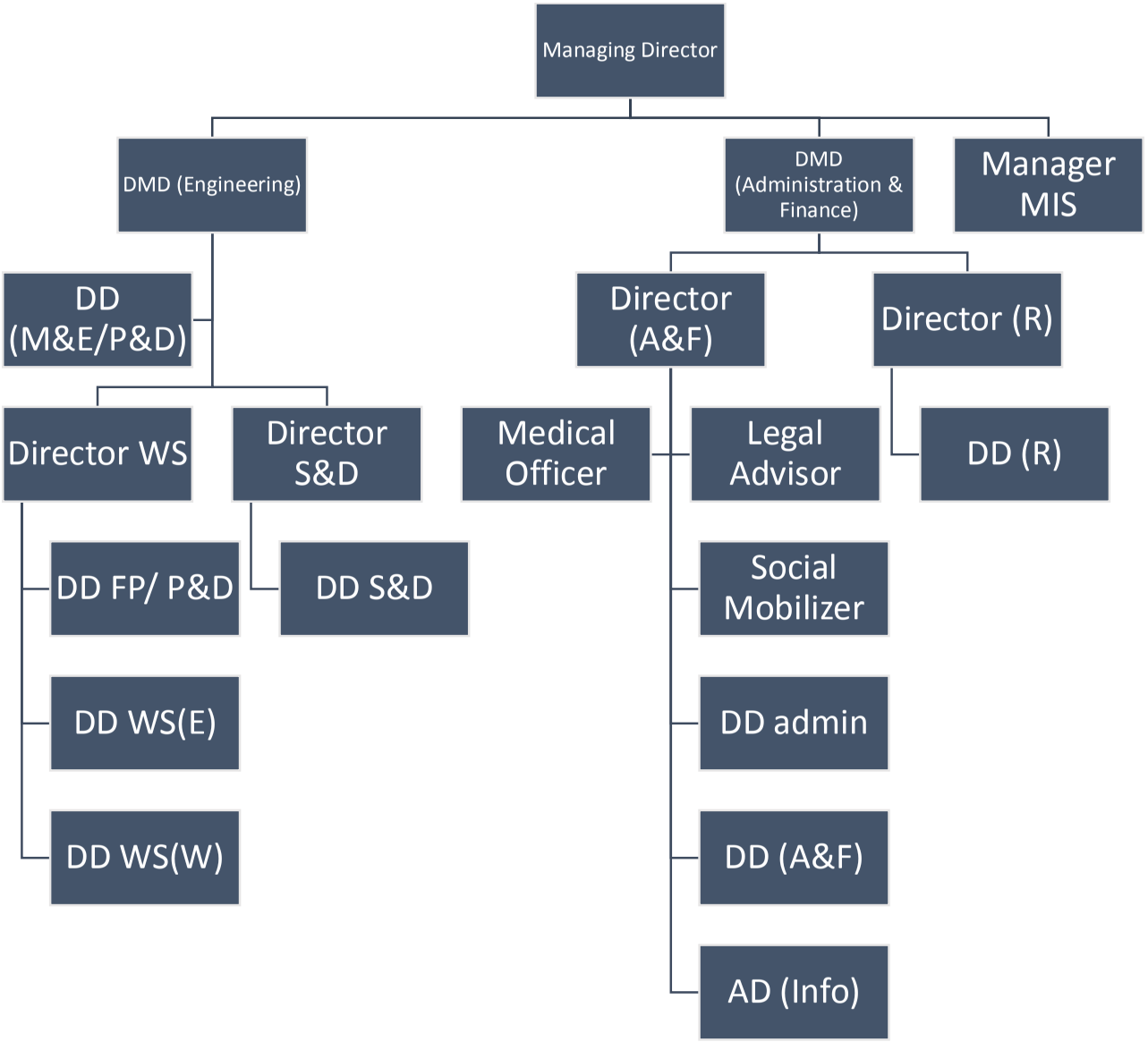
Director (Water Supply)

Grade 19	= 1
Grade 18	= 3
Grade 17	= 15
Grade 16	= 6
Grade 14	= 3
Grade 11	= 27
Grade 9	= 7
Grade 7	= 11
Grade 6	= 34
Staff (1 to 5)	= 1084

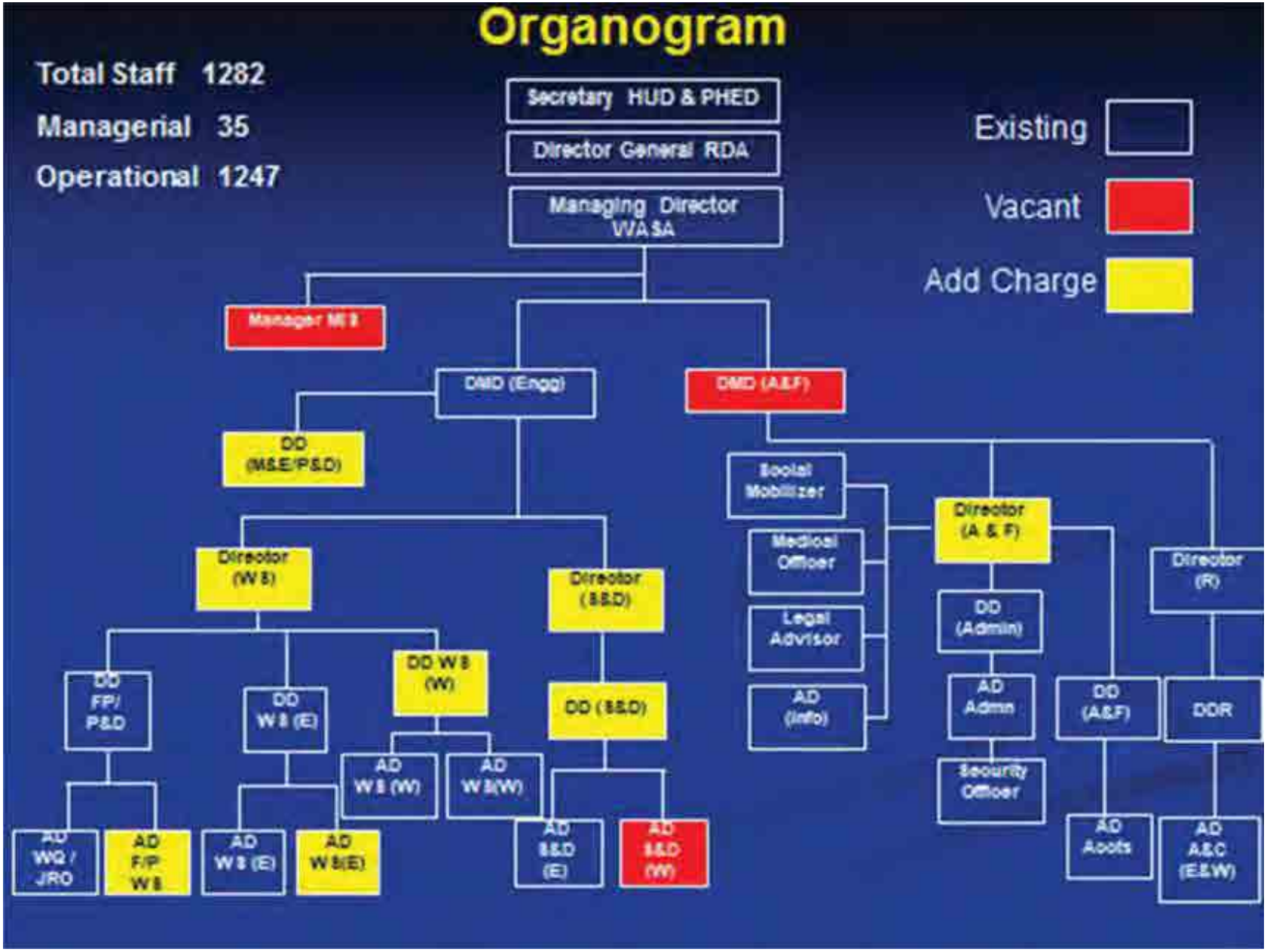
Director (S&D)

Grade 19	= 1
Grade 18	= 1
Grade 17	= 2
Grade 16	= 1
Grade 14	= 1
Grade 11	= 3
Grade 9	= 7
Grade 7	= 2
Grade 6	= 4
Staff (1 to 5)	= 138

ORGANOGRAM

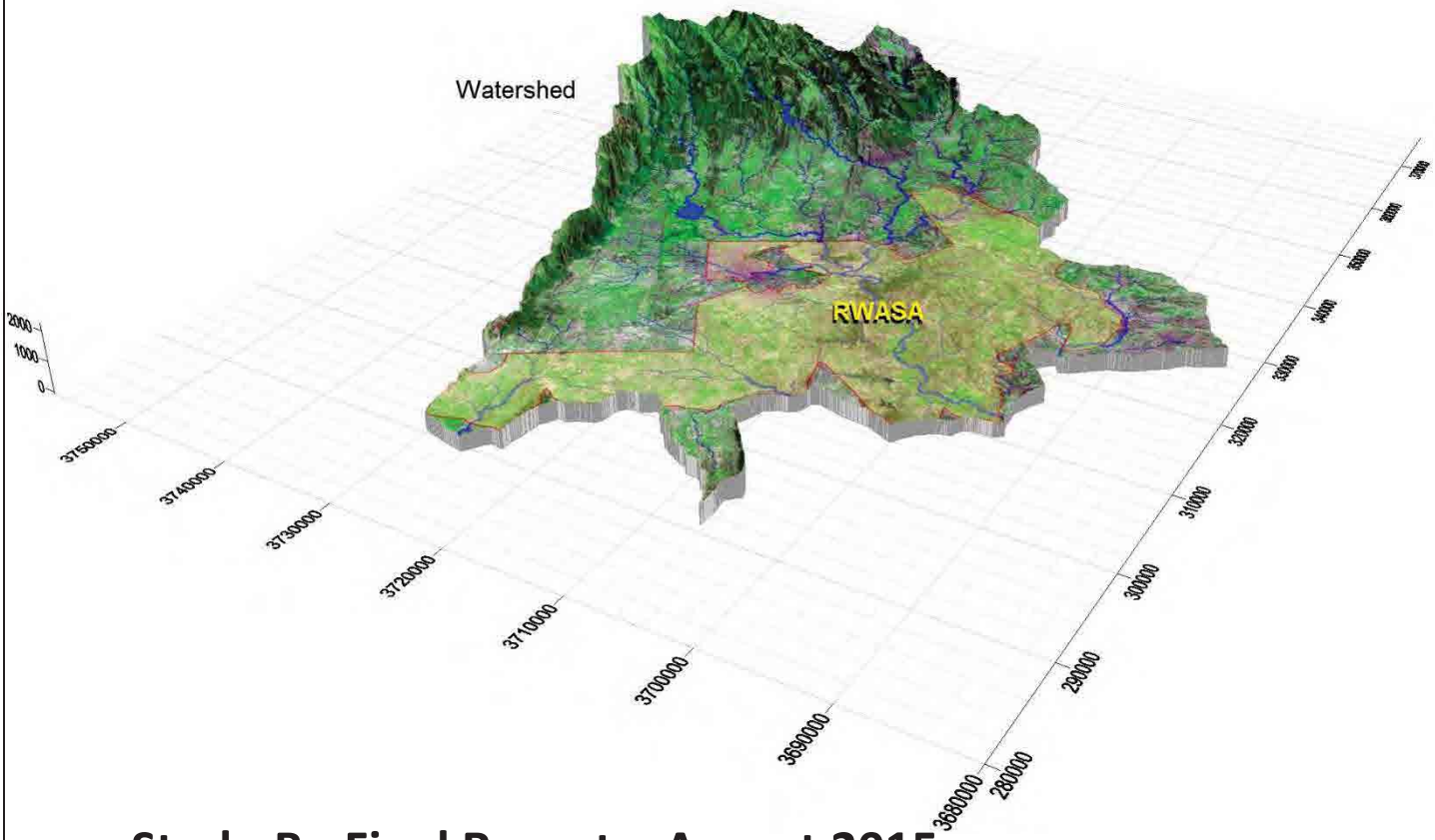

Managing Director
DMD (Engineering)
DMD (Administration & Finance)
Manager MIS
DD (M&E/P&D)
Director (A&F)
Director (R)
Director WS
Director S&D
Medical Officer
Legal Advisor
DD (R)
DD FP/ P&D
DD S&D
Social Mobilizer
DD WS(E)
DD admin
DD WS(W)
DD (A&F)
AD (Info)

ORGANOGRAM


Organogram
Total Staff 1282
Managerial 35
Operational 1247
Existing
Vacant
Add Charge
Secretary HUD & PHED
Director General RDA
Managing Director WASA
Manager M&E
DMD (Engg)
DMD (A&F)
DD (M&E/P&D)
Director (W&S)
Director (S&D)
DD FP/ P&D
DD W&S (E)
DD W&S (W)
DD (S&D)
AD WQ / JRO
AD F/P W&S
AD W&S (E)
AD W&S(E)
AD W&S (W)
AD W&S(W)
AD S&D (E)
AD S&D (W)
Social Mobilizer
Medical Officer
Legal Advisor
AD (Info)
Director (A & F)
DD (Admin)
AD Admn
Security Officer
DD (A&F)
AD Accts
Director (R)
DDR
AD A&C (E&W)

Annex - 5.4

Study on Water Resources, Develop Environmental & Social Guidelines/Protocols for Development Schemes I/C Strategies for Climate Change and Energy Conservation



Study-B - Final Report – August 2015

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Consulting Engineers, Pakistan

عثمانی OSMANI
Engineering - Architecture - Planning - Mapping - Technology

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STUDY-B

Study on Water Resources, Develop Environmental & Social Guidelines/Protocols for Development Schemes I/C Strategies for Climate Change and Energy Conservation

Executive Summary

This report gives out the conceptual elements for a fully sustainable plan for water supply, sewerage and storm water drainage in Rawalpindi urban and peri-urban areas. The plans are based upon a comprehensive analysis of the region's ability to support an estimated population of up to 6 million. The plans presented here fully factor-in the important elements of: environmental sustainability; energy use and efficiency; control and prevention of pollution; risk mitigation and management; projected population until year 2040; and, climate change. The plans are developed with a fully integrated contemporary approaches based on the general principles of integrated water resources management (IWRM), water sensitive urban design (WSUD) and integrated urban water management (IUWM). The plans also lead to achieving financial self-sustainability and provision of 24/7 water supply. Risk assessment for drought, hydrological hazards (especially flooding) and use of water against fire is also factored-in.

Resource Sustainability: The report begins with an overall review of the natural conditions in the study area with particular reference to the availability of renewable water in the study area. A basic principle of sustainability dictates that if water usage within a given area exceeds the natural capacity of the ecosystem to renew water within that area, the water usage could become unsustainable. This implies that either the natural storage (both surface and groundwater) will start depleting, or water will have to be imported from a distant source. Either of the two situations may be deemed unsustainable. The estimation of total renewable water in the study area, therefore, becomes the lynchpin for sustainable water management. The availability of renewable water, in other words, would also dictates the sustainable limits of growth for Rawalpindi's urban and peri-urban areas.

Integrated Resource Management: Various principles and practices of IWRM can be optimally applied at regional and sub-regional scales if the watershed boundaries are used as the administrative boundaries for managing water resources. The boundaries of RWASA jurisdiction, though, are not perfectly aligned with the regional or sub-regional watershed boundaries in the region. RWASA area lies almost entirely within the watershed of Soan River. For the sake of integrated water resources evaluation and management, this study evaluates the upper watershed of Soan River as shown in Figure 1. The watershed is defined by Margalla Ridge in the northwest, Murree Hills in the north and then the less conspicuous ridgelines to the east and west which generally define the upper watershed boundaries of Soan River. The watershed boundary in the

south is defined by cut off points of Soan River and its tributaries flowing down stream of the RWASA jurisdiction. The watershed boundaries enclose Islamabad and surrounding hills in the north and Rawalpindi and its surrounding peri-urban areas in the south. The current configuration of water shed vis-à-vis the administrative boundaries makes RWASA jurisdiction the lower riparian while Islamabad and surrounding hills as the upper riparian. Total of area of the water shed is 2763 square kilometer while that of RWASA jurisdiction, as highlighted in Figure **1**, is 873 square kilometre. This water shed was analyzed in the study for evaluation of water resources, including the development of a regional groundwater model.

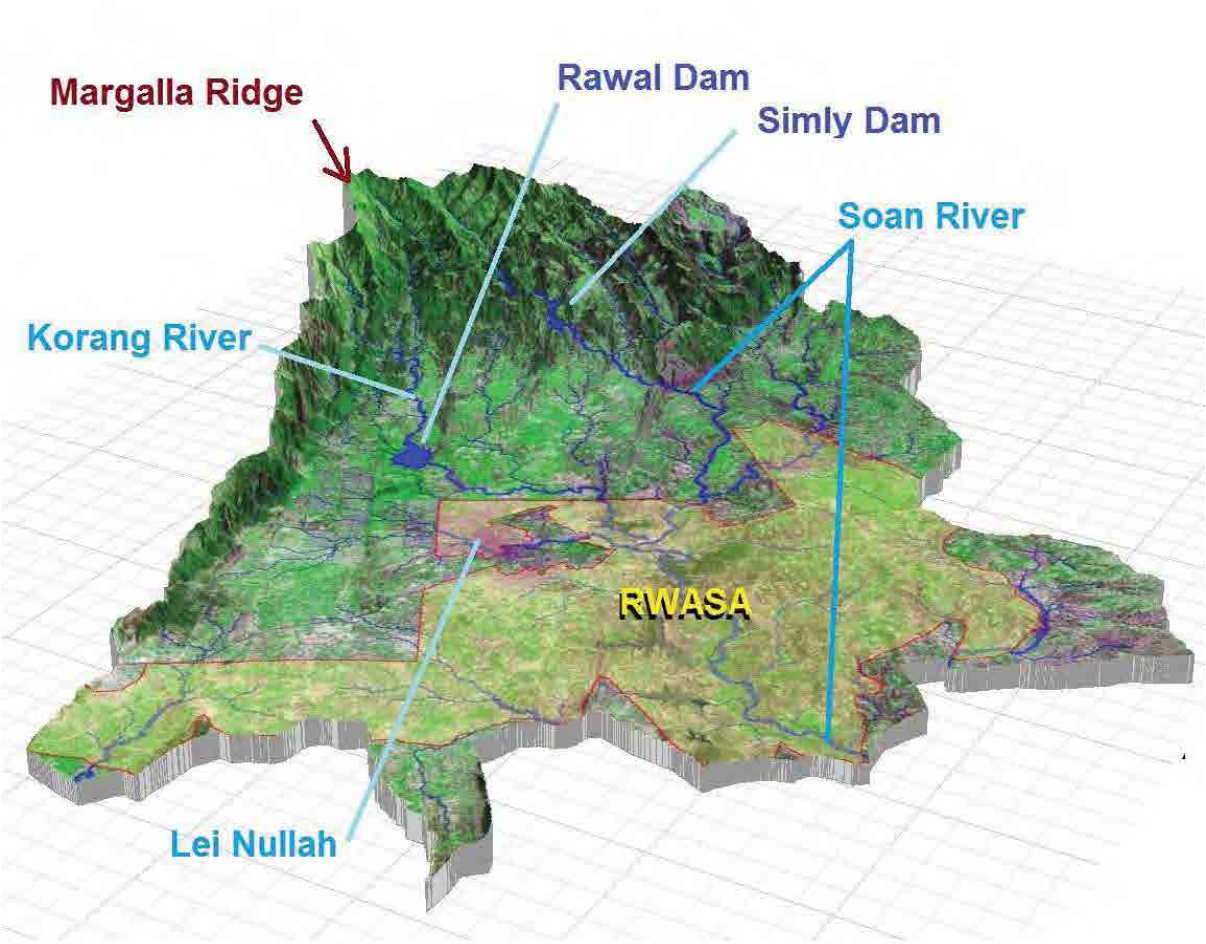

Figure 1: 3D representation of watershed. The RWASA jurisdiction is demarcated which lies in the southern part of the watershed.

Population Projection: The combined population of Rawalpindi and Islamabad (the twin cities), as per 1998 census, was 1.94 million. Projected at the current growth rates, the combined population of the twin cities could exceed 11 million by 2040 as estimated by Ministry of Finance[1], while that of RWASA jurisdiction will be close to 5.8 million. This estimate may look on the higher side as the fertility rates are on the decline, however, with increasing trend of urban migration to Rawalpindi and Islamabad (with a trend of lots of housing schemes being promoted in the area), this estimate may even exceed. For the sake of planning water requirements within RWASA Jurisdiction for the planning horizon, a population of 6 million has been assumed.

Water Demand: Water supply at the rate of 40 gallons per capita per day (0.5 cubic meters per person per day) has been envisaged for the residents of RWASA jurisdiction as already approved in Rawalpindi Master Plan (1996-2016) [2] . The annual water requirement for the planning year 2040 for an estimated population of 6 million comes out to be 398 million cubic meter (MCM). Daily water demand for RWASA for the planning horizon then comes out to be 1.1 MCM per day or 242 million gallons per day (mgd).

Renewable Water within the Water Shed: Rainfall is the main source of renewable freshwater in the area. All other renewable resources in the area are directly or indirectly driven by rainfall. This makes measurement and management of rainfall as one of the most important elements of sustainable development of water resources. Estimates of rainfall distribution over the watershed were made based on the annual rainfall data acquired from Pakistan Meteorological Department. Water flowing in the rivers/streams, storages in natural and artificial lakes, and groundwater (aquifers), all comes through this precipitation within the watershed. The mean total annual rainfall in the watershed varies from more than 1554 mm in the mountains in the north to 1052 mm in the plateaus in the south as shown in Figure 2. Total mean annual rainfall over the watershed is averaged at 1296 mm, bringing in an average annual volume of water equal to 3571 MCM which drives the hydrological cycle of the watershed.

[1] Ministry of Finance http://www.finance.gov.pk/survey/chapter_10/16_Population.pdf
[2] Rawalpindi Master Plan 1996-2016, Government of the Punjab, Local Government and Rural Development Department, No. So, 111(LG) 7-12/98 dated 25 Sept 1998

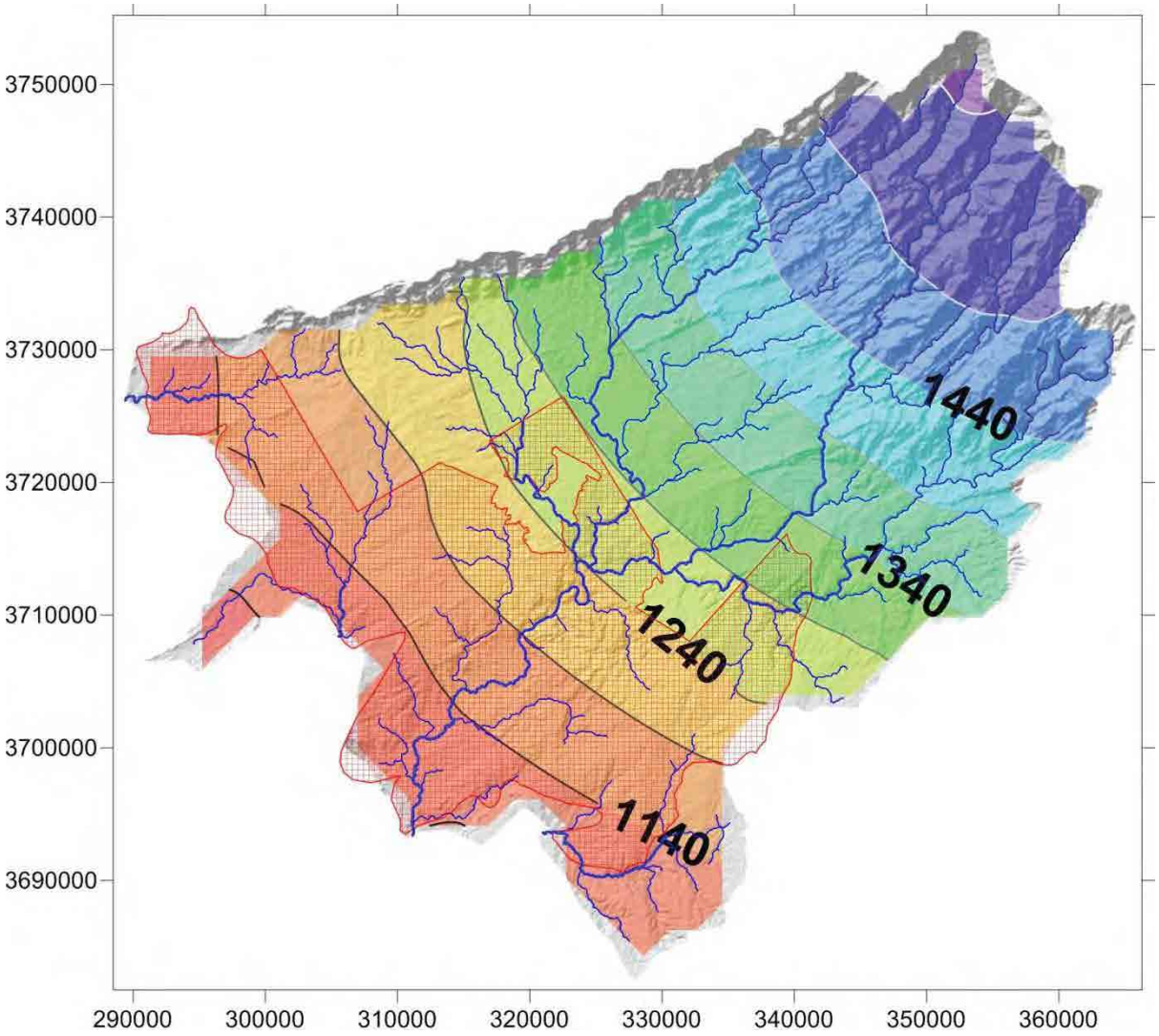

Figure 2 Variation of mean annual rainfall in millimeters over the watershed. RWASA boundary is also shown where rainfall average is lower than the northeastern part of the watershed

Evapotranspiration (ET) estimates for the study area were obtained from Bastiaanssen et. al. (2012)[3], based on NOAA/MODIS satellite data of the Indus Basin as shown in Figure 3. ET in the study area varies from 461 mm/year to 750 mm/year. For the planning purposes, it was taken as 700 mm/year, leaving behind 596 mm/year which renews water in the rivers, streams, lakes and aquifers. The mean annual renewable volume of water thus becomes 1645 MCM, which is reckoned as the total annual renewable water in the watershed.

[3] Bastiaanssen, W.G.M., Cheema, M.J.M., Immerzeel, W.W., Miltenburg, I.J. and Pelgrum, H. (2012). Surface energy balance and actual evapotranspiration of the transboundary Indus Basin estimated from satellite measurements and the ETLook model. *Water Resources Research 48:*

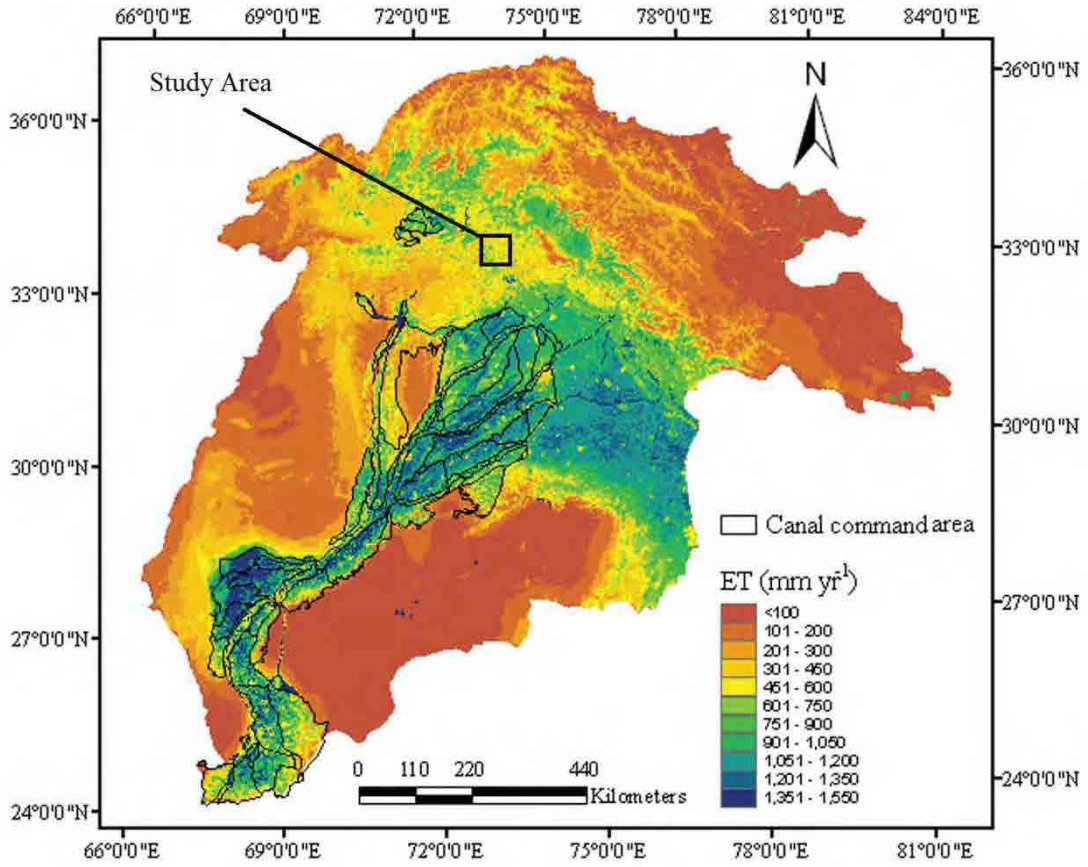

Figure 3 Evapotranspiration estimate from MODIS/NOAA satellite data (Betiaanssen et al 2012)

Renewable Water for RWASA Jurisdiction: Mean annual rainfall within RWASA jurisdiction is 1176 mm, which translates to annual volume of 1027 MCM. Excluding 700 mm loss in evapotranspiration, estimated renewable water from rainfall in RWASA jurisdiction is 417 MCM. Since RWASA jurisdiction is lower-riparian, it also receives overland flow (primarily river runoff) from the upper riparian areas and boundary flow into its underlying aquifer. Several datasets were analysed from the studies undertaken by CENTO[4] before the construction of Simly and Rawal Dams in the region. From these data sets it was estimated that mean annual river runoff, excluding the baseflow, is approximately 18% of annual rainfall. Using regional groundwater model for the area, analysis of

[4] The Role of Science in Developing Natural Resources With Particular Reference to Pakistan Iran and Turkey, Ist Edition, Pergamon Press, London, 1964, Part 4 "Surface Water Resources of the Federal Capital Area" pp . 163-176

hydrogeological data available from USGS[5] , and further analysis of data incorporating ET estimates, water balance components were derived for RWASA as shown in Figure 4:

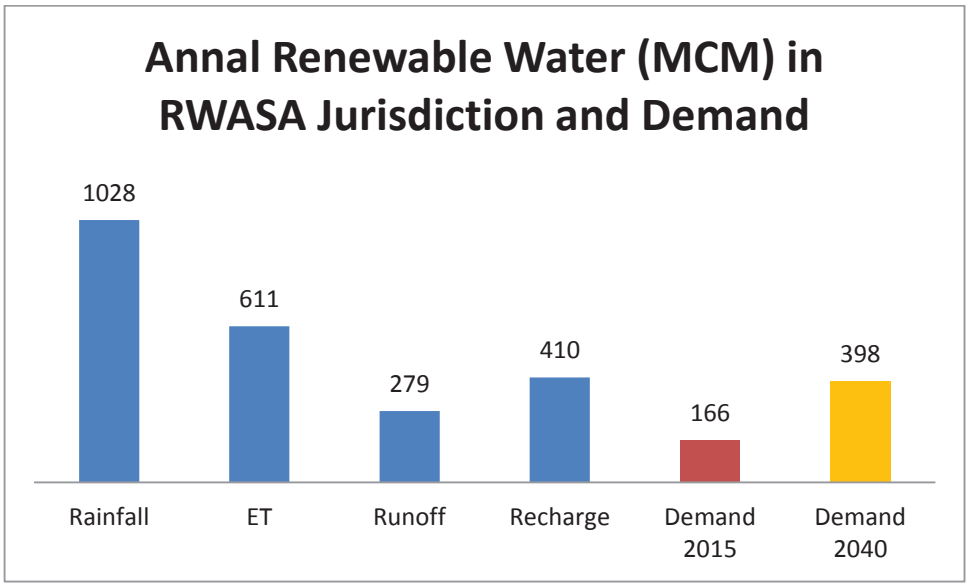

Figure 4 Water balance components for annual renewable water (in million cubic meter) versus current and future demand

From the regional level study presented in this report, the above figures point towards the potential of groundwater recharge in the RWASA jurisdiction which exceeds the total demand for 2040. However, at this point in time, the simplistic conclusion that current recharge rates are enough to meet the future demand may not be drawn. It should be noted that this figure for recharge is spread over an area of 873 square kilometres and also includes the boundary flow entering RWASA jurisdiction from up-slopes of Islamabad and surroundings. The area is full of irregularities and local geological variability which must be analysed in detail to exploit and/or manage this potential. This study, therefore, only highlights the potential and possibilities of managed recharge to meet future demands while concludes that there is enough renewable water (689 MCM, both surface water and groundwater), flowing though the area to meet future demands (398 MCM).

Future Water Works: The future water works required to exploit the potential of total renewable water within RWASA jurisdiction, as shown in Table 1, include important elements of water sensitive urban designs for storm water management, rain water harvesting (at local, municipal and regional scales), management and treatment of waste water, computer controlled well fields with high

[5] Environmental Geology of the Islamabad-Rawalpindi Area, Northern Pakistan. USGS Bulletin 2078G, U.S Department of Interior, U.S. Geological Survey

capacity well clusters, recovery and rehabilitation of right of ways of natural water courses, additional construction by-laws (to include water used efficiency and WSUD), and solid waste management etc. If the potential of renewable water as shown in the table is successfully exploited, it will bring perpetual sustainability of water resources to meet current and future demands.

Table 1 Annual Water Demand Compared to Renewable Water in the Study Area

Component	Quantum
Mean available renewable water per year	689 MCM
Yearly demand by 2040	398 MCM
Yearly demand as % of available renewable water in 2040	75%
Current yearly demand	166 MCM
Current yearly demand as % of available renewable water	31%

24/7 Water Supply: The plan presented here takes advantage of water resources within the area and has the potential to develop water resources and distribution systems to cater for 24/7 water supply.

Risk Management and Protection from Droughts: An estimation of aquifer capacity was also made. Based on the geological information, most of the area within the RWASA jurisdiction is capable of holding water within the top 200 meter of regolith. Given the mean specific yield at 0.17, the storage capacity for extractable groundwater in the aquifer is estimated at 3000 MCM. Once the aquifer is filled to its capacity, it can store 7.5 years' worth of water to meet the 2040 demand projections. In other words, managing the aquifer at 3000 MCM means a protection against total drought for more than 7 years. This in-built safety against droughts is one of the major highlights of the master plan being presented in this project.

Rainwater Harvesting: Based on above figures, this study proposes a plan for water supply by exploiting the most abundant and local resource of water within the study area, i.e., rainfall. The study proposes state-of-the-art rainwater harvesting infrastructure which can be gradually build within RWASA jurisdiction by setting aquifer recharge/rainwater-harvesting targets for phase-wise development. The rainwater harvesting targets will begin at 16% and will gradually rise to 33%.

Paradigm Shift from Surface to Groundwater: All previous reports and studies, as analysed in Study A, have mostly emphasized on exploitation of surface water resources and proposed construction of more dams and/or proposed import of water from the distant resources outside the study area. All such solutions are unsustainable in the long run (energy costs, silting of dams etc.). Unfortunately, no previous study has looked into the huge potential offered by rainfall and available aquifer storage within the study area. This study, however, carried out a comprehensive analysis of the combined potential of rainwater and natural aquifer systems in the study area and concludes that it is possible to meet all water demands, in a fully sustainable manner, by proper management of rainwater and aquifers.

A Touch of Future: The proposals made in this study are based on contemporary concepts and principles of Integrated Water Resources Management (IWRM), Urban Strom Water Drainage (USWD), Waster Sensitive Urban Design (WSUD) and Holistic Catchment Management. Using these modern-day tools and best management practices, a conceptual framework for water supply, sewerage, drainage and waste water treatment systems in Rawalpindi has been envisaged in this study, which is fully integrated with environmental protection, climate change and energy efficiency. The conceptual framework targets sustainability in all aspects of environmental, economic and social elements. Both hard and soft solutions for holistic water management have been proposed in the study which are built around Education, Enforcement and Engineering. The hard solutions generally include engineering designs and infrastructure and are strongly linked to economic and environmental sustainability. The soft solutions include institutional restructuring and capacity building for RWASA staff, other operations/maintenance staff, and law enforcement staff. Awareness campaigns for public are also suggested to achieve full social sustainability in the system.

Regional Master Plan: The last Master Plan for Rawalpindi was made for the period of 1996 to 2016[6] and was approved in 1998. An update on Master Plan beyond 2016 has not yet been made. This study focusing on Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi up to year 2040, therefore, is being done in the absence of an overall Master Plan for the same planning horizon. The plan presented in this study would, therefore, be subject to revision as and when future/updated Master Plan of Rawalpindi beyond 2016 is adopted by Rawalpindi Development Authority (RDA).

[6] Rawalpindi Master Plan 1996-2016, Government of the Punjab, Local Government and Rural Development Department, No. So, 111(LG) 7-12/98 dated 25 Sept 1998

Background

Rawalpindi is an older and much larger city and is a centre of industrial, commercial, and military activity. It lies along the ancient trade route from Persia and Europe across the Khyber Pass to India. The area has been a cultural meeting place and invasion route for millennia and was visited by Alexander the Great, Genghis Khan, the Mogul conquerors, and other prominent historical figures. Rawalpindi itself was settled around 1765 and grew to importance during the late 1800's, when it became an important staging ground for the British Afghan campaigns. Today it remains the site of a major military cantonment and headquarters of the Pakistan Armed Forces.

Rapid growth of both Islamabad and Rawalpindi to a combined population exceeding 3 million has made ever-increasing demands on natural resources and caused adverse effects on the environment. Some of the major concerns are the degradation in the quality of water resources, unsustainable withdrawal of groundwater, ever increasing demand of water in all sectors, and pollution of both surface and groundwater resources due to improper disposal of both solid and liquid waste.

Increasing stress on the available water resources in the search for improved economic well-being and concerns for the pollution of surface water and groundwater have highlighted the central role of hydrology in all water and environment initiatives. Hydrology forms the basis for water resources assessment and management and the solution of practical problems relating to water consumption by humans, floods, droughts, erosion/sediment transport, environment, and pollution.

The accepted principles of integrated water resources management (IWRM) dictate that, in order to achieve environmental sustainability and economic productivity leading to social well being of citizens, the rivers must be managed at the basin level. This approach calls for integrated solutions within a watershed boundary, which may be shared between more than one political or administrative jurisdiction. The approach adopted in this study takes advantage of the latest best management practices and cutting edge methodologies of contemporary water management.

Study Area & Watershed Boundaries

The study area comprises RWASA jurisdiction which includes a total of 73 Union Councils (UCs).

The water shed boundaries surrounding the Study Area (RWASA's Jurisdiction) are generally defined by the northern water shed boundaries of Soan River. The topography is rolling down from Northeast to Southwest. Margalla Ridge in the North and Northeast forms the crest line of the

watershed in the hilly terrain which receives most of the rainfall feeding the watershed. The watershed is shared between Islamabad Capital Territory (ICT) – mostly administered by Capital Development Authority (CDA), Murree-Kahuta Development Authority (MKDA) and Rawalpindi Development Authority (RDA).

The following map in Figure 5 outlines the RWASA jurisdiction within the contributing watershed on the up slopes.

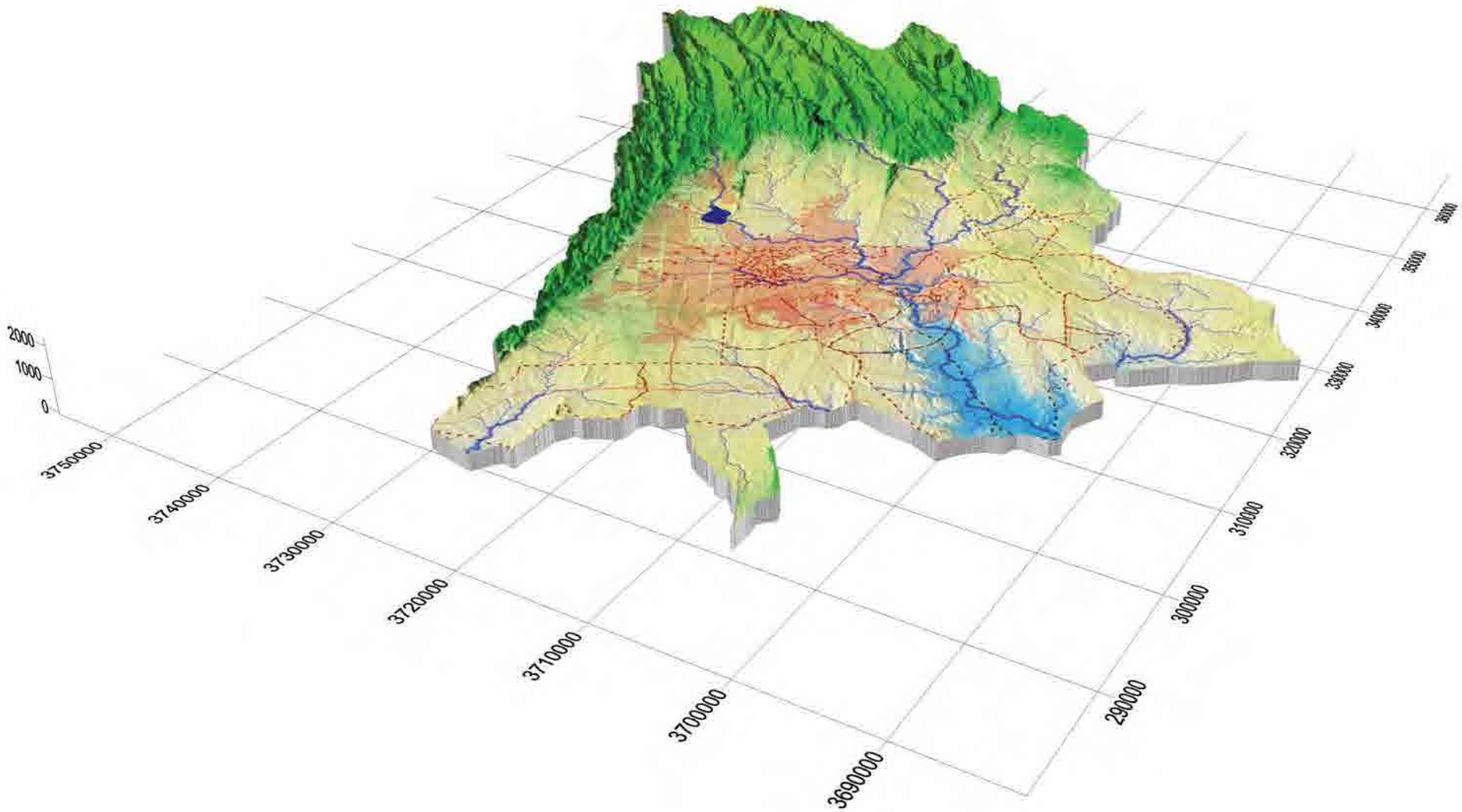

Figure 5 RWASA UC Boundaries have been shown in dotted rid lines. Lightly shaded red areas are the buildup urban areas of Rawalpindi and Islamabad.

Today, when water is perceived to be a matter of mutual concern, all stakeholders, from all the political and administrative jurisdictions within the watershed need to participate and play important roles in the process of developing a Master Plan for future, which is integrated in nature, environmentally sustainable and brings social and economic wellbeing to the residents of the watershed – irrespective of their administrative/political jurisdiction.

Many institutions and agencies within the watershed are engaged in the collection of hydrological data and information using different measurement procedures. The resulting lack of homogeneity in the observations gives rise to a lack of confidence. It is imperative, therefore, that all these partners be made aware of the manner in which the hydrological data are collected, the limitations and the reliability of the data, and how they are to be managed by the responsible organizations in the watershed. Transparency in data collection, storage and sharing is an essential element for cooperation among various users.

> In a sustainable community, resource consumption is balanced by resources assimilated by the ecosystem.

A tedious exercise and effort was required to collect and organize the datasets in GIS Format before it could be utilized in conducting the hydrological and hydrogeological studies presented in this study. A quality management framework for hydrological information was adopted while developing the protocols for GIS database. Inclusion of metadata for all GIS layers had been a part of this protocol.

The growing demand for freshwater resources has increasingly focused the attention of governments and civil society on the importance of cooperative management. Sharing the benefits of cooperation and even conflict prevention stem from a broad understanding of the principles and mechanisms through which these results can be achieved.

The risk factor in resource development for water supply, primarily due to hydrological variability was given due consideration. The risks mitigation strategies have been implemented in the conceptual design and operations proposed in this study. The mitigation strategies are primarily based on integrated management of resources.

Allocation of the resources or distribution of the benefits is essentially dependent on the knowledge of water availability and the related hydrological variability. A shared and accepted knowledge of the

resources, their projected availability and the confidence in their accuracy greatly helped in assessing the feasibility and fairness of alternative management and investment scenarios presented here.

Surface water quantity and sedimentation are incessant elements of un-sustainability in the older water supply systems, as it reduces the capacity of lakes and reservoirs. It is also concerned with the measurement of sediment discharge and causes adverse environmental impacts on downstream ecology. The modern methodologies of resource development and exploitation adopted in this study forego the need for creating more surface reservoirs. It shifts focus to more sustainable and environmentally friendly approaches for managing the resources.

The sustainability of a community is largely determined by the web of resources providing its food, fibre, water, and energy needs and by the ability of natural systems to process its wastes

Groundwater is concerned with measurements from wells and the hydraulic properties of aquifers. The study has laid a huge emphasis not only on the exploitation of groundwater but also on managing recharge of the aquifer across the watershed to make groundwater exploitation a fully sustainable operation.

The development of water resources is not only constrained by their quantity but also by their quality. The study recommends and proposes methods for taking optimal advantage of ecological services for treatment and purification of both waste water and drinking water. Such approaches not only make the whole water supply and drainage operations more sustainable, but also cut down huge energy and infrastructure costs when supplemented with conventional water and wastewater treatment plants.

This study has been conducted in three parts as follows:

Part I Study of Water Resources (Hydrology and Hydrogeology)

Part II Development of Environmental and Social Assessment Guidelines and Protocols for WSS&D schemes

Part III Climate Change & Energy Conservation Strategy for RWASA

The study of water resources presented here is based on the latest, most advanced and cutting edge scientific concepts in the realm of contemporary water management. The conceptual thinking

governing these concepts and interrelated science has also been explained to facilitate the readers who are not currently familiar with the latest science and best management practices of water management. For the benefit of general public as well as experts, the conceptual thinking behind this study is presented beforehand. It is generally believed, and wrongly so, that spending money on the projects related to restoration/protection of environment is less important than the development projects for human communities. The fact, however, is that if designs of development projects take advantage of ecological services through smart designs can not only save energy and infrastructure costs but also synergistically protect the environment and achieve sustainability. Ecological services can be used for aquifer recharge, decomposing pollution, improving water quality, generate renewable energy etc., thus leading to a sustainable future.

Part I

Study of Water Resources

(Hydrology and Hydrogeology)

1. Hydrology and Hydrogeology of the Study Area

For the purpose of this study, upper water shed of Soan River was analyzed for availability of water resources in the area. A comprehensive geological mapping for Islamabad and surrounding hill was conducted by USGS[7] as shown in Figure 6. The delineated boundary of the water shed covering the upper Soan watershed and RWASA jurisdiction as overlain on the USGS Geological study is shown in Figure 7.

The Soan and Kurang Rivers are the main streams draining the area. Their primary tributaries are the Ling River, draining north-westward into the Soan; Gumreh Kas, draining westward into the Kurang from the area between the Kurang and Soan; and Lei Nala, draining southward into the Soan from the mountain front and urban areas. The Kurang and Soan Rivers are dammed at Rawal and Simly Lakes, respectively, to supply water for the urban area. Extensive forest reserves in the headwaters of the Kurang and Soan Rivers benefit the quality and quantity of supply. A supplemental network of municipal and private wells as deep as 200 meters (m) produces ground water primarily from Quaternary alluvial gravels. The altitude of the water table decreases from about 600 m at the foot of the Margalla Hills to less than 450 m near the Soan River, so that the saturated zone generally follows the topography. The water tables used to be from 2-20 m below the natural ground surface in the eighties[8]. These have now dropped down to more than 100m at in the urban areas due to unsustainable exploitation of groundwater.

Lei Nala carries most of the liquid waste from Rawalpindi and contributes greatly to the pollution of the Soan River below their confluence. Solid-waste disposal practices threaten the quality of surface water and groundwater reserves.

[7] Plate A1 from Environmental Geology of the Islamabad-Rawalpindi Area, Northern Pakistan. USGS Bulletin 2078G, U.S Department of Interior, U.S. Geological Survey

[8] Ashraf, K.M., and Hanif, Mohammad, 1980, Availability of ground water in selected sectors/areas of Islamabad—Phase I and II: Pakistan Water and Power Development Administration Ground Water Investigation Report 35, 30 p

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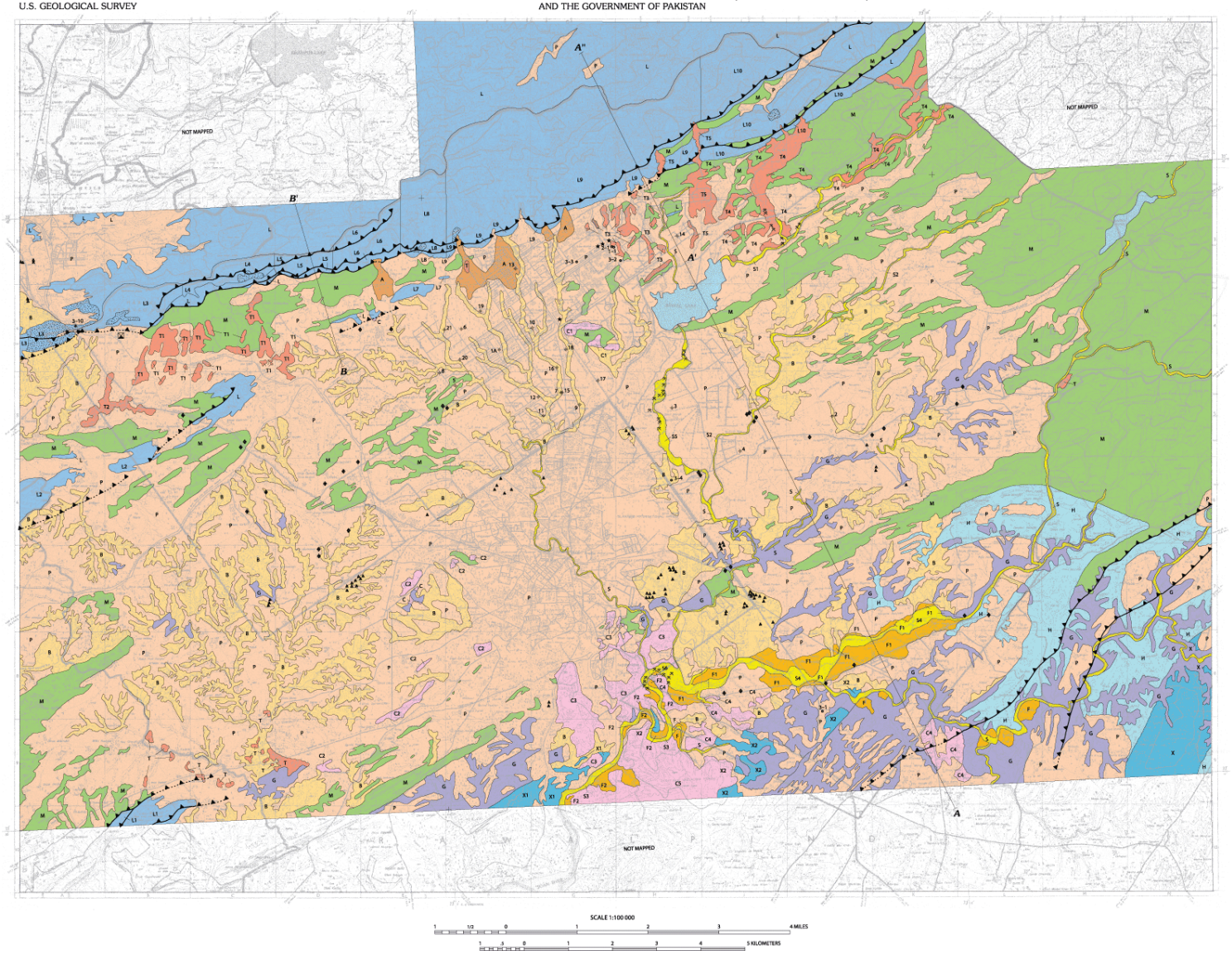
GEOLOGICAL SURVEY OF PAKISTAN,
UNDER THE AUSPICES OF THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT, U.S. DEPARTMENT OF STATE,
AND THE GOVERNMENT OF PAKISTAN

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

BULLETIN 2078
PLATE G1



EXPLANATION OF ENVIRONMENTAL MAP UNITS

(Some units are divided into areas designated by number after the letter symbol (for example, T4); see table G5 for definition of these subdivisions used to calculate aggregate reserves. Refer to table G1 for relation of map unit to geology, lithology, and landform; table G2 for relation to engineering properties, hazards, and hydrology; table G3 for relation to resources and land-use considerations)

LOOSE SEDIMENT

- S S1–S6 — **Stream-channel alluvium**—Unit symbol without number refers to areas not included in aggregate-reserve calculations (table G5)
- F F1–F2 — **Flood-plain alluvium**—Unit symbol without number refers to areas not included in aggregate-reserve calculations (table G5)
- T T1–T5 — **Stream-terrace alluvium**—Unit symbol without number refers to areas not included in aggregate-reserve calculations (table G5)
- A — **Fan alluvium**
- P — **Undissected windblown silt**
- B — **Dissected windblown silt**

WEAK ROCK

- H — **Undissected, unconsolidated or very weakly consolidated mudstone and sandstone**
- X X1–X2 — **Crystalline gravel conglomerate**—Unit symbol without number refers to areas not included in aggregate-reserve calculations (table G5)
- G — **Eroded, unconsolidated or very weakly consolidated sandstone, mudstone, and conglomerate**

MODERATELY STRONG ROCK

- C C1–C5 — **Limestone gravel conglomerate**—Unit symbol without number refers to areas not included in aggregate-reserve calculations (table G5)
- M — **Interbedded sandstone and shale**
- L L1–L10 — **Limestone**—Unit symbol without number refers to areas not included in aggregate-reserve calculations (table G5)

EXPLANATION OF MAP SYMBOLS

- **Contact**—Boundaries of loose sediments approximately located
- **Potentially active fault**—Dashed where approximately located; dotted where concealed. Sawteeth on upper plate
- B B' **Geologic cross section**—See figures G8–G10
- 3–2 **Soil-sample site**—Number refers to location mentioned in the text
- +3 **Capital Development Authority hydrologic test hole**—Number refers to test hole shown in figure G10
- **Building taller than 10 stories**
- **Cement factory**
- **Solid-waste disposal site**
- **Brick kiln**
- **Gravel pit**
- **Major rock quarry area**

ENVIRONMENTAL GEOLOGY OF THE ISLAMABAD-RAWALPINDI STUDY AREA, NORTHERN PAKISTAN

USGS science for a changing world

Figure 6 USGS study – Geology map for Rawalpindi Islamabad

USGS Geological Study

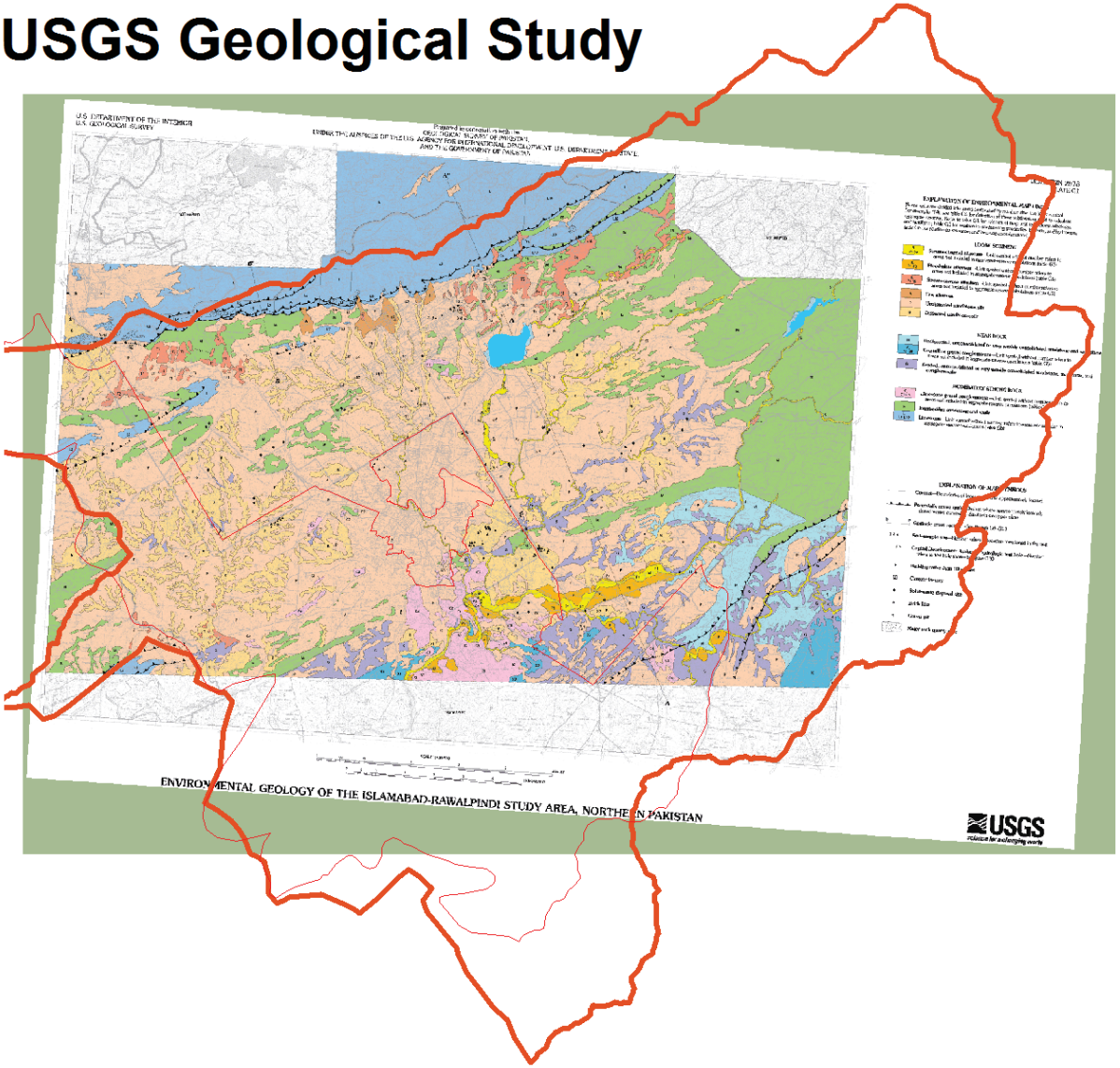


Figure 7 Study Area in the backdrop of USGS Map

1.1. Terrain & Landforms

When discussing with reference to water resources, the terrain of Rawalpindi cannot be discussed in isolation as the higher grounds to the north and north-east, mostly in the political jurisdiction of Islamabad, control the hydrology and hydrogeology of the area. The following discussion is covers the terrain and landforms of the watershed within which both Rawalpindi and Islamabad are located.

The terrain in the metropolitan area of Islamabad-Rawalpindi consists of plains and mountains whose total relief exceeds 1,175 m. Three general physiographic zones trend generally east-northeast. The northern part of the metropolitan area lies in the mountainous terrain of the Margalla Hills, a part of the lower and outer Himalayas, which also includes the Hazara and Kala Chitta Ranges. The Margalla Hills, which reach 1,600-m altitude near Islamabad, consist of many ridges of Jurassic through Eocene limestone and shale that are complexly thrusted, folded, and generally overturned.

South of the Margalla Hills is a southward-sloping piedmont bench underlain primarily by folded sandstones and shale of the Rawalpindi Group (Miocene). Although the relief of the piedmont area is generally low and dominated by extensive plains of windblown silt, the piedmont area also includes many ridges and valleys that have been buried by alluvial deposits from the hills. Buried ridges of sandstone are generally covered by inter-bedded sandy silt and limestone gravel that locally exceed 200 m in thickness; these deposits, in turn, have been dissected and then buried under a layer of eolian loess and reworked silt that locally exceeds a thickness of 40 m. The gravel and loess are especially important to the environmental geology because they form most of the building foundations and because gravel is the primary ground-water aquifer. West of Rawalpindi, plains of thick, easily eroded loess are extensively dissected into shallow badland valleys. East of Rawalpindi, the folded ridges of Rawalpindi Group rocks rise above the alluvial cover to form prominent hills. Urban development is concentrated in the piedmont bench area, which is little dissected in its northern part, where Islamabad is located, but is more deeply dissected toward the south near the Soan River, where Rawalpindi is located.

In the southernmost part of the area, the Soan River valley extends generally along the axis of the Soan syncline at an altitude of about 425 m. The Soan is incised more than 40 m below the level of extensive silt-covered plains north and south of the river. Southeast of Rawalpindi, upstream from the Grand Trunk Road Bridge, the Soan channel and flood plain extend 1.5 kilometer (km) across the valley floor. Elsewhere, the valley bottom is much narrower. Beds of fluvial sandstone, mudstone,

and conglomerate of the Siwalik Group of Neogene to Pleistocene (?) age underlie the southern area and crop out along the many steep-sided stream valleys that dissect the land. The beds dip steeply on the north limb of the syncline north of the Soan River, and more gently on the south limb. The piedmont bench and Soan valley make up the northern edge of the Potwar Plateau, which extends south-westward for 150 km.

1.1.1. Depositional Landforms

Depositional Landforms in the area can be classified as follows:

Streambeds, low islands, and bars.—Low land in valley bottoms that is generally covered and reshaped by flowing water each year. These features are formed by braided or meandering streams. The surface is generally sand and gravel, and there is little or no soil development. The surface is unstable and lacks vegetation except for quick-growing grass. Slopes are less than 4 percent.

Stream flood plains.—Low benches slightly above the stream channels in valley bottoms. They are above water level most of the year but are commonly flooded whenever the streams overtop their banks. The surface is generally fine sand, silt, and clay with a relatively high organic content and fertile soil. Slopes are less than 4 percent.

Stream and fan terraces.—Lower terraces form wide benches along the sides of modern stream valleys similar to flood plains, but the terraces are higher above the stream and are seldom flooded. Higher terraces form gravel-capped ridges and flat-topped hills that never flood. Terraces are dissected relict flood plains; uplift of the old depositional surface and erosional lowering of streambeds have left the terrace surfaces above the reach of most floods. The highest terraces are along the mountain front in stream valleys and alluvial fans and generally are preserved where limestone gravel that was cemented by calcium carbonate from ground water forms hard layers resistant to erosion. Under the terrace surface, a thin layer of fine-textured soil generally overlies channel deposits of sand and gravel. The terrace surfaces generally slope less than 10 percent, but erosional scarps on the side of the terrace slope steeply.

Alluvial fans.—Fan-shaped bodies of gravel-rich alluvium deposited near the mountain front where streams emerge from steep canyons. Streams on the fan surface commonly shift their courses laterally; floods and debris flows episodically cover parts of the fan surface with water and thick layers of sediment. The time interval between major debris flows may be tens of years, so the hazard is commonly underestimated. Cemented limestone gravel in the alluvium may make excavation difficult. Slopes are less than 15 percent.

Loess plains.—Plains and gently sloping hills of fine silt and clay built up from airborne dust burying pre-existing hills and valleys. The landscape has also been smoothed by thin sheets of rainwater flowing across the surface. The soil is fertile and easily tilled but is easily eroded by water and wind. The geologic formation underlying these plains is the Quaternary Potwar Clay. Slopes are less than 15 per cent.

1.1.2. Erosional Landforms

Loess badlands and gullies.—Steep-sided but generally shallow ravines eroded in soft loess (windblown silt and clay of the Potwar Clay). These gullies tend to grow and coalesce through headward erosion. Growth of loess badlands can be controlled, and some of the land can be reclaimed through conservation measures. Loess badlands are especially extensive south and west of Rawalpindi.

Bedrock badlands and gullies.—Areas of generally parallel, deep ravines eroded in steeply dipping soft mudstone and sandstone of the Siwalik Group. Most of the gullies have formed along the strike of weakly consolidated beds separated by ridges of resistant, cemented sandstone. This landform develops from loess badlands and gullies when streams cut down through the base of the loess into steeply dipping bedrock. Such terrain is extensive west of Riwat on either side of the Soan River. Bedrock badlands are more difficult to reclaim than loess badlands. Slopes are 50–100 percent.

Gentle hill slopes with angular clasts.—Rolling hills generally sloping more than 15 percent but less than 75 percent. Some ledges of rock may crop out, but the surface generally is covered with thin soil of sand, clay, and broken rock derived from weathering of the underlying bedrock. This type of slope is generally found on low hills underlain by sandstones of the Rawalpindi and Siwalik Groups.

Gentle hill slopes with rounded clasts.—Rolling hills generally sloping more than 15 percent but less than 100 percent. Some ledges of rock may crop out, but the surface generally is covered with thin sandy soil derived from weathering of the underlying rock; the soil contains rounded cobbles

1.2. Geology

Sedimentary rocks exposed in the Islamabad area record 150 million years (Ma) of geologic history from the Middle Jurassic to the Quaternary. The period from about 150 to 24 Ma was characterized by slow, primarily marine deposition and little tectonic activity; that from 24 to 1.9 Ma by rapid, voluminous, continental deposition and slow subsidence; and that since 1.9 Ma by intense tectonism, extensive erosion, and subordinant local deposition dominated by coarse clastic continental sediment.

The oldest rocks exposed in the study area are Jurassic marine limestone and dolomite that were deposited on a continental shelf along the northern edge of the continental part of the Pakistan-India tectonic plate as it migrated northward before converging with the Eurasian plate. The oolitic, biomicritic, and intrasparitic types of limestone in the Samana Suk Formation indicate different amounts of energy in the various carbonate depositional environments. A short break in deposition during the Late Jurassic is represented by the unconformity between the Samana Suk and Chichali Formations. From the Late Jurassic to the Early Cretaceous, anaerobic bottom conditions and chemically reducing environments accompanied deposition of the glauconitic shale and sandstone of the Chichali Formation. During the Early Cretaceous, conditions changed to a slightly saline, shallow-water, reducing environment when the glauconitic sandstone of the Lumshiwal Formation was deposited. The calcareous facies of the Lumshiwal Formation are near shore shallow-water deposits. Emergence of the area above sea level during the mid-Cretaceous is indicated by the unconformity between the Lumshiwal and Kawagarh Formations north of the map area (the Kawagarh is missing from the study area). During the early Late Cretaceous, the sea transgressed again, and the limestone and marl of the Kawagarh Formation were deposited in shallow- to deep-marine water.

During the Late Cretaceous to Paleocene, the area rose again above sea level. The exposed surface of the marine Kawagarh Formation was first eroded and then buried beneath highly weathered continental sediments of the Hangu Formation. In the map area, the Kawagarh was entirely removed; thus, the Hangu unconformably lies on the Lumshiwal Formation. Intense lateritic and bauxitic weathering of the Hangu Formation reflects the equatorial latitude of the Pakistan-India tectonic plate during the Paleocene. Following deposition and weathering of the Hangu, marine conditions returned and persisted through the early Eocene. Calcareous and argillaceous sediments of the Lockhart Limestone, Patala Formation, Margalla Hill Limestone, and Chorgali Formation were deposited during this time. This marine depositional sequence was followed by alternate marine and continental environments during which the Kuldana Formation was deposited. During the middle Eocene, initial contact of the Pakistan-India plate with Asia elevated the region above sea level and produced the unconformity beneath the continental Murree Formation.

By Miocene time, the sea had completely receded south of the map area, and during the Miocene and Pliocene, very thick continental deposits of the Rawalpindi and Siwalik Groups accumulated in the subsiding Himalayan foredeep region. These deposits consist of sediments eroded from highlands to the north that were uplifted and deformed by tectonic forces in the zone of convergence. The south margin of the deformed zone migrated southward into the Islamabad area, where it first caused coarser sedimentation but eventually so deformed and uplifted the area that

deposition drastically decreased and erosion became the predominant sedimentary process. The tectonic migration that began during the Eocene continues to the present. The estimated average rate of southward migration during the Pliocene was 3 cm/1,000 yr, and the average accumulation of mud, sand, and gravel in the subsiding foredeep region was about 28 cm/1,000 yr[9].

During the Pliocene, sedimentation was controlled by an eastward-flowing river system. The conglomerate of the Soan Formation that was deposited by that river system during the late Pliocene consisted chiefly of quartzite and metamorphic clasts eroded from the Himalayan core and are similar to clasts in modern Indus River gravels. Local sedimentation stopped between 3 Ma and 1 Ma, when the Hazara fault zone developed, when limestone of the Margala Hills was thrust up along the north border of the study area, and when the sandstone and mudstone of the Rawalpindi and Siwalik Groups were folded and faulted throughout the area. The eastward-flowing river system was disrupted and superseded by the much smaller, southward-flowing Soan River system, and locally derived limestone gravel became the dominant component of the Lei Conglomerate; this conglomerate accumulated most thickly over the Soan Formation and other upturned Siwalik Group rocks along the axis of the subsiding Soan syncline at the southern edge of the map area.

During the Quaternary, climatic fluctuations along with tectonic uplift caused periodic incision of the drainage south of the Margala Hills and alternate periodic accumulations of silt and alluvial gravel from the Margala Hills, which filled the valleys and spread laterally to form wide plains of low relief. A great influx of windblown silt probably was blown from the braided outwash channel that originated in the highly glaciated headwaters of the Indus River. This eolian silt formed the thick deposits of loess that mantle the landscape and contribute to the burial of preexisting valleys. Loess deposition was probably most rapid during the glacial maximums, but it continues despite the present interglacial climate because very large glaciers still exist in the Indus River basin and contribute large amounts of fine-grained sediment, which causes the Indus to form a braided channel below the mountain front 50 km long and 10 km wide. Calculated rates of loess accumulation during the period from 170 to 20 ka range from 6 to 27 cm/1,000 yr .

[9] Raynolds, R.G.H., 1980, The Plio-Pleistocene structural and stratigraphic evolution of the eastern Potwar Plateau, Pakistan: Hanover, New Hampshire, Dartmouth College, Ph.D. dissertation, 264 p

Strongly developed soils are scarce in the Islamabad area, perhaps because of the seasonally dry climate and the lack of stable surfaces caused by alternation of erosion and loess deposition. Some paleosols, however, are preserved within the loess.

Pleistocene stream and fan-terrace deposits along the mountain front, preserved as much as 30 m above present drainage levels, reflect stream incision and provide a measure of continued tectonic uplift of the piedmont zone since their deposition. Distant tectonic events may also have affected the balance of aggradation and degradation. Tectonic tilting and uplift across the course of the Indus River (McDougall, 1989) near the gorge at Kalabagh, 200 km to the west, have caused major shifts in the course of the Indus and affected the base level of the Soan River[10] .

Active tectonism across the area continues in the form of folding, thrust faulting, and seismicity. A very large earthquake in A.D. 25 destroyed the Buddhist community at Taxila, about 25 km west-northwest of Islamabad. A more recent earthquake in 2005 also jolted the city.

1.3. Climate and Rainfall

Rawalpindi has monsoonal climate of rainy hot summers and cool dry winters; precipitation is characteristic of the semiarid zone of Pakistan. The monsoon rains usually start in June, peak in August, and end by September. A much smaller winter monsoon peaks in March. The four monsoon summer months always have some precipitation, but any of the other months can be completely dry. Annual rainfall of only 249.1 millimetres (mm) was recorded in 1982. The high of 1,732 mm was recorded in 1983. The average for 1931–87 was 1,055 mm. The maximum recorded temperature was 45.9 degrees Celsius (°C) in June 1972, and the minimum was –3.9°C in one January before 1961. Freezing temperatures are rare and have been recorded only in November, December, and January.

The highest intensity of storm/rainfall that has been recorded in the region was on 23rd July 2001. Islamabad received 622mm and Rawalpindi received 150mm in 6 hours duration. As a result of this heavy downpour, Lai Nullah, which is a drainage channel for both the cities, had its banks over flowing in Rawalpindi area, inundating and damaging property, livestock, and above all, human life.

[10] McDougall, J.W., 1989, Tectonically induced diversion of the Indus River west of the Salt Range, Pakistan: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 71, nos. 3–4, p. 301–307

The following map in Figure 8, generated from annual rainfall data[11], shows that annual rainfall over the region varies from 1450mm to 1140mm. Rainfall is the only ecological mechanism for renewable water in the area. It provides water to all surface water reservoirs (natural or artificial), streams and groundwater aquifers. An estimated annual rainwater volume of 3580 Million Cubic Meter (MCM) pours into the watershed.

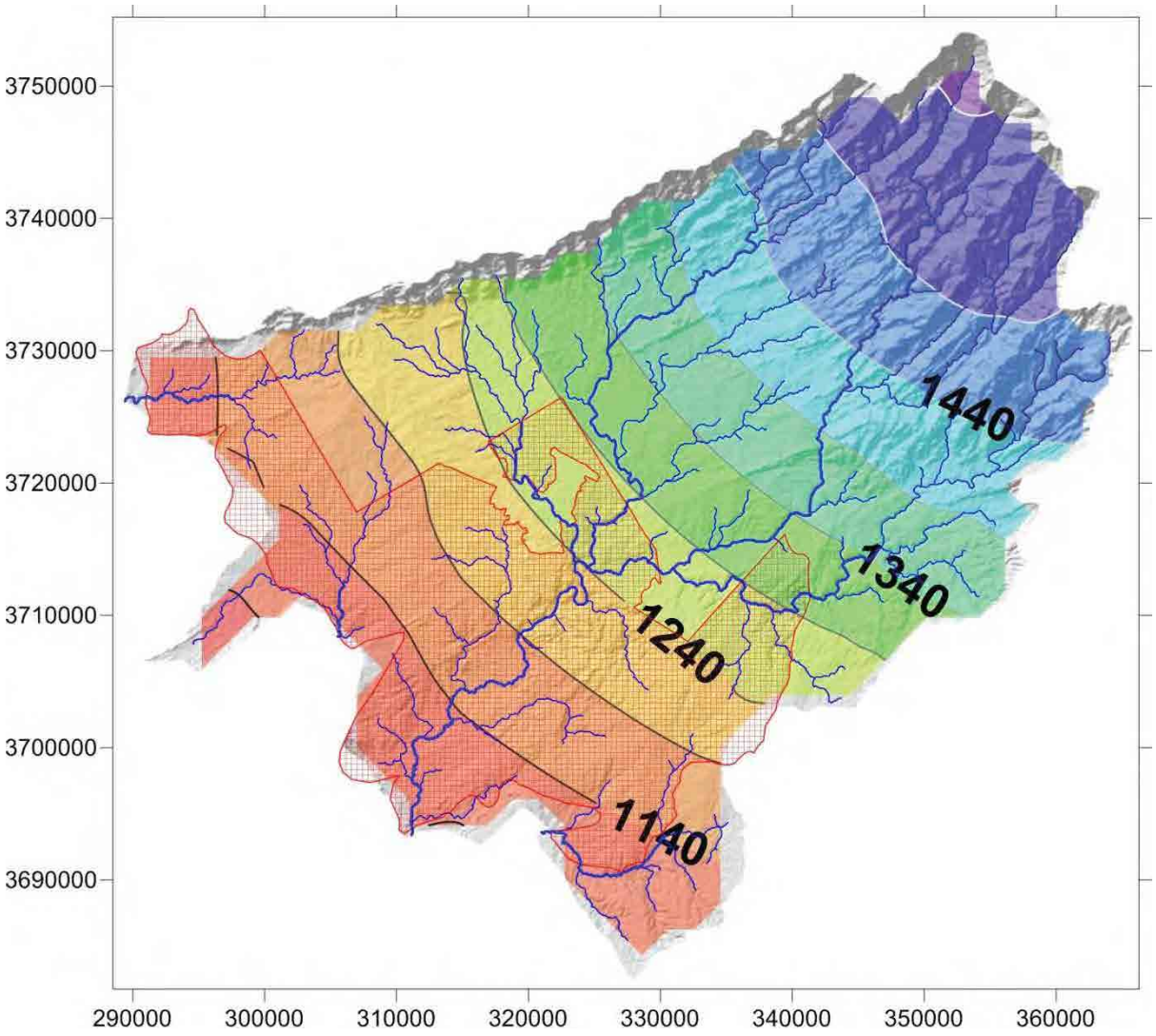


Figure 8 **Map showing mean annual rainfall in upper Soan watershed. RWASA jurisdiction is shown as shaded area within the watershed.**

[11] http://www.pmd.gov.pk/cdpc/Pakistan_mean_rainfall.pdf

1.4. Evapotranspiration

The surface energy fluxes and related evapotranspiration processes across the Indus Basin were estimated for the hydrological year 2007 using satellite measurements[12]. This study generated a map as shown in Figure 9. The study area lies in the ET band ranging from 450mm to 750mm per year. In order to make a conservative estimate of evapotranspiration losses, a planning figure of 700mm per year for the watershed was assumed for this study. The total estimated evapotranspiration losses for the entire watershed are estimated to be 1934 MCM.

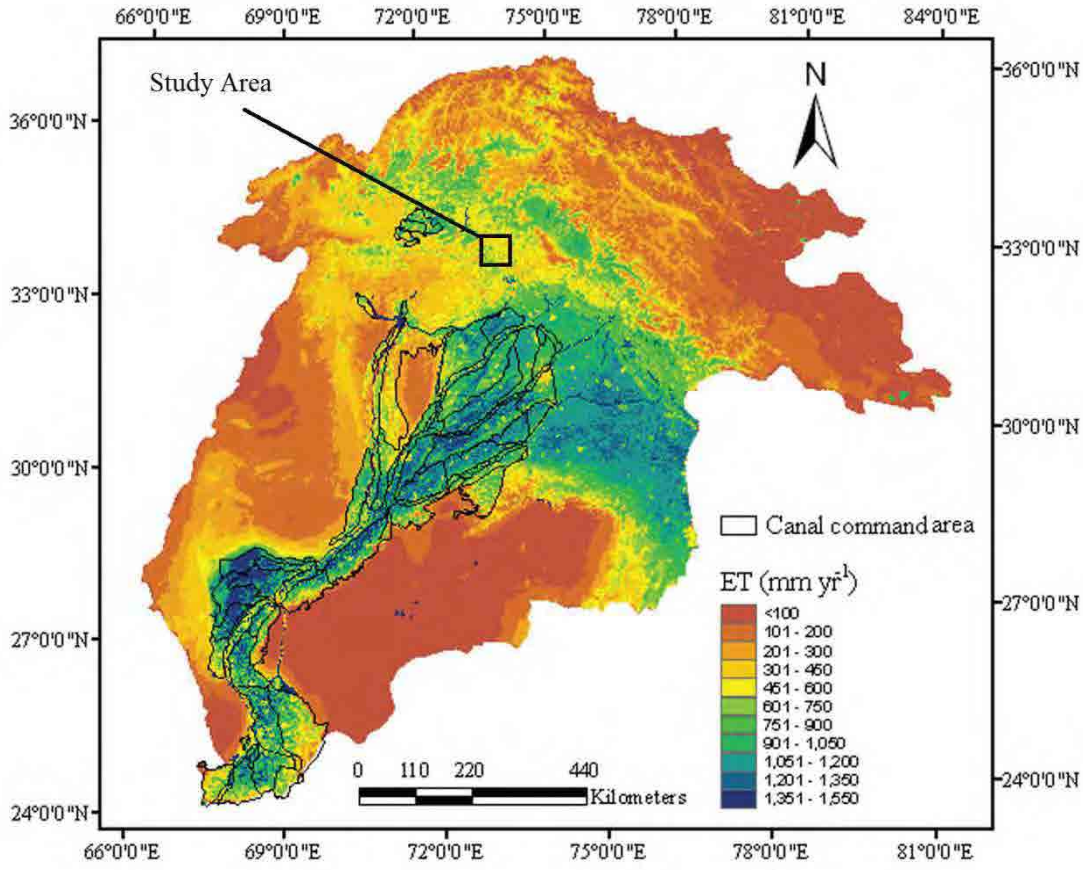


Figure 9 **Evapotranspiration estimates for the entire Indus Basin using MODIS/NOAA data. The Study Area for RWASA is marked within the basin.**

[12] Bastiaanssen, W. G. M., M. J. M. Cheema, W. W. Immerzeel, I. J. Miltenburg, and H. Pelgrum (2012), Surface energy balance and actual evapotranspiration of the transboundary Indus Basin estimated from satellite measurements and the ETLook model, Water Resour. Res., 48

1.5. Net Renewable Water in the Study Area

The difference between rainfall precipitation and evapotranspiration in the area is the net renewable water which is available to flow in streams and rivers and which can be stored in surface and subsurface reservoirs. Subtracting the mean annual evapotranspiration volume of 1936 MCM from the mean annual rainfall volume of 3580 MCM, the net renewable water in the area is estimated to be 1645 MCM for the entire water shed. This may be taken as the planning figure for exploitation of renewable water in a sustainable manner for the entire watershed.

1.6. State of Surface Water

The Soan and Kurang Rivers are the main streams draining the area. Their primary tributaries are the Ling River, draining northwestward into the Soan; Gumreh Kas, draining westward into the Kurang from the area between the Kurang and Soan; and Lei Nala, draining southward into the Soan from the mountain front and urban areas. The Kurang and Soan Rivers are dammed at Rawal and Simbly Lakes, respectively, to supply water for the urban area. Extensive forest reserves in the headwaters of the Kurang and Soan Rivers benefit the quality and quantity of supply. A supplemental network of municipal and private wells as deep as 200 m produces ground water primarily from Quaternary alluvial gravels. The altitude of the water table decreases from about 600 m at the foot of the Margalla Hills to less than 450 m near the Soan River, so that the saturated generally follows the topographic slopes and provides baseflow to Soan River at the dipping altitudes in the watershed. Lei Nala carries most of the liquid waste from Rawalpindi and contributes greatly to the pollution of the Soan River below their confluence. Solid-waste disposal practices threaten the quality of ground-water reserves.

1.7. State of Groundwater

The water table which used to exist in the urban areas at an average depth between 2 to 20 m in the 1980's[13] has now been reached 50 to 90 m[14]. However, regolith depth above the bedrock in most of the study area exceeds 400m. Top 35 m of the surface is overlain mostly alluvium mixed with broken rock fragments. Underneath this layer lies Lei Conglomerate formation, more than 150m

[13] Ashraf, K.M., and Hanif, Mohammad, 1980, Availability of ground water in selected sectors/areas of Islamabad—Phase I and II: Pakistan Water and Power Development Administration Ground Water Investigation Report 35, 30 p

[14] Primary data collected during this study from old 46 UCs.

thick, which forms the aquifer for most of the area. Moreover, the regolith, mostly composed of broken rocks, sandstone, and sand/gravel layers, is well capable of providing unconfined aquifer storage. If managed properly, there is huge aquifer storage space available in the study area. Un-managed exploitation of aquifer and with no managed recharge, the groundwater quality and quantity has issues at present. However, as explained in the chapter on Groundwater Model, the potential of groundwater as one of the most important available resource in the RWASA jurisdiction has been discussed in more detail.

2. GIS Mapping of Existing Infrastructure and Resources

The building of adequate databases through the monitoring of hydrological systems is a fundamental prerequisite of water resources assessment and management. This chapter reviews the adequacy of current monitoring networks and techniques in the light of a changing resource base and evolving water management philosophies related to sustainable development.

Data collection and processing will remain an incessant function throughout the project. A database structure has already been developed in GIS format. All existing/available data has been added to that database. There are both GIS and non-GIS (spatial and non-spatial) data. The database caters for both formats. At the end of the project, the complete database in its soft form will be handed over to RWASA

2.1. Existing Water Supply Infrastructure

Existing water supply infrastructure has been survey by the consultants, in collaboration with RWASA staff. All the GIS based components have been added to GIS Database. No spatial information and tabulated formats of spatial information on existing water supply infrastructure has been provided in Annexure D through H.

2.2. Existing Drainage Infrastructure

Existing drainage infrastructure within RWASA jurisdiction has been survey by the consultants, in collaboration with RWASA staff. All the GIS based components have been added to GIS Database. No spatial information and tabulated formats of spatial information on existing water supply infrastructure has been provided in Annexure D through H.

2.3. Existing Sewerage Infrastructure

Existing sewerage infrastructure within RWASA jurisdiction has been survey by the consultants, in collaboration with RWASA staff. All the GIS based components have been added to GIS Database. No spatial information and tabulated formats of spatial information on existing water supply infrastructure has been provided in Annexure D through H.

3. Water Quality

The review of various studies and periodic testing was undertaken in Study A. From the same review, following important points are drawn and explained below:

3.1. Sources of Pollution

Disposal of the large quantities of liquid and solid waste generated by the combined populations of more than 1.3 million people in Rawalpindi and Islamabad is a major problem that presently causes extensive pollution of ground water, surface water, and air. Islamabad has one of the most modern sewage treatment plants in Pakistan; sewage is carried by pipes to a disposal plant just north of Rawalpindi, where it is treated and the relatively clean effluent passes into a tributary of Lei Nala. Immediately downstream, however, waste water of all types enters Lei Nala as it passes through Rawalpindi. On the south side of Rawalpindi, Lei Nala enters the Soan River as a putrid stream covered with brown foam. Toxic waste may be part of the mixture, as Lei Nala passes through industrial areas, and the Rawalpindi area lacks an organized facility for disposal of toxic waste.

3.2. Solid Waste in Natural Water Ways

Solid waste is also dumped into Lei Nala and at various sites in the surrounding countryside. These sites are generally unsuitable for agriculture, either because of bedrock outcrops or because of gullies in the silt. The waste is spread, burned, and, in some places, covered with a thin layer of soil. These practices represent an attempt to reclaim waste land, and in a few places, crops are planted over the buried waste. Air pollution results from the burning in either case, but potential problems with pollution of surface and ground water are more severe in the bedrock outcrop areas. There is no impermeable barrier between the waste and the exposed bedding planes of steeply dipping permeable sandstone of the Murree Formation, so leachate from the waste can move rapidly into the ground-water flow system. Also, steep slopes in bedrock areas combined with lack of adequate cover material and drainage control structures allow leachate to move rapidly into surface streams. During the summer monsoon, leaching of waste is accelerated by precipitation averaging more than 250 mm/month and maximum temperatures averaging more than 34°C. Control of ground-water pollution is important because municipal and private wells are used extensively in Islamabad and Rawalpindi to supplement supplies from the Rawal and Simbly Lakes.

Potentially favorable sites for waste disposal near Rawalpindi exist in exhausted clay pits within the Postwar Clay. Compacted clay-rich silt has low permeability, and areas of silt suitable for cover can

usually be found. When properly engineered, filled, and covered, the reclaimed pits may be suitable for low-intensity uses such as agriculture, storage yards, or parks and recreation.

3.3. Flooding

Lei Nala heads in the Margalla Hills and passes through the center of Rawalpindi, where homes and lives have been lost to flooding in low-lying areas. Although the stream is relatively small, it is entrenched, so floodwaters are confined to the narrow flood-plain zone at the valley bottom. This confinement increases the depth and suddenness of flooding in the small area affected but protects most of the population, who live above flood level. If continued losses are to be minimized, land use in the affected areas may have to be changed. Wide flood plains along the Soan River above the Grand Trunk Road bridge are subject to flooding but are not densely populated. Expansion of residential or industrial development onto the Soan flood plain should be carefully controlled, although dams on tributaries to the Soan help to reduce potential problems.

3.4. Waste Disposal

Disposal of the large quantities of liquid and solid waste generated by the combined populations of more than 1.3 million people in Rawalpindi and Islamabad is a major problem that presently causes extensive pollution of ground water, surface water, and air. Islamabad has one of the most modern sewage treatment plants in Pakistan; sewage is carried by pipes to a disposal plant just north of Rawalpindi, where it is treated and the relatively clean effluent passes into a tributary of Lei Nala. Immediately downstream, however, waste water of all types enters Lei Nala as it passes through Rawalpindi. On the south side of Rawalpindi, Lei Nala enters the Soan River as a putrid stream covered with brown foam. Toxic waste may be part of the mixture, as Lei Nala passes through industrial areas, and the Rawalpindi area lacks an organized facility for disposal of toxic waste.

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3.5. Rawal Lake Pollution Control

Rawal Lake is one of the major sources of drinking water for RWASA jurisdiction by it is prone to pollution due to rapidly expanding population centres in its catchment area. Most of these expansions are unplanned and unregulated and are dumping their solid waste and sewerage into the water channels leading to the Lake.

A comprehensive survey was carried out by the consultants to identify locations of pollution into the Lake. The following figure shows the point sources of pollution into the lake.

Annexure F through C give the description of each of these pollution sources and the type of pollution they are creating.

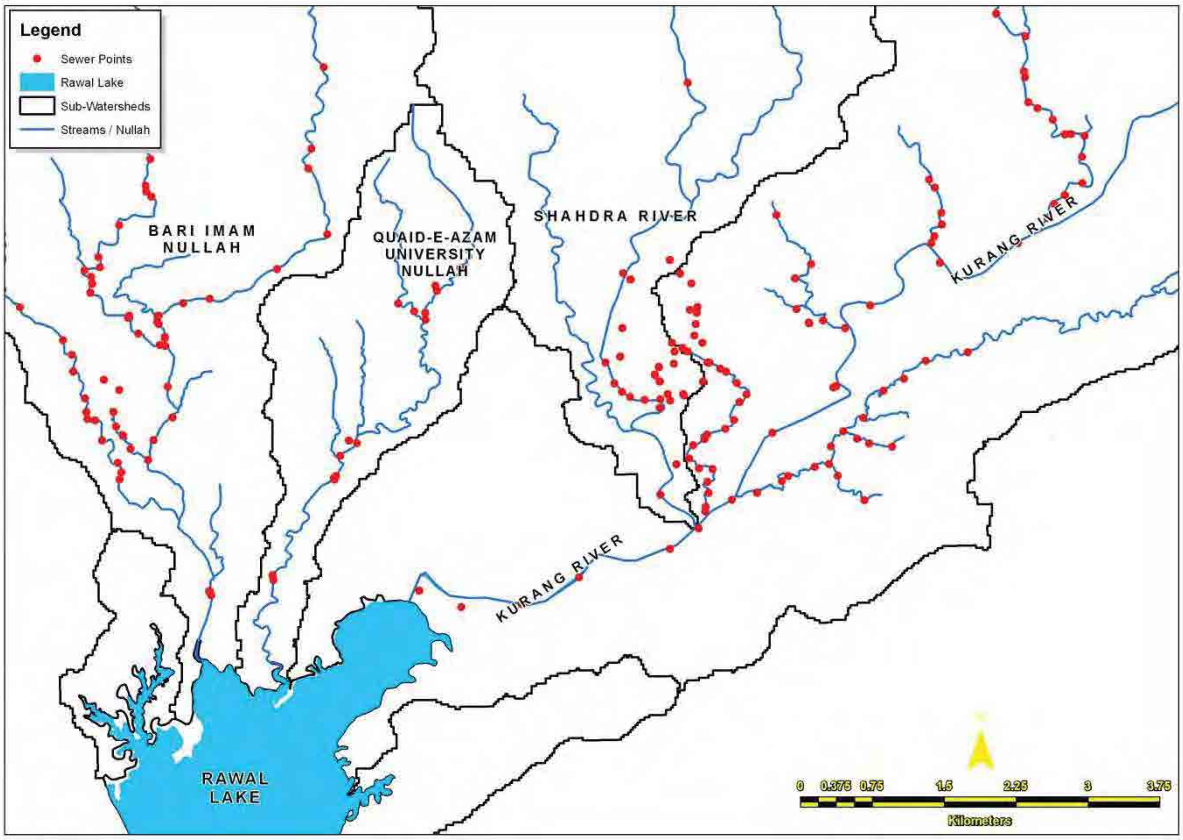

Figure 10 Sources of pollution in Rawal Lake

4. Groundwater Flow & Transport Model

The groundwater flow and transport model presented in this study was prepared using Interactive Groundwater (IGW)[15] – a numerical modeling system based on Modflow and MT3D algorithms. IGW is a finite difference groundwater flow and transport modeling system which solves the following partial differential equation within the model domain:

The partial differential equation describing flow in porous medial is usually written as

$$S_s \frac{\partial h}{\partial t} = \frac{\partial}{\partial X_i}(K_{ij} \frac{\partial h}{\partial X_j}) + q_s$$

Where S_s = the specific storage of the aquifer materials [L^{-1}],

h = the hydraulic head [L],

K_{in} = the hydraulic conductivity tensor [L/T]

X_i = the Cartesian coordinate [L], and

q_s = the source/sink term [T^{-1}].

The depth-averaged form of the equation (where depth is *b*) can be presented as follows which was used for the layered based geological layers in the model

$$S \frac{\partial h}{\partial t} = \frac{\partial}{\partial X_i}(T_{ij} \frac{\partial h}{\partial X_j}) + Q_s$$

where $S = S_s b$ = the storage coefficient [-],

$T_{ij} = K_{ij} b$ = the transmissivity tensor [L^2/T], and

$Q_s = q_s b$ = the source/sink term [L/T]

Layer based modeling was carried out for which the latter equation was solved for the model domain.

[15] IGW Reference Manual for Version 3. Copyright © 2003 by Dr. Shuguang Li and Associates at Michigan State University. All rights reserved.

4.1. Purpose of the Model

The purpose of building a numerical groundwater model was to understand the flow dynamics of the aquifer under RWASA jurisdiction and to assess the sustainable capacity of the aquifer to supply good quality potable water in RWASA jurisdiction

4.2. Conceptual Model

After studying the general layout of topography, rainfall pattern, stream flows, natural drainage network, geology and anthropological stresses, a conceptual model for RWASA jurisdiction was made as illustrated in Figure 11

4.2.1. Sources

Rainfall infiltration is reckoned as the primary source of recharge to the aquifer. Other sources include seepage from dams and large streams. Wastewater disposal in natural water ways also infiltrates in the aquifer.

4.2.2. Sinks

Groundwater abstraction is one of the major anthropogenic sink of groundwater. Natural sinks include boundary flow and baseflow.

4.2.3. Contaminant Transport

Leachate from solid waste and infiltration of waste water into the aquifer after being disposed off in the natural water courses are the major sources of contamination of groundwater.

4.2.4. Physical components of the Aquifer

The physical components of the aquifer include high infiltration zones in the higher altitudes while the infiltration is variable in the lower altitudes. Paved surfaces in the built up areas act as impervious surfaces where infiltration almost nil. The major water bearing formation is Lei Conglomerate which is approximately 150m thick. Quaternary gravel beds within Lei formation form the most productive aquifers. Beneath Lei Conglomerate is Soan Formation, approximately 250m thick, primarily composed of shale and sandstone. Above Lei Conglomerate are alluvium deposits with thickness varying from 3m to 35m. There are no well defined and continuous impervious layers which may produce confined aquifer conditions. Most of the aquifer is, therefore, unconfined within Lei and Soan formations

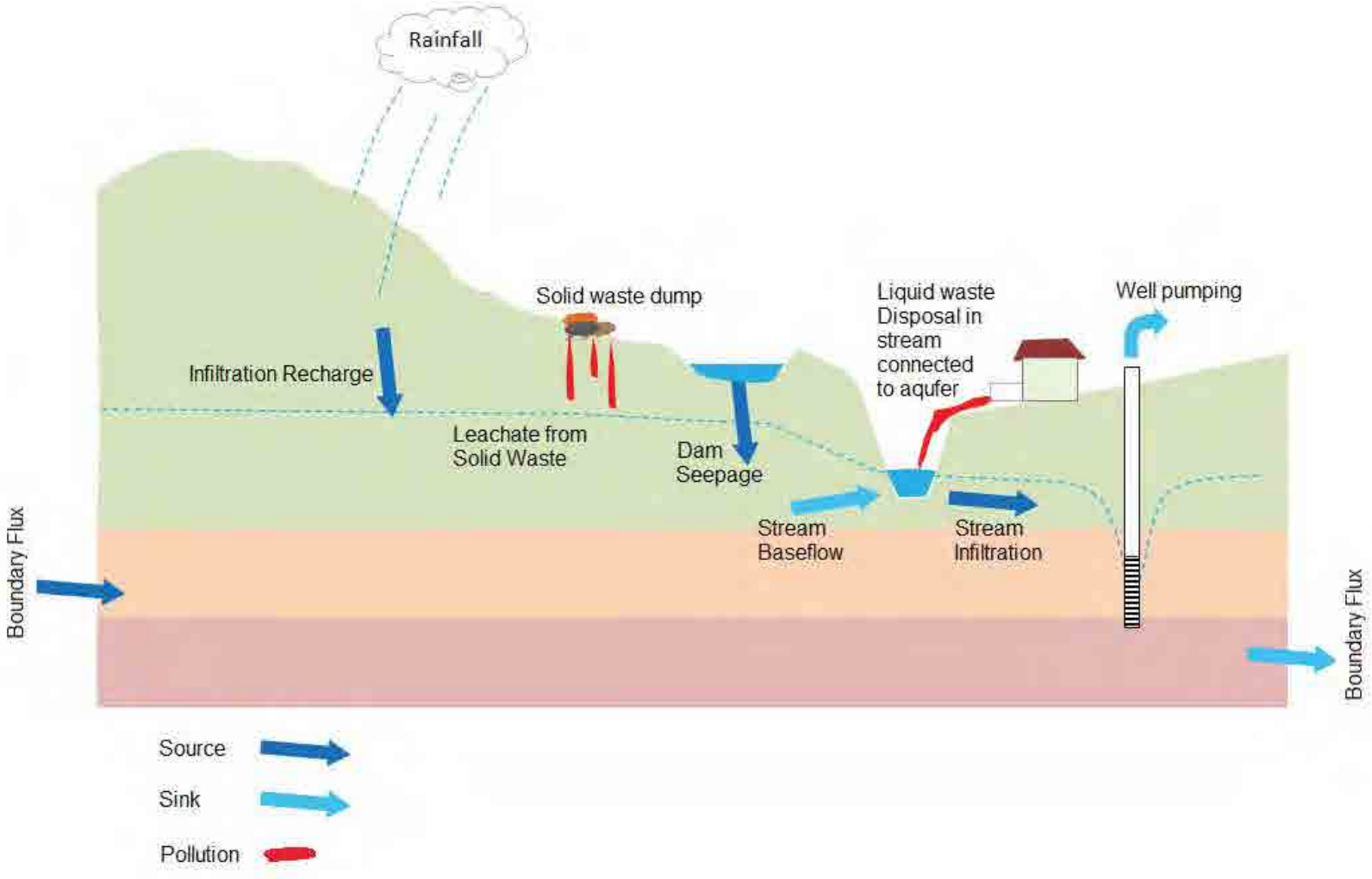

Figure 11 Groundwater conceptual model

4.3. Delineation of Model Domain

In an ideal situation, a groundwater model's boundaries should coincide with physical no-flow boundaries. However, seldom this condition is completely fulfilled. So was the case for the groundwater model presented in this study, however, an attempt was made to be as ideally close to natural no-flow boundaries around the model domain as possible.

RWASA Jurisdiction does not conform to the natural boundaries which define surface or sub-surface hydrologic regime. The model boundaries, therefore, were extended to the nearest watershed boundaries outside RWASA Jurisdiction. The following map shows RWASA boundary with respect to various watersheds in the area. Total area of RWASA jurisdiction is 873 square kilometer, whereas the model area, thus formed was 2763 square kilometer.

The model domain thus becomes the upper watershed of Soan River. The model area is typically bounded in the north and north west by well defined crest of Margalla Ridge. To the east, the model boundaries run over the less conspicuous ridge lines defining the watershed of Soan and its tributaries.

To the south, the model boundaries were truncated along the boundaries of RWASA Jurisdiction. These boundaries approximately follow the soft no-flow condition as the groundwater converges to Soan and its tributaries. It is expected, however, that model results are less certain because of this less robust boundary condition.

The model domain in shown in Figure 12 on the backdrop of a satellite image covering the entire region around RWASA Jurisdiction and the complete model domain. For better visualization of watersheds, the same image is presented in perspective view in Figure 13.

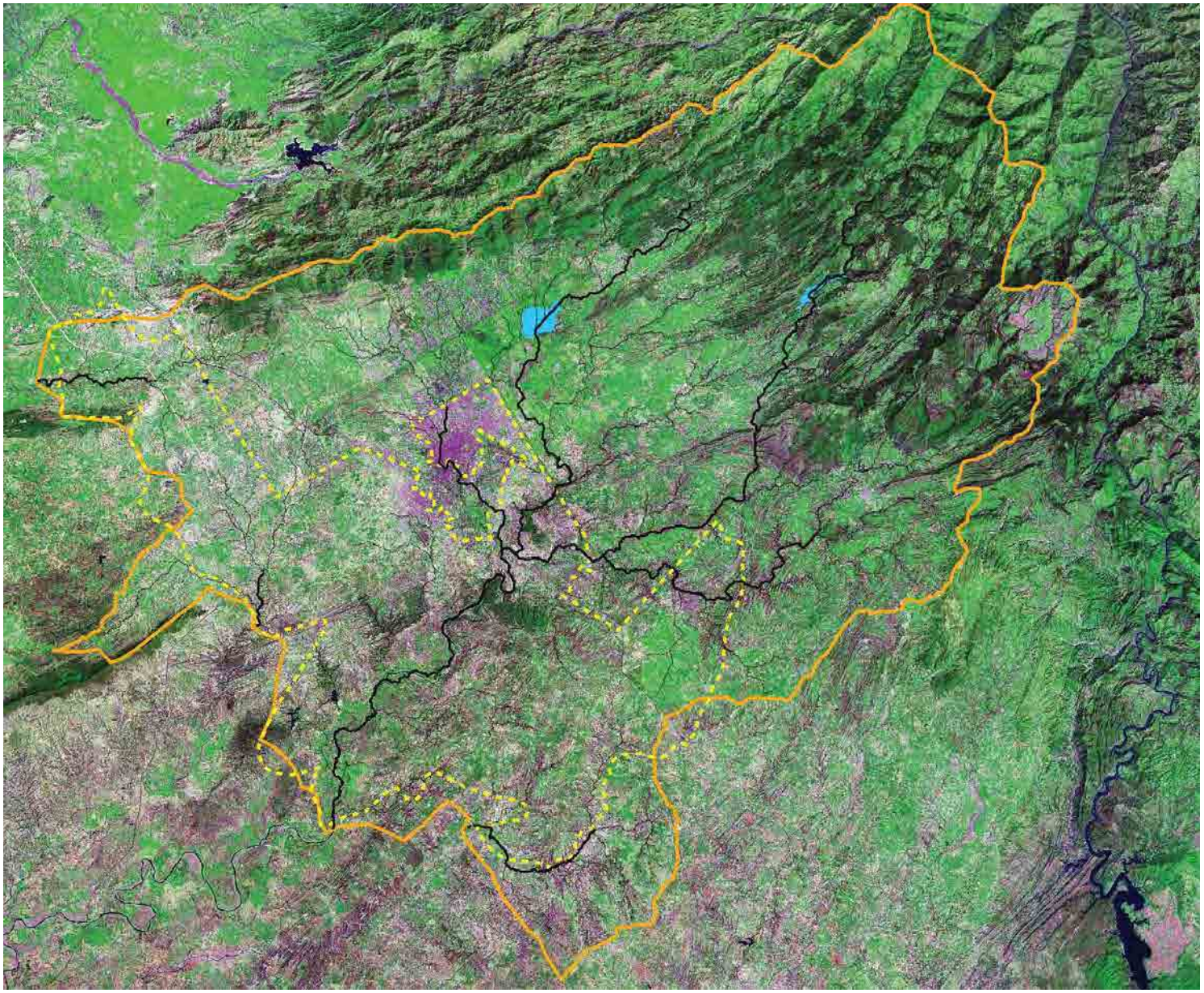

Figure 12 Model Domain

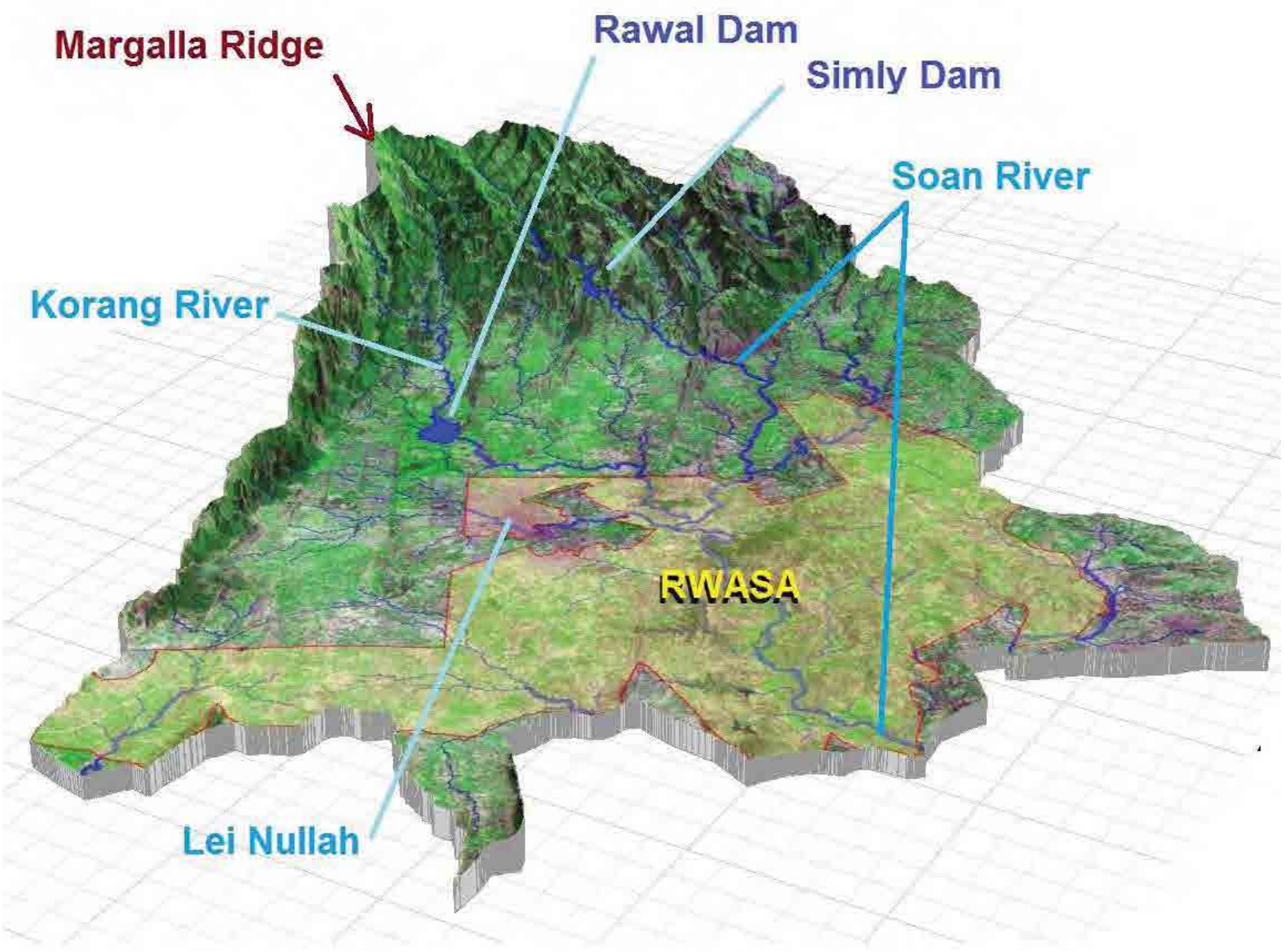

Figure 13 Model Domain, perspective view.

4.4. Model Constraints

The groundwater model presented in this study only captures the regional dynamics of the sub-surface flow system within its domain. The water balance and flow regime presented in the model delineates regional water budget and flow directions and should be used with caution if interpretation is to be made for a local area the size of a single UC (especially the old 46 UCs which have very small areas compared to newly added UCs).

The regional scale model was built using secondary data only as there were no specific provisions of physical hydrogeological investigations for the sake of groundwater model development, calibration or validation. The model interpretation, therefore, may be made within the constraints of available secondary data set (as explained in following sections) and the regional scale dynamics which were the primary focus of the model.

4.5. Data

Following data sets were employed for development of the model, its calibration and validation. The data sets are listed as follows and shown from Figure 14 through Figure 21

4.5.1. Bore Logs and Water Wells

Three sources of data on bore logs and water wells were used as follows:

- Primary data taken from RWASA wells in old 46 UCs
- Well logs from USGS geological investigations in CDA Area
- Well logs and resistivity survey data from various UCs of RWASA conducted for PHED Water Supply Scheme and other similar works[16] and shown in Annexure I

4.5.2. Hydraulic Properties of the Aquifer

Satellite images from Landsat data were used to identify vegetation and density of construction in the built-up areas

Topography was acquired from 30m DEM

Soils maps from Soil Survey of Pakistan was used to assign

[16] Various reports prepared by Zahid, et. al, Tatara Engineering, Wah Cantt, Rawalpindi

Geological subdivisions of the study area were ascertained from the Geological Maps acquired from Geological Survey of Pakistan and USGS Report on the geology of Rawalpindi and Islamabad region

Precipitation data, representing mean annual rainfall in the study area, was obtained from Pakistan Meteorological Organization

4.5.3. Hydrology

Stream network was delineated by using 30m DEM and GIS tools. In the groundwater model, 2nd and 3rd order streams were used at regional scale discretization. The former were modelled as drains while the latter was considered 2-way streams.

River flow data and rainfall/runoff relationships for the natural conditions (i.e. before the construction of Rawal Lake and Simly Dam) were acquired through extensive literature search from the archives of CENTO hydrological studies of the region.

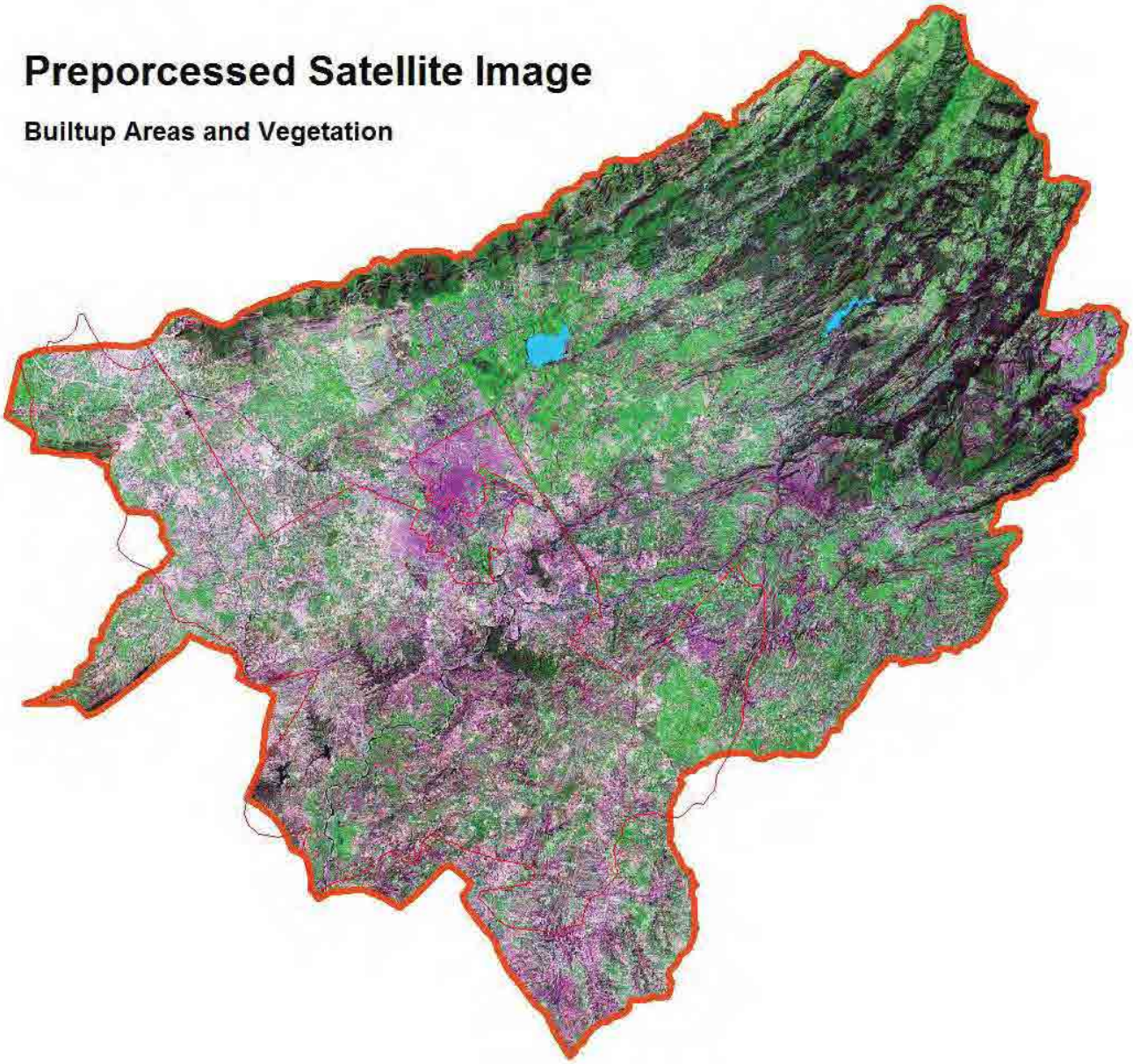

Figure 14 **Preprocessed satellite image of the study area giving vegetation and built-up areas (from UC Berkley data portal)**

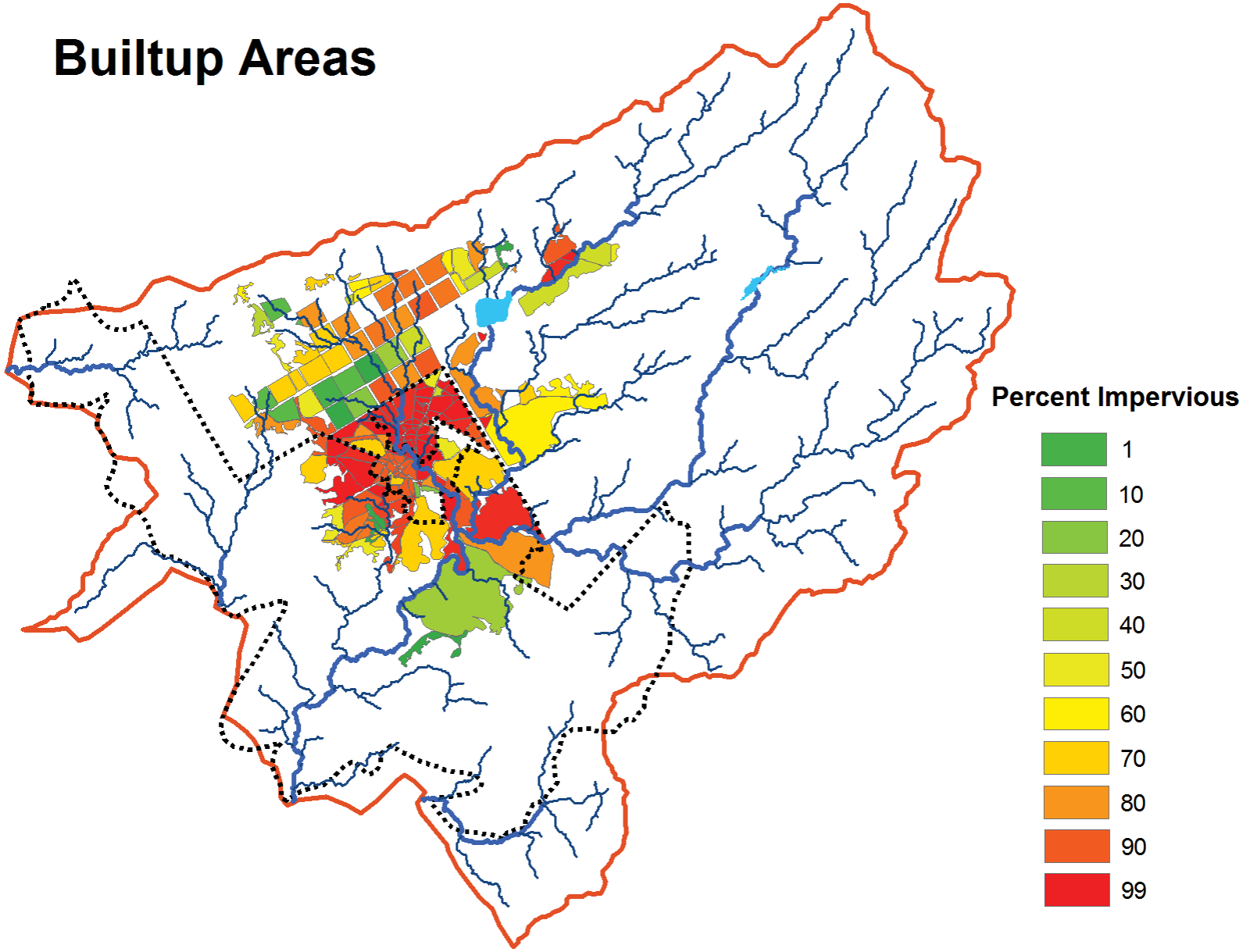

Figure 15 Density of construction in urban areas derived from satellite data

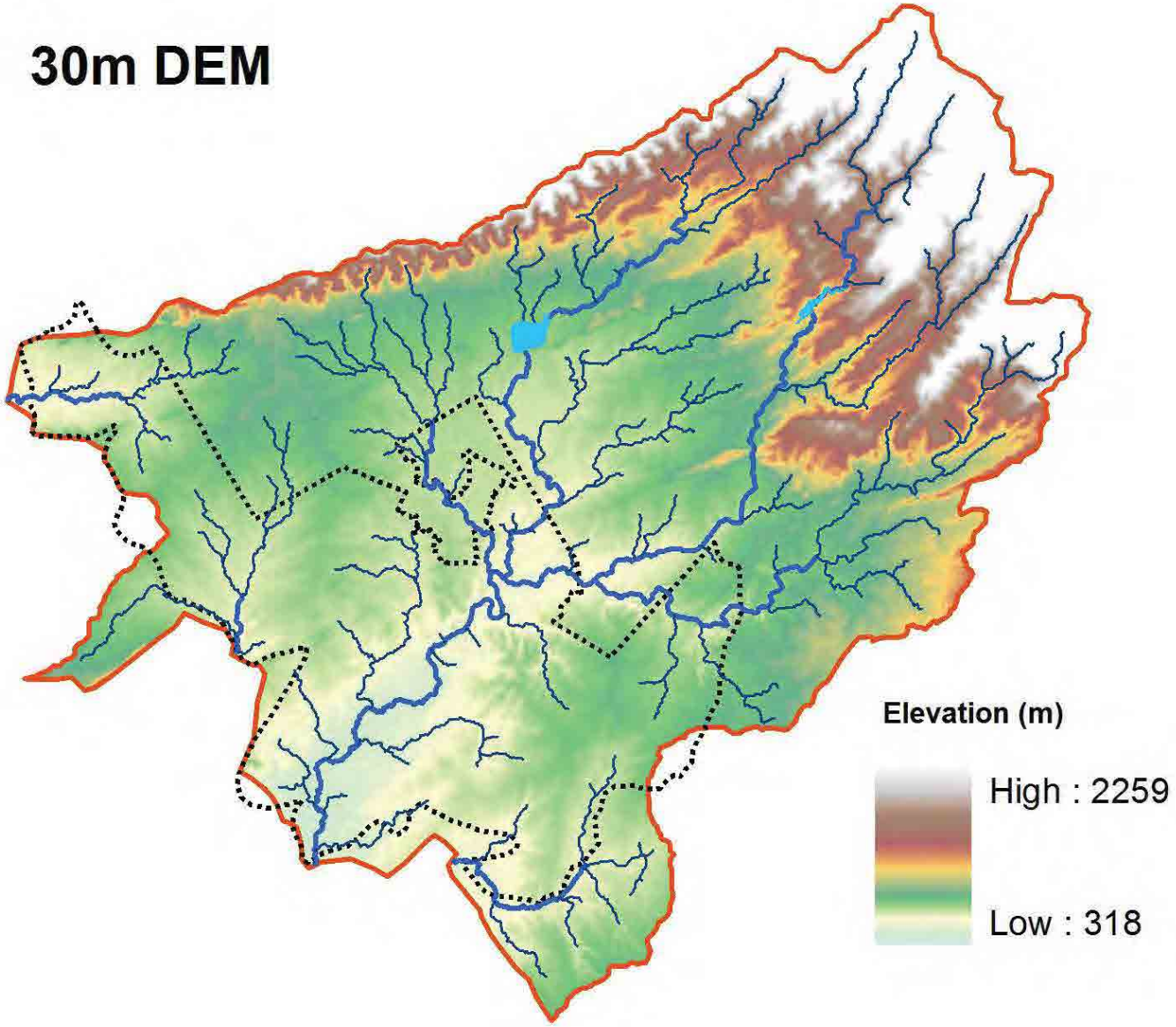

Figure 16 30m DEM for groundwater model domain

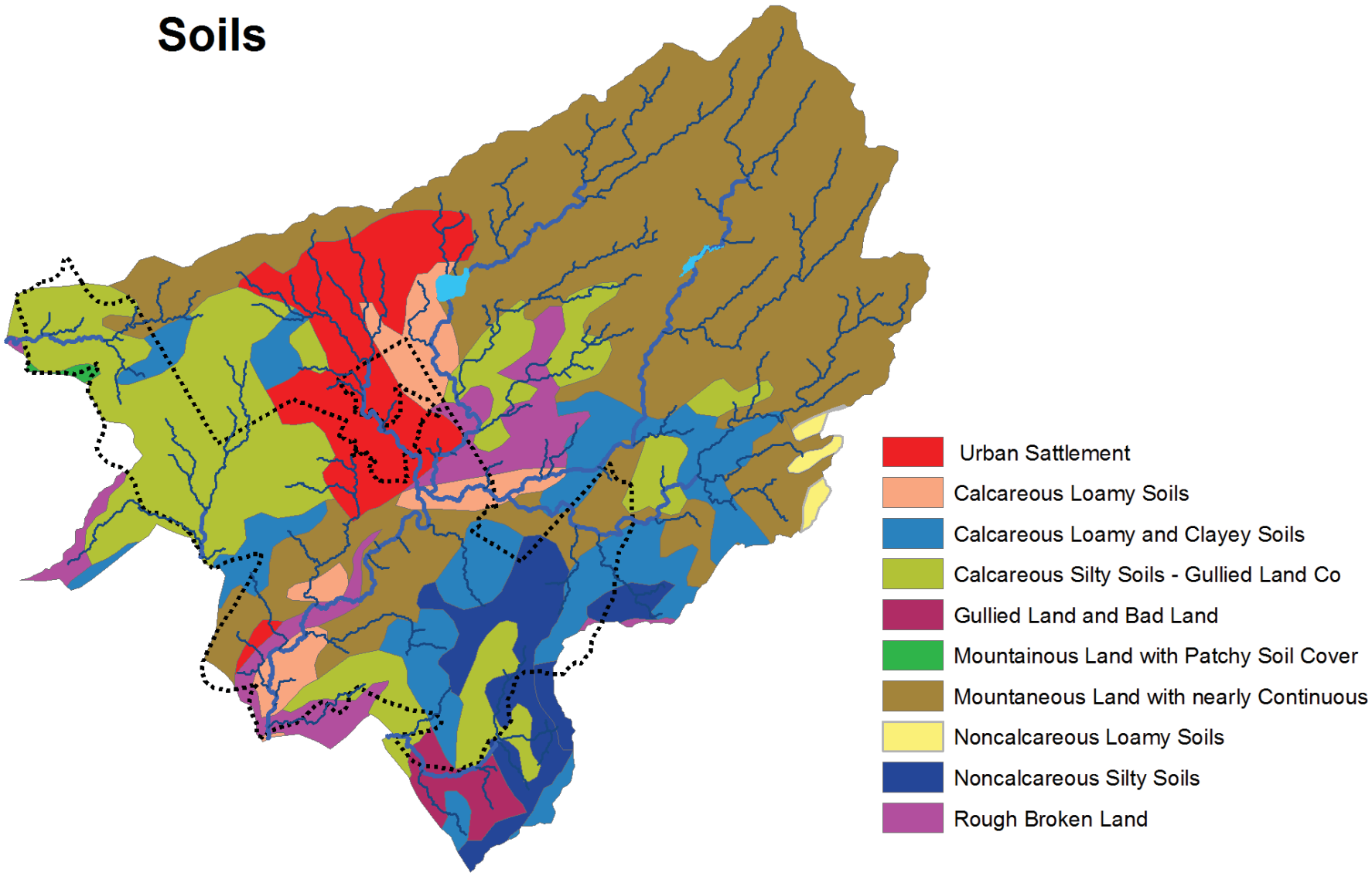

Figure 17 Types of soils in groundwater model domain

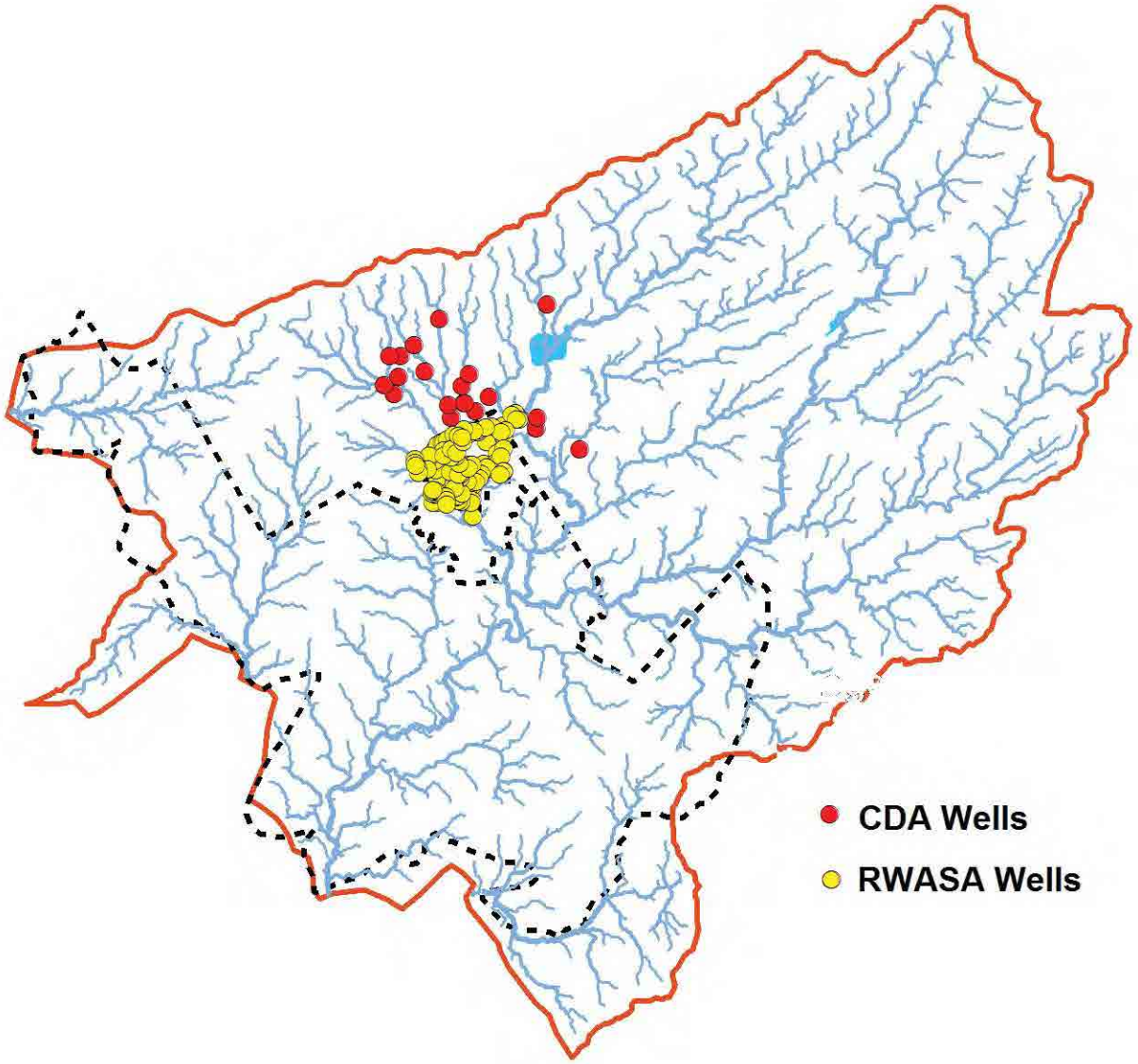

Figure 18 Wells

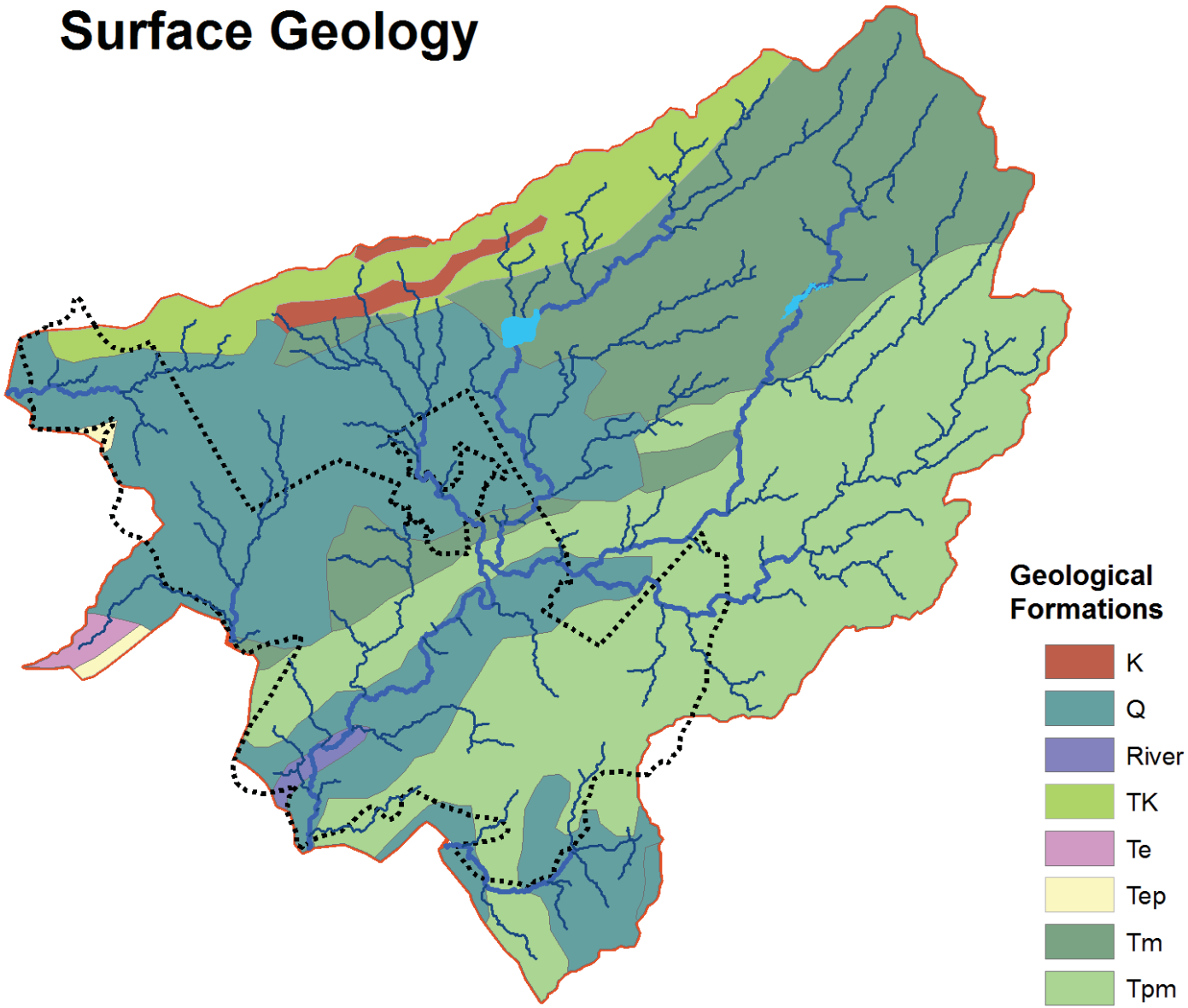

Figure 19 Geological units in groundwater model domain

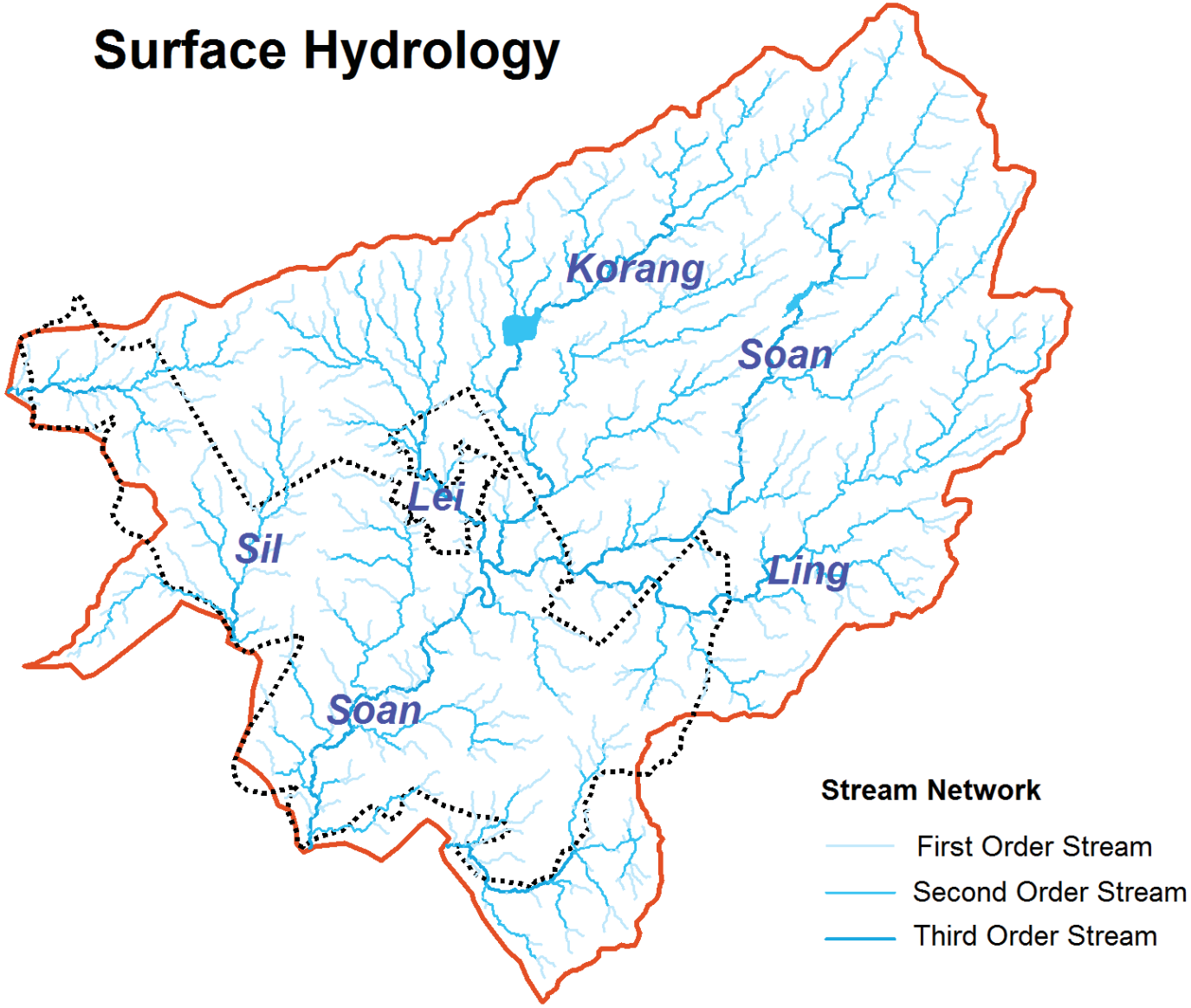

Figure 20 Surface hydrology network derived from 30m DEM

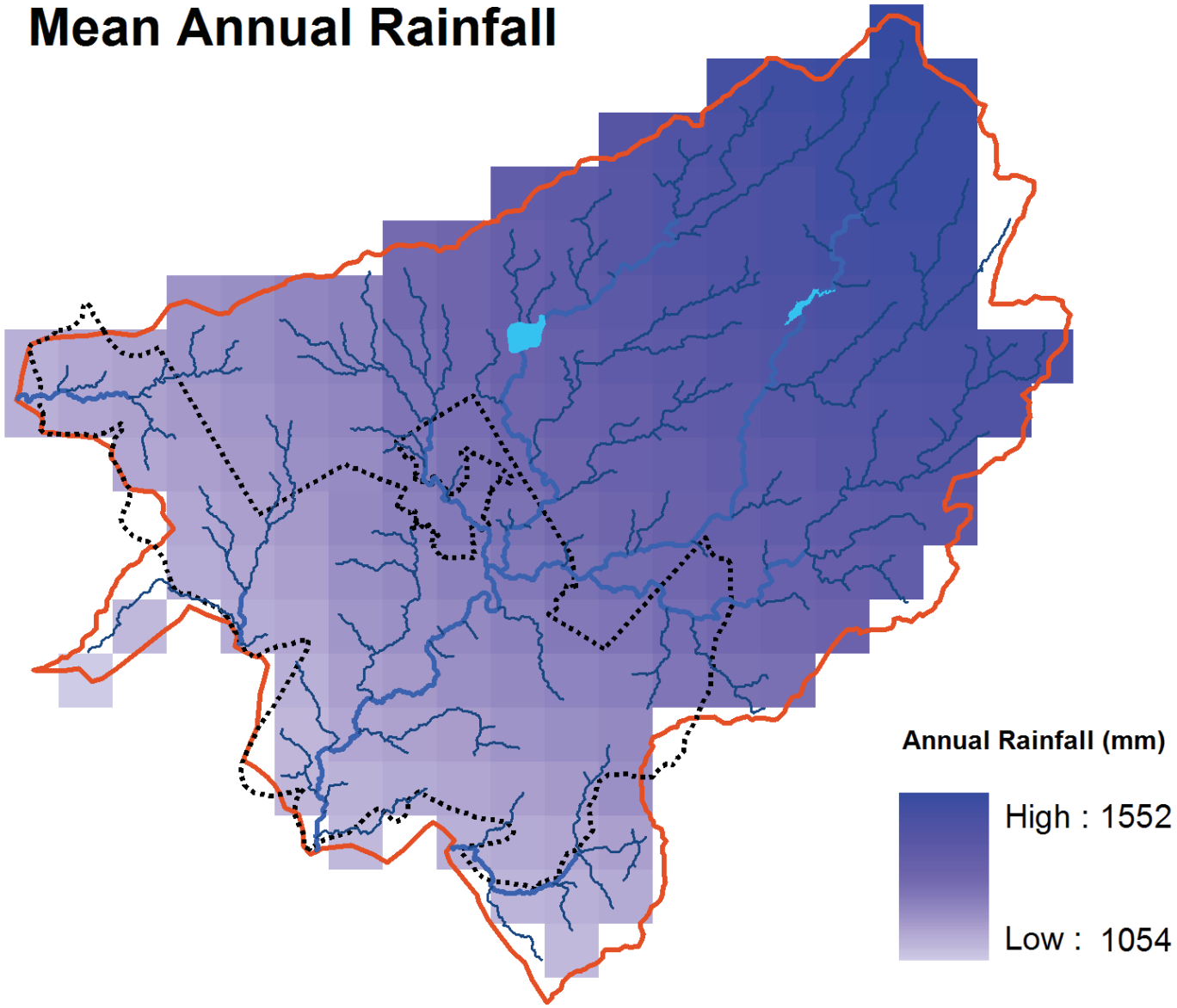

Figure 21 Mean annual rainfall distribution in groundwater model domain derived from PMO preprocessed data

Evapotranspiration Estimates were obtained from NOAA/MODIS pre-processed map for the Indus Basin. The band for the study area lies between to 450 to 750 mm per year for the study area.

4.6. Geologic History of the Aquifer

Un-cemented conglomerate beds are the most important ground-water aquifer in the area. The Lei Conglomerate is interpreted as an alluvial basin-fill sequence of coarse, angular gravel derived from the uplifting Margalla Hills to the north interbedded with finer sediment derived from sandstone and shale of the Rawalpindi Group and windblown silt. The unit was deposited along the axis of the subsiding Soan syncline. Cemented conglomerate beds are resistant to erosion and form ledges and hills.

By Miocene time, the sea had completely receded south of the study area, and during the Miocene and Pliocene, very thick continental deposits of the Rawalpindi and Siwalik Groups accumulated in the subsiding Himalayan foredeep region. These deposits consist of sediments eroded from highlands to the north that were uplifted and deformed by tectonic forces in the zone of convergence.

During the Pliocene, sedimentation was controlled by an eastward-flowing river system (Reynolds, 1980). The conglomerate of the Soan Formation that was deposited by that river system during the late Pliocene consisted chiefly of quartzite and metamorphic clasts eroded from the Himalayan core and are similar to clasts in modern Indus River. The eastward-flowing river system was disrupted and superseded by the much smaller, southward-flowing Soan River system, and locally derived limestone gravel became the dominant component of the Lei Conglomerate; this conglomerate accumulated most thickly over the Soan Formation.

During the Quaternary, climatic fluctuations along with tectonic uplift caused periodic incision of the drainage south of the Margalla Hills and alternate periodic accumulations of silt and alluvial gravel from the Margalla Hills, which filled the valleys and spread laterally to form wide plains of low relief.

These depositional history explained above now comprise the aquifer formations underneath the study area. A supplemental network of municipal and private wells as deep as 200 m produce ground water primarily from Quaternary alluvial gravels. The altitude of the water table decreases from about 600 m at the foot of the Margalla Hills to less than 450 m near the Soan River. Soan River

and its tributaries get their baseflow from the aquifer and thus from the natural sink for the aquifer in the study area.

4.7. Characteristics of the Aquifer of Rawalpindi

The Soan and Kurang Rivers are the main streams draining the area. Their primary tributaries are the Ling River, draining north-westward into the Soan; Gumreh Kas, draining westward into the Kurang from the area between the Kurang and Soan; and Lei Nala, draining southward into the Soan from the mountain front and urban areas. The Kurang and Soan Rivers are dammed at Rawal and Simly Lakes, respectively, to supply water for the urban area. Extensive forest reserves in the headwaters of the Kurang and Soan Rivers benefit the quality and quantity of supply. Lei Nala carries most of the liquid waste from Rawalpindi and contributes greatly to the pollution of the Soan River below their confluence. Solid-waste disposal practices threaten the quality of ground-water reserves.

Lei Nala heads in the Margalla Hills and passes through the center of Rawalpindi, where homes and lives have been lost to flooding in low-lying areas. Although the stream is relatively small, it is entrenched, so floodwaters are confined to the narrow flood-plain zone at the valley bottom. This confinement increases the depth and suddenness of flooding in the small area affected but protects most of the population, who live above flood level. If continued losses are to be minimized, land use in the affected areas may have to be changed. Wide flood plains along the Soan River above the Grand Trunk Road Bridge are subject to flooding but are not densely populated. Expansion of residential or industrial development onto the Soan flood plain should be carefully controlled, although dams on tributaries to the Soan help to reduce potential problems.

Debris flows issuing from mountain canyons onto alluvial fans at the mountain front create another flooding hazard that is less easily recognized than most conventional flood hazards. Infrequent, extreme precipitation events may trigger such flash floods of mud, boulders, and water, but during the periods between events, sediment accumulates in the mountain canyons, and the longer the time between flushing events, the more violent may be the final release. Deposits from such events seem to occur in northern Islamabad in parts of Sectors F6, E8, F8, E9, F9, and E10.

4.8. Model Outputs

Model was run for steady state simulation of the mean annual hydrologic conditions. The existing pumping was also simulated in the model. After calibration and validation of the model, the final steady state water balance matched the regional water budget for rainfall, evapotranspiration and stream flow. Model out puts with water budgets are shown in Figure 22.

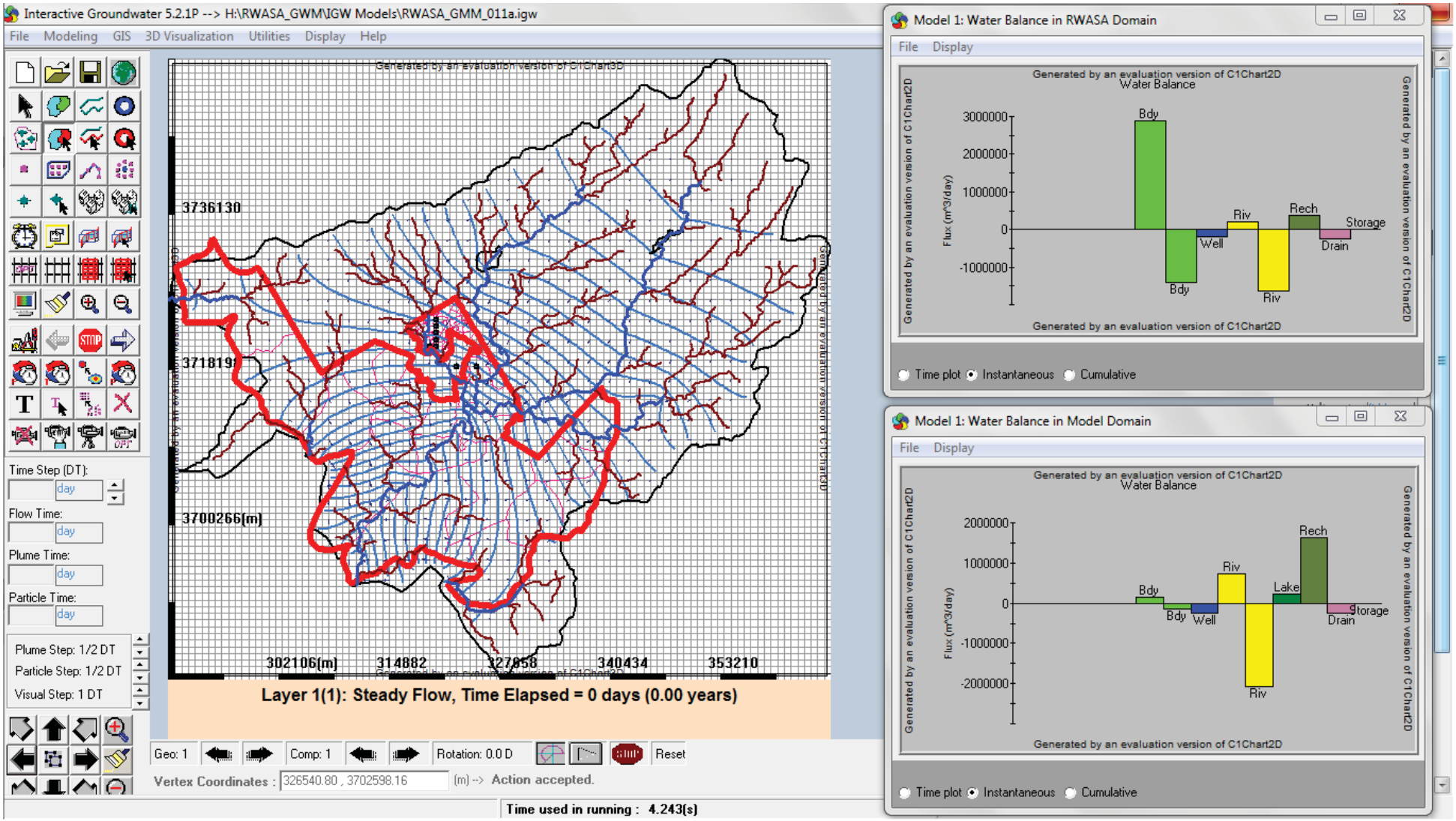

Figure 22 Steady state model out puts to simulate existing conditions of recharge and pumping.

The model explains that the groundwater regime in the water shed is receiving most of its recharge in the hilly areas of the north, especially in the zone marked by fan alluvium at the foothills of mountains. Lower Soan Basin, which mostly lies within RWASA jurisdiction, is the major discharge zone of groundwater, giving baseflow to the river, as shown in

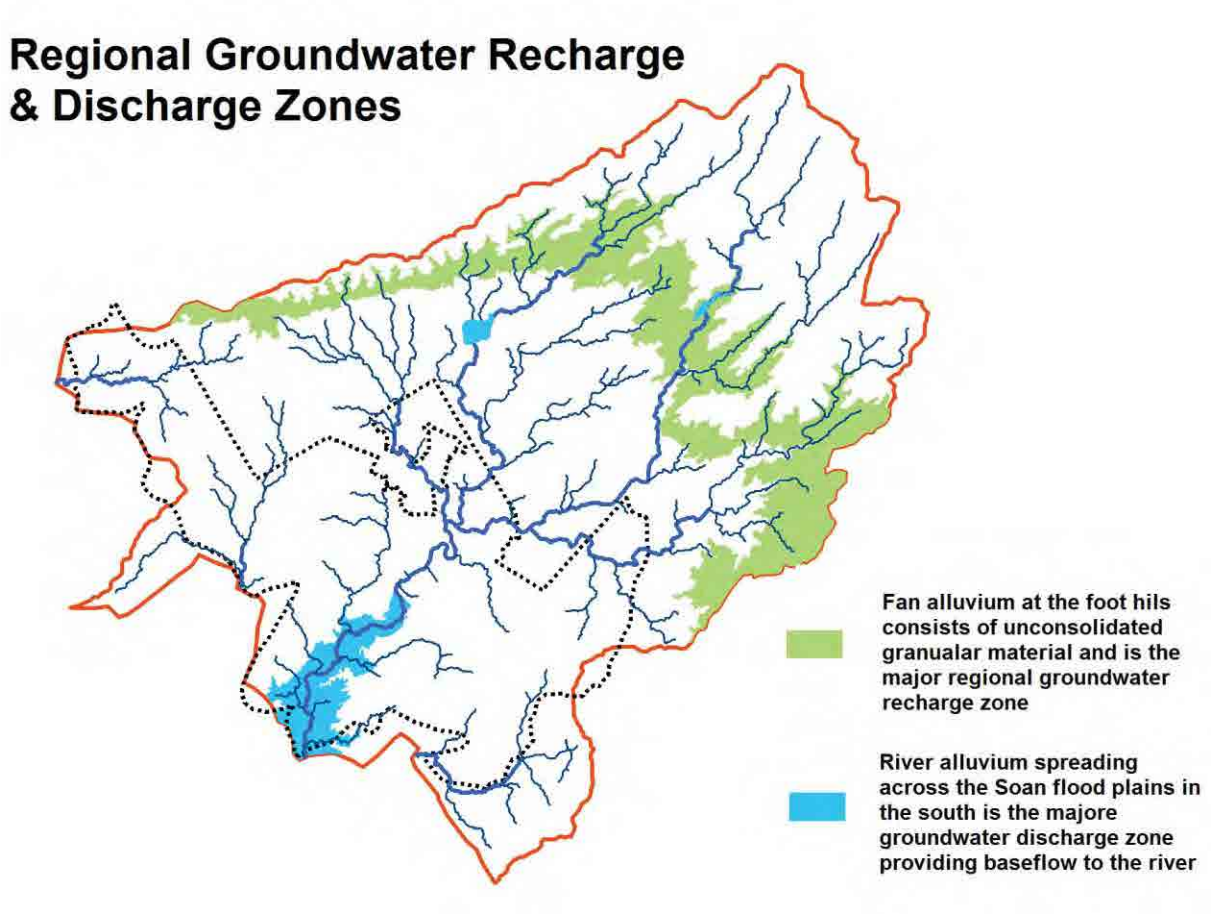

Figure 23 Major recharge and discharge zones of the groundwater regime

RWASA jurisdiction, as a consequence, is not contributing as much to the recharge of the aquifer but contributing to most of the discharge through river baseflow and municipal pumping. The water budget of the steady state model also suggests that there is a lot of groundwater flow moving into RWASA jurisdiction as boundary flow. This situation may be exploited by putting a well field in lower Soan Basin. The model was used to simulate high capacity well fields and suggested that up to 280 mgd well field, as shown in Figure 24, in the basin can be installed. However, this figure may be treated with caution because a regional scale may not capture local details for individual high capacity wells. The potential of groundwater in this area for future development, however, may be there.

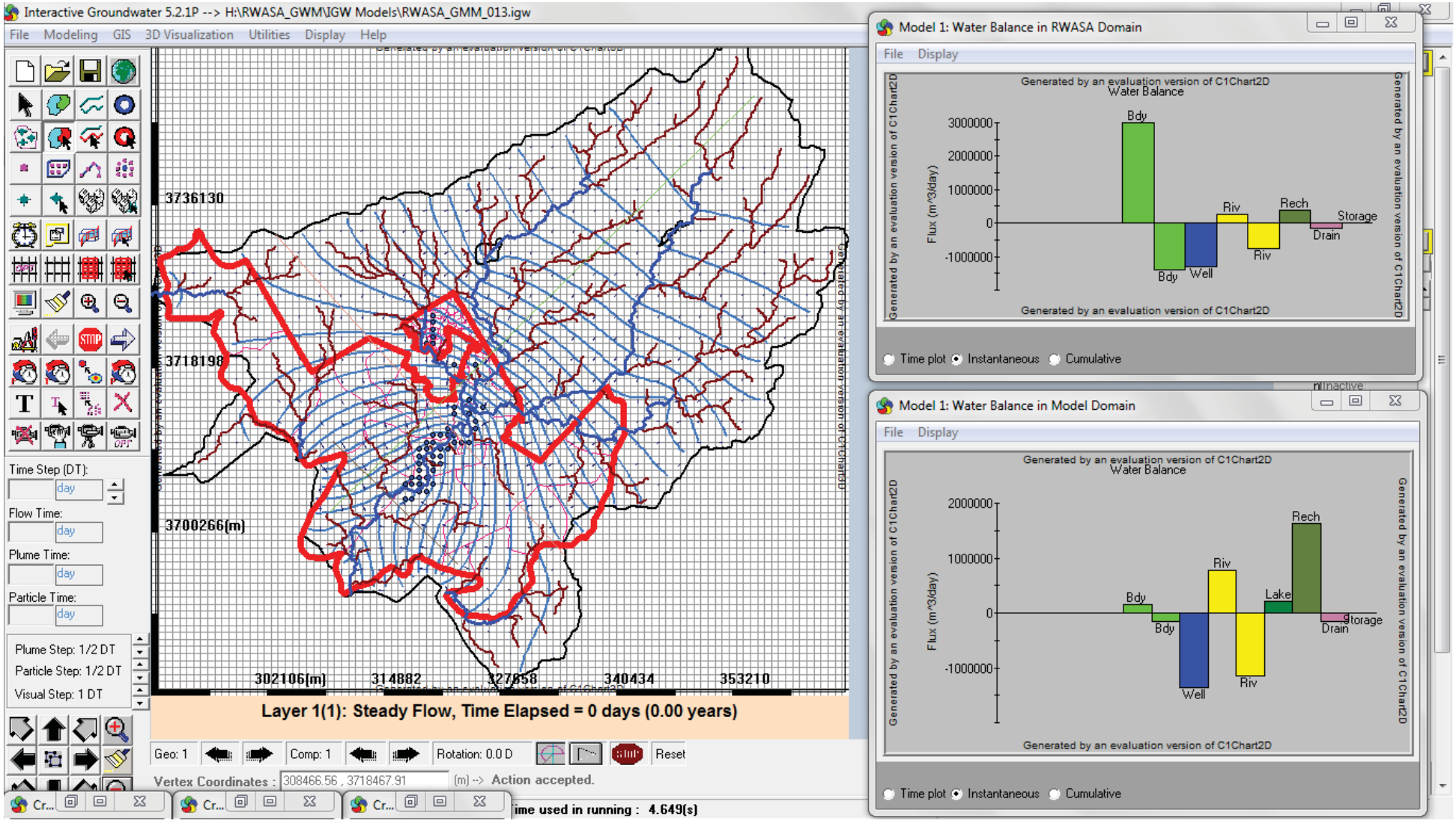

Figure 24 Steady state simulation of model with augmented recharge and 280 mgd well field closer to river in the Soan Main sub-watershed.

4.9. Recommendations from Modeling Exercise

Based on the groundwater modeling exercise in this study, following recommendations are made:

- The model has identified high recharge zones within the watershed. RWASA and other governing bodies within the modeling domain (such as CDA, ICT, etc.), may coordinate for the collective good of the shared aquifer. The cooperation may entail:
- Plans, bylaws and enforcement for the protection of sensitive aquifer recharge zones for long term sustainability and maintaining good water quality in the aquifer.
- Urban areas should be designed on the principles of IUWM / WSUD (as explained in the subsequent chapters) to enhance aquifer recharge and prevent pollution.
- Proper urban recharge management plans should be developed within the watershed.

4.10. Aquifer Potential

The preliminary groundwater modeling exercise covering the watershed scale shows a good potential of aquifer as reliable resource for future. However, it must be borne in mind that the aquifer modeling was only based on secondary data as there were no provisions within the scope of this study to carry out expensive field investigations such as deep drilling and yield tests. In the absence of such validation, specific locations of high capacity wells and detail design of well fields is not possible. It is recommended, therefore, that the areas recommended for installation of well fields may be investigated with primary data and hydrological testing.

5. Integrated Water Resources Management (IWRM)

Sustainability is the key concept on which exploitation and utilization of water resources for RWASA have been proposed in this study. The study takes advantage of the basic principles and best management practices advocated in IWRM. This section explains the conceptual elements of IWRM which have been employed in evaluation sustainable management of water resources for the future.

IWRM is about building synergy and links between various facets of water resources in order to sustainability. Since the 1970s, there has been a growing awareness that natural resources are limited and that future development must come to terms with this fact. The concept of sustainability has on the whole gained wide acceptance worldwide and may be defined as "improving the quality of human life while living within the carrying capacity of supporting ecosystems"[17].

Integrated water resources management can be interpreted at three different levels. First, it involves the systematic consideration of various dimensions of water: surface and groundwater, and quantity and quality. The key is that water represents an ecological system, containing interrelated parts. Each part can influence, and be influenced by, other parts, and therefore needs to be planned for and managed with regard to those interrelationships. At this level, attention normally is given to how to integrate considerations related to water security and water quality.

Sustainability

Improving the quality of human life while living within the carrying capacity of supporting ecosystems

At the second level, managers recognize that while water is an ecological system, it also interacts with other resource systems, ranging from terrestrial to other environmental systems. This second level is broader than the first, and turns attention to matters such as flood-plain management, drought mitigation, erosion control, irrigation, drainage, non-point sources of pollution, protection of wetlands and fish or wildlife habitat and recreational use. At this level, integration is needed

[17] IUCN/UNEP/ WWF, 1991

because many water problems are triggered by land use or other development decisions involving major implications for aquatic systems.

The third level is broader still, and directs the manager toward interrelationships among the economy, society and the environment – of which water is but one component. Here, the concern is the extent to which water can facilitate or hinder economic development, reduce poverty, enhance health and well-being and protect heritage. All three levels highlight the fact that planners and manager's deal with a mix of systems.

A community is unsustainable if it consumes resources faster than they can be renewed, produces more wastes than natural systems can process or relies upon distant sources for its basic needs

Concept of sustainability applied to water resources management would imply to assess the safe and adequate supply of good quality potable water to the inhabitants in the study area in planning horizon. However, the sustainability should be perpetual and may not fail beyond the planning horizon.

The past few decades have witnessed dramatic changes in water management. There have been two important underlying themes. First, there is a growing awareness that water is a fundamental element in the natural environment. The presence and movement of water through all biological systems is the basis of life. Water, land and biological systems must be viewed as interlinked, and monitoring of the various components of the ecosystem should be harmonized. Secondly, water is absolutely essential to all forms of economic activity, for example, agriculture and food production, for much of industrial production and for commerce related navigation. Water is also a critical factor in human health. Too much water, in the form of floods, or too little, such as drought, can lead to human and environmental disasters. But floods and droughts are natural occurrence too, and therefore, should be incorporated in risk management plans.

5.1. Watershed Management

There is general recognition that the natural management unit is the river basin. It makes sense to manage the water resources within a river basin and in a coordinated manner, as the water is often used several times as it moves from the headwaters to the river mouth. It also makes sense to manage all natural resources – vegetation, soils and the like – within the basin unit. Water demands for human activities should also be managed within the basin in an integrated manner.

Unfortunately, political boundaries do not normally coincide with basin boundaries. This adds another essential layer for trans-boundary cooperation within the watersheds. In the context of this study, the twin cities of Rawalpindi and Islamabad share the same watershed (of Upper Soan River). Rawalpindi, or RWASA Jurisdiction, constitutes the lower riparian within the watershed while Islamabad (CDA and ICT), and Murree-Kahuta Development Authority form the upper riparian areas.

5.2. Surface and Groundwater

In many regions of the world, groundwater is the major source of the flow in surface streams during the dry season. In addition, certain land-based activities, such as those causing leakage from underground storage tanks, can lead to pollution of aquifers. Other land-based activities, for instance, withdrawal, which is implemented to meet urban or agricultural needs that exceed rates of recharge, can also bring about the depletion of groundwater reserves.

Given the interconnections identified above, in order to achieve effective management of aquatic systems, it is necessary to study and manage surface water and groundwater as connected systems, particularly to ensure secure water supplies of acceptable quality. An integrated approach encourages – indeed, requires – the joint management of surface water and groundwater systems.

5.3. Ecological Services within the Watershed

Hydrologists today need a much broader view of hydrology, including ecological, biological and human-use aspects of the aquatic system. The contemporary concepts of IWRM dictate that the value of ecological services, such as pollution control, improvement in water quality, etc., provided by flowing rivers, wetlands, and aquatic ecology, also be factored-in in a synergistic way with the engineered facilities built for the same (i.e. pollution control, water treatment, storm water, aquifer recharge etc.).

In order to conserve the hydrological and ecological function of the drainage network, the physical regime of the river must not be altered or dried up. The amount of water that is needed to sustain an ecological value of an aquatic ecosystem is referred to as environmental water demand. The question of a minimum flow is particularly important in arid and semi-arid regions and must be borne in mind in river basin planning and management. An ecological minimum flow can artificially be maintained by reservoir management. To model environmental demand, a given river stretch can be assigned a minimum flow requirement that has to be met.

There have been significant socio-economic changes in many parts of the world. Rapid population growth, particularly in developing countries and in burgeoning urban centres, combined with industrialization and rising living standards have increased the demand for water. Pollution in many regions has reduced the quantities of safe drinking water. Groundwater levels have declined in many regions. Growing demand, outstripping supply, will become more common. Thus, more efficient and effective water management is imperative

5.4. Monitoring Requirements

Hydrological monitoring is also an integral element of IWRM which helps adaptive management, risk evaluation, long term record keeping, and prediction of trends – both in resource availability and consumption. Well-equipped and institutionally organized hydrologic services should continually monitor changing demands for water-related data.

Monitoring requirements are also continually evolving. They are influenced by trends in governmental policy and practice as well as new emerging sciences. What is more, they work in a rapidly evolving environment characterized by the following factors:

- Heightened global commitment to sustainable management of natural resources and the environment, combined with efforts to improve the living conditions of the poor, who generally are the most dependent on natural resources;
- An expanding emphasis on the need for integrated water resources management, as pressure on the world's water and other natural resources creates a general awareness that resources must be developed and managed in a sustainable manner;
- A seemingly inexorable increase in the impact wrought by natural disasters, particularly floods and droughts. At the same time, risk management is becoming more widely adopted;
- The impact of socio-economic trends on the day-to-day operations;
- Ever-growing use of the Internet or the web-based delivery of hydrological data and products – leading to more public awareness which necessitates more transparency in procedures and decisions taken by the water managers.

5.5. Environment, Economy and Society

Historically, water management has been dominated in developed and developing nations by three professions: engineering, agriculture and public health. As a result, engineers began focusing on structural solutions for issues ranging from water security – whether for urban, industrial or agricultural use – to water quality and flood damage. In addition, health professionals started

turning their attention to the treatment and disposal of sewage and other wastes detrimental to health.

6. Resource Evaluation for Sustainable Water Supply

6.1. Population Projection

The combined population of Rawalpindi and Islamabad (the twin cities), as per 1998 census, was 1.94 million. Projected at the current growth rates, the combined population of the twin cities could exceed 11 million by 2040 as estimated by Ministry of Finance[18], while that of RWASA jurisdiction will be close to 5.8 million. This estimate may look on the higher side as the fertility rates are on the decline, however, with increasing trend of urban migration to Rawalpindi and Islamabad (with a trend of lots of housing schemes being promoted in the area), this estimate may even exceed. For the sake of planning water requirements within RWASA Jurisdiction for the planning horizon, a population of 6 million has been assumed.

6.2. Water Demand

Water supply at the rate of 40 gallons per capita per day (0.5 cubic meters per person per day) has been envisaged for the residents of RWASA jurisdiction as already approved in Rawalpindi Master Plan (1996-2016) [19] . The annual water requirement for the planning year 2040 for an estimated population of 6 million comes out to be 398 million cubic meter (MCM). Daily water demand for RWASA for the planning horizon then comes out to be 1.1 MCM per day or 242 million gallons per day (mgd).

6.3. Renewable Water within the Water Shed

Rainfall is the main source of renewable freshwater in the area. All other renewable resources in the area are directly or indirectly driven by rainfall. This makes measurement and management of rainfall is one of the most important elements of sustainable development of water resources. Estimates of rainfall distribution over the watershed were made based on the annual rainfall data acquired from Pakistan Meteorological Department. Water flowing in the rivers/streams, storages in

[18] Ministry of Finance http://www.finance.gov.pk/survey/chapter_10/16_Population.pdf
[19] Rawalpindi Master Plan 1996-2016, Government of the Punjab, Local Government and Rural Development Department, No. So, 111(LG) 7-12/98 dated 25 Sept 1998

natural and artificial lakes, and groundwater (aquifers), all comes through this precipitation within the watershed. The mean total annual rainfall in the watershed varies from more than 1554 mm in the mountains in the north to 1052 mm in the plateaus in the south as shown in Figure 2. Total mean annual rainfall over the watershed is averaged at 1296 mm, bringing in an average annual volume of water equal to 3571 MCM which drives the hydrological cycle of the watershed.

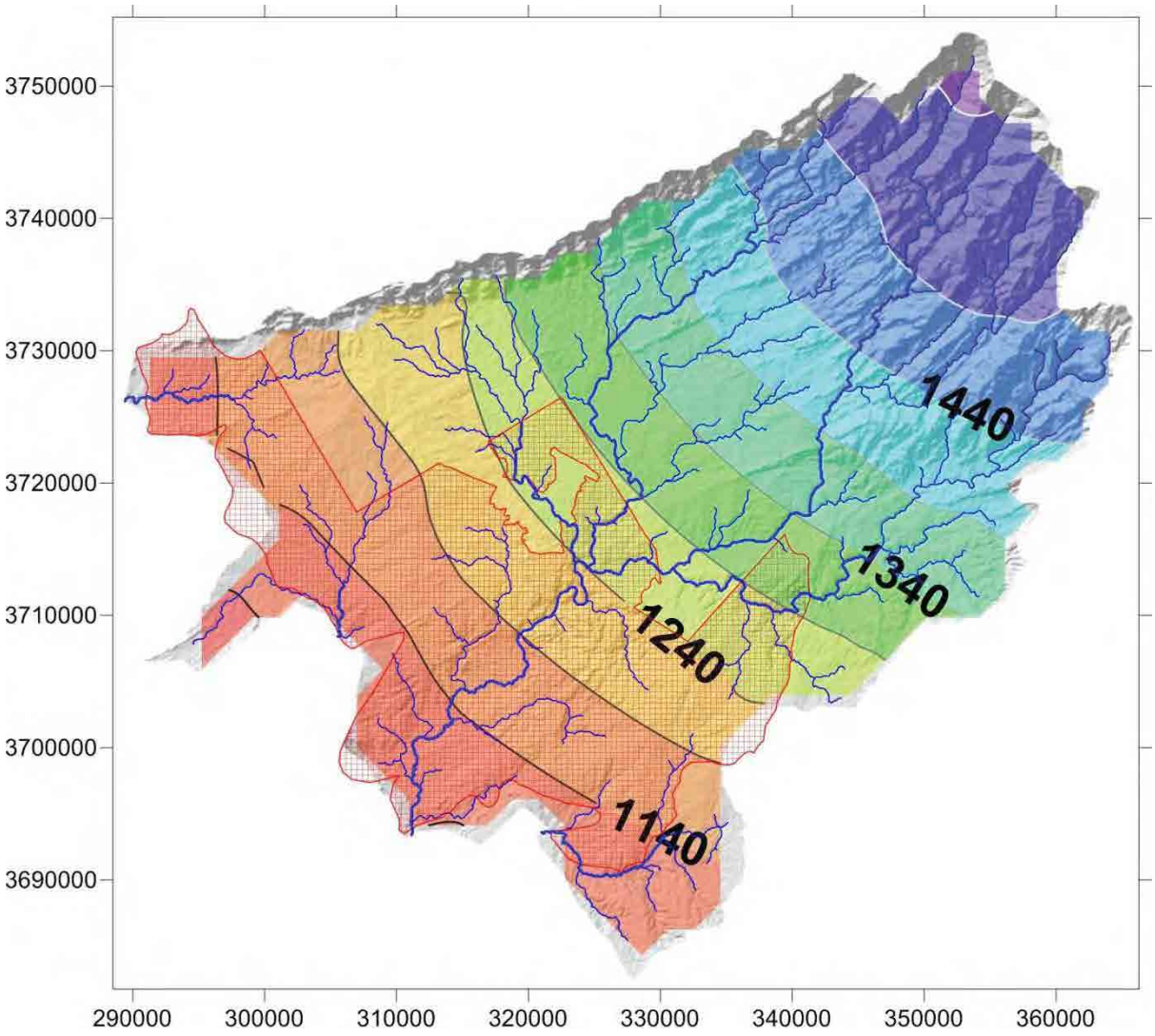

Figure 25 Variation of mean annual rainfall in millimeters over the watershed. RWASA boundary is also shown where rainfall average is lower than the northeastern part of the watershed

Evapotranspiration (ET) estimates for the study area were obtained from Bastiaanssen et. al. (2012)[20], based on NOAA/MODIS satellite data of the Indus Basin as shown in Figure 3. ET in the study area varies from 461 mm/year to 750 mm/year. For the planning purposes, it was taken as 700 mm/year, leaving behind 596 mm/year which renews water in the rivers, streams, lakes and aquifers. The mean annual renewable volume of water thus becomes 1645 MCM, which is reckoned as the total annual renewable water in the watershed.

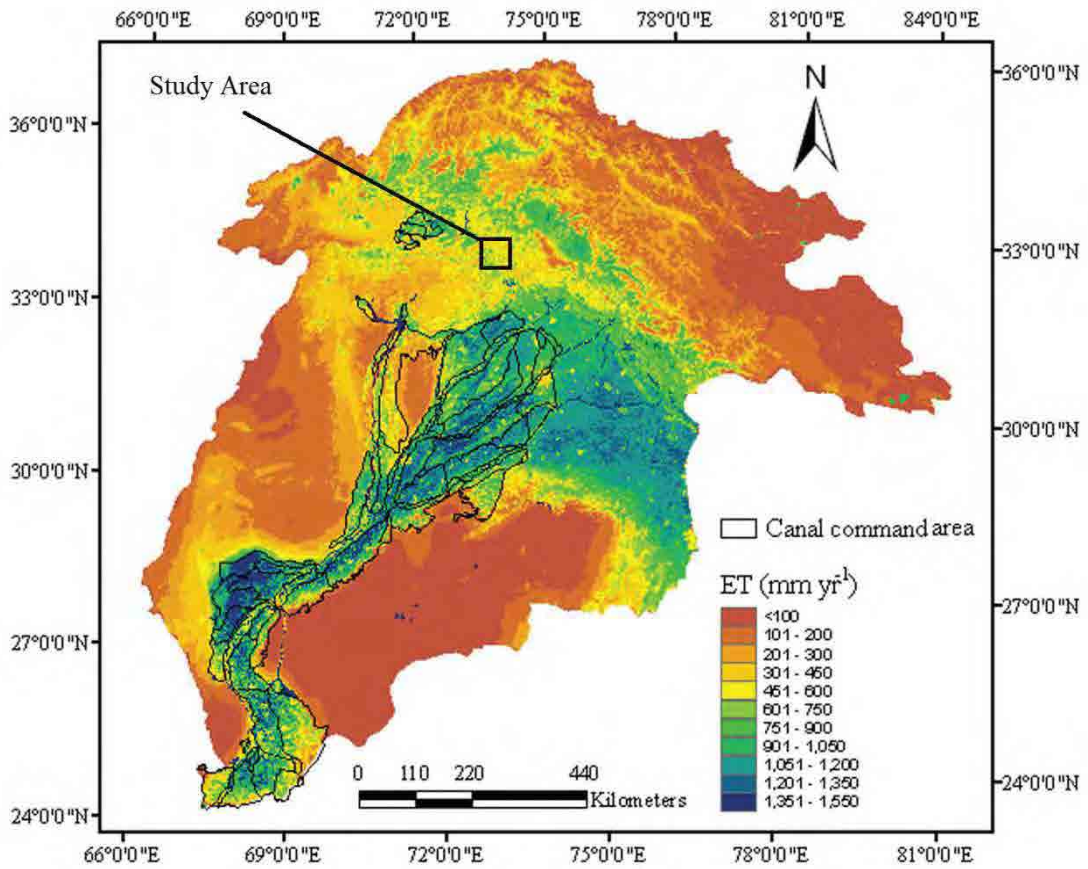

Figure 26 Evapotranspiration estimate from MODIS/NOAA satellite data (Betiaanssen et al 2012)

[20] Bastiaanssen, W.G.M., Cheema, M.J.M., Immerzeel, W.W., Miltenburg, I.J. and Pelgrum, H. (2012). Surface energy balance and actual evapotranspiration of the transboundary Indus Basin estimated from satellite measurements and the ETLook model. *Water Resources Research 48:*

6.4. Renewable Water for RWASA Jurisdiction:

Mean annual rainfall within RWASA jurisdiction is 1176 mm, which translates to annual volume of 1027 MCM. Excluding 700 mm loss in evapotranspiration, estimated renewable water from rainfall in RWASA jurisdiction is 417 MCM. Since RWASA jurisdiction is lower-riparian, it also receives overland flow (primarily river runoff) from the upper riparian areas and boundary flow into its underlying aquifer. Several datasets were analysed from the studies undertaken by CENTO[21] before the construction of Simly and Rawal Dams in the region. From these data sets it was estimated that mean annual river runoff, excluding the baseflow, is approximately 18% of annual rainfall. Using regional groundwater model for the area, analysis of hydrogeological data available from USGS[22] , and further analysis of data incorporating ET estimates, following water balance components were derived for RWASA:

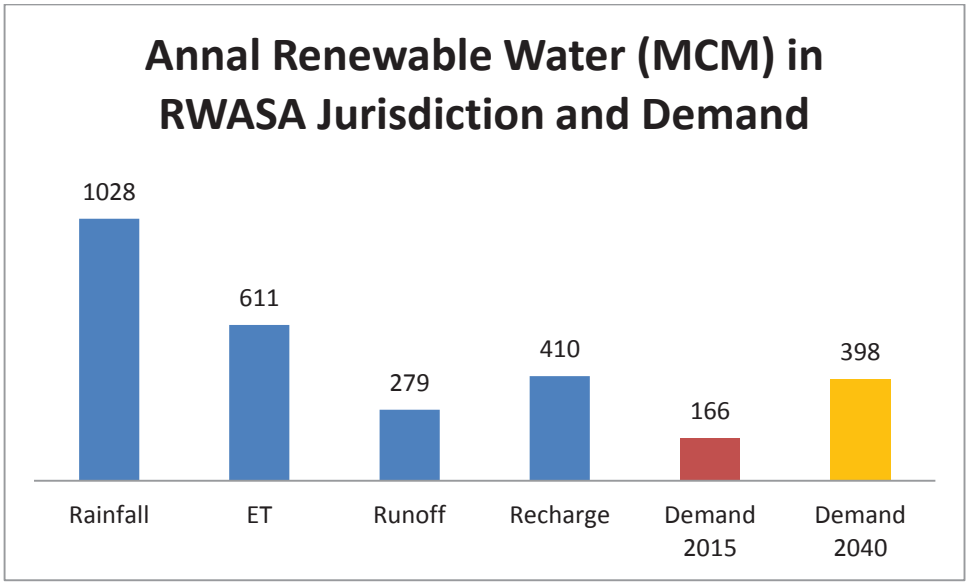

Figure 27 Water balance components for annual renewable water (in million cubic meter) versus current and future demand

From the regional level study presented in this report, the above figures point towards the potential of groundwater recharge in the RWASA jurisdiction which exceeds the total demand for 2040. However, at this point in time, the simplistic conclusion that current recharge rates are enough to

[21] The Role of Science in Developing Natural Resources With Particular Reference to Pakistan Iran and Turkey, Ist Edition, Pergamon Press, London, 1964, Part 4 "Surface Water Resources of the Federal Capital Area" pp . 163-176

[22] Environmental Geology of the Islamabad-Rawalpindi Area, Northern Pakistan. USGS Bulletin 2078G, U.S Department of Interior, U.S. Geological Survey

meet the future demand may not be drawn. It should be noted that this figure for recharge is spread over an area of 863 square kilometres and also includes the boundary flow entering RWASA jurisdiction from up-slopes of Islamabad and surroundings. The area is full of irregularities and local geological variability which must be analysed in detail to exploit and/or manage this potential. This study, therefore, only highlights the potential and possibilities of managed recharge to meet future demands while concludes that there is enough renewable water (689 MCM, both surface water and groundwater), flowing though the area to meet future demands (398 MCM).

6.5. Future Water Works

The future water works required to exploit the potential of total renewable water within RWASA jurisdiction, as shown in Table 1, include important elements water sensitive urban designs for storm water management, rain water harvesting (at local, municipal and regional scales), management and treatment of waste water, computer controlled well fields with high capacity well clusters, recovery and rehabilitation of right of ways of natural water courses, additional construction by laws (to include water used efficiency and WSUD), and solid waste management etc. If the potential of renewable water as shown in the table is successfully exploited, it will bring perpetual sustainability of water resources to meet current and future demands. The future water works

Table 2 Annual Water Demand Compared to Renewable Water in the Study Area

	RWASA Jurisdiction
Mean available renewable water per year	689 MCM
Yearly demand by 2040	398 MCM
Yearly demand as % of available renewable water in 2040	75%
Current yearly demand	166 MCM
Current yearly demand as % of available renewable water	31%

6.6. Sustainable Yield from Surface Water

It has been assessed that exploitation of surface water resources, especially by creating artificial reservoirs on rivers/streams will not be sustainable in the long run. Surface water in the area is highly prone to pollution and silting and cannot handle serous droughts. Transfer of water from the

surface water resources outside the study area is both expensive in terms of infrastructure as well as operational costs. Moreover, in case of a major damage to infrastructure, e.g. earthquake, the population at risk would be difficult to manage.

6.7. Sustainable Yield from Groundwater

Regional scale groundwater model suggests that up to 280 mgd of water can potentially be sustainably abstracted from the groundwater in the study area if rainwater recharge is properly managed. However, more hydrogeological investigations will be required before making any plan for exploitation of this potential.

7. Integrated Urban Water Management

Integrated Urban Water Management (IUWM) or Water-sensitive urban design (WSUD) is a land planning and engineering design approach which integrates the urban water cycle, including storm water, groundwater and wastewater management, water recycling, and water supply, into urban design to minimise environmental degradation and improve aesthetic and recreational appeal. IUWM/WSUD is a fully integrated approach that deals with all facets of water management in the urban and peri-urban environments and involves all stake holders in the processes of planning and design.

This study uses the term IUWM or WSUD interchangeably which is similar to Low-impact Development (LID) mostly used in North America or Sustainable Urban Drainage Systems (SUDS) mostly used in United Kingdom. IUWM is mostly preferred by World Bank while WSUD is mostly used in Australia.

7.1. Rationale for Using IUWM/WSUD Approach

Storm water management has historically focussed on directing water away from properties and managing pollution, flooding and erosion problems within the drainage system. It is now widely recognised that rainwater should be used within buildings and delivered to the environment in a more sustainable fashion, replicating natural water cycles. The advantages of sustainable water management extend beyond just the environmental benefits of improved receiving water quality, because WSUD helps break the flood peaks, reduces the quantity of storm flows, recharges the groundwater, helps reduce water demand for municipal needs, integrates rainwater harvesting, and reduces the demand on the reticulated water supply.

Development, construction and maintenance costs can be reduced with an integrated series of water management techniques that utilise water as an asset rather than a nuisance. A combination of recreational, habitat and flood mitigation benefits can be gained from the same piece of land while improving the amenity of the land to the community.

The practice of sustainable water management is usually referred to as integrated water cycle management (IWCM). This is similar to IWRM but while IWRM deals with water resources management at the Watershed/River Basin Scale, IWCM is primarily concerned with smaller scale urban environments.

7.1.1. Key Benefits of Adopting IUWM/WSUD Approach

Urban water management is now on the verge of a revolution in response to rapidly escalating urban demands for water, as well as the need to make urban water systems more resilient to climate change. Growing competition, conflicts, shortages, waste and degradation of water resources make it imperative to rethink conventional concepts – to shift from an approach that attempts to manage different aspects of the urban water cycle in isolation to an integrated approach supported by all stakeholders

IUWM/WSUD fully integrates the principles and practices of IWCM and IWRM within the urban settings, and hence it may be adopted as policy in RWASA jurisdiction to address the following key benefits[23]:

- The world's towns and cities are growing rapidly. Sustainable urban development means focusing on the relationships between water, energy, and land use, and diversifying sources of water to assure reliable supply.
- IUWM/WSUD provide a framework for planning, designing, and managing urban water systems. It is a flexible process that responds to change and enables stakeholders to predict the impacts of interventions.
- IUWM/WSUD includes environmental, economic, social, technical, and political aspects of water management. It brings together fresh water, wastewater, storm water, and solid waste, and enables better management of water quantity and quality.
- IUWM/WSUD calls for aligning urban development with basin management to ensure sustainable economic, social, and environmental relations along the urban-rural continuum.
- Developing, policies and strategies supported by financing strategies, technological developments, and tools for decision-making, in cooperation with both public and private sector partners, can facilitate putting IUWM into practice at all levels.
- Urban water planners will shift from being resource users to resource managers, change their consumption patterns, waste management, and planning to better balance resource flows to and from cities.
- IUWM projects require significant funding, but public agencies in many countries have limited ability to invest in infrastructure.

[23] GWP Policy Brief (2013): Integrated Urban Water Management – Toward Diversification and Sustainability

- Improving economic service efficiency and minimising water losses involves redesigning systems and changing consumer behaviour. This will need increased cooperation with the private sector.
- Developing 'eco-cities' will enable waste products to be used to meet energy and material needs.

7.1.2. Principles of Integrated Urban Water Management

Integrated Urban Water Management calls for the alignment of urban development and basin management to achieve sustainable economic, social, and environmental goals. It brings together water supply, sanitation, storm- and wastewater management and integrates these with land use planning and economic development.

An IUWM approach integrates planning for the water sector with other urban sectors, such as land, housing, energy, and transport to avoid fragmentation and duplication in policy- and decision-making. Cross-sector relationships are strengthened through a common working culture, collective goals and benefits are better articulated, and differences in power and resources can be negotiated. It includes the urban informal sector and marginalised communities. The basic principles of IUWM/WSUD include:

- Encompass alternative water sources;
- Match water quality with water use;
- Integrate water storage, distribution, treatment, recycling, and disposal;
- Protect, conserve and exploit water resources at their source;
- Account for non-urban users;
- Recognise and seek to align formal and informal institutions and practices;
- Recognise relationships among water, land use, and energy;
- Pursue efficiency, equity and sustainability; and,
- Encourage participation by all stakeholders

Figure 28 further elaborates how integrated urban water management helps a fully coordinated planning and management of water sector with other important sectors within the planning regime of an administrative jurisdiction. The IUWM approach begins with clear national policies on integrated water resources management, backed by effective legislation to guide local authorities. A successful approach requires engaging local communities to solve the problems of water

management. Collaborative approaches should involve all stakeholders in setting priorities, taking action, and assuming responsibility.

IUWM/WSUD assesses both water quantity and quality, estimates future demand, anticipates the impacts of climate change, and recognises the importance of efficiency, without which water operations cannot be sustainable. It also recognises that different water sources can be used for different purposes – fresh water for domestic use; rain/storm water for supplementing aquifer recharge; and treated wastewater for agriculture, industry, and the environment.

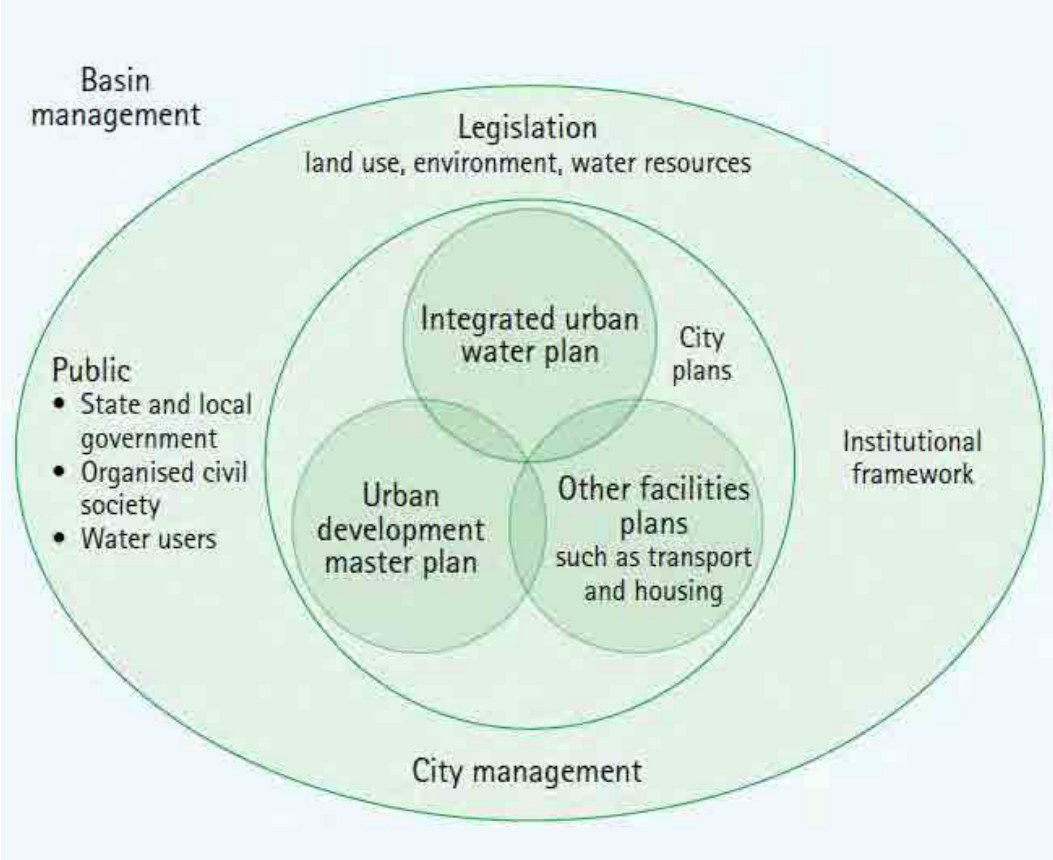

Figure 28 Integrated Urban Water Plan within the master planning of a city and a basin (GWP 2013)

7.1.3. Economics of IUWM/WSUD

Under IUWM, water prices and allocations reflect the costs of developing and delivering water supplies and maintaining the system. Price signals the true value of water. Accurate pricing will encourage all users to manage water wisely, consistent with an integrated urban water management strategy. Differential tariffs that account for water quality can incentivise all users to reduce surface water or groundwater consumption in favour of reclaimed water for example.

Tariffs, taxes, and subsidies can be used to distribute benefits fairly without diminishing the productivity of water resources. But if tariffs are set too low so they favour poor users and then cannot support effective operations and maintenance, the system may inadvertently contribute to greater inequality.

Pricing instruments can be designed so users pay more for higher levels of consumption or quality. Financial incentives like rebates, subsidised retrofits, water audits, and seasonal and zone pricing can also be used. Schemes under the 'polluter pays' principle, in which charges relate to the effluent that users generate, can improve the cost-effectiveness of treatment and reuse. They can even fund the construction of new infrastructure. But IUWM projects require significant levels of funding for both capital and operation and maintenance costs.

7.1.4. Policy Recommendations for RWASA to Implement IUWM/WSUD

Adopting IUWM/WSUD and its iterative processes will help RWASA jurisdiction to significantly reduce the number of people without access to water and sanitation by providing water services of appropriate quantity and quality. It is recommended that RWASA should:

Ensure their policies and strategies facilitate putting IUWM into practice at local and national levels, supported by financing strategies, technological developments, and tools for decision-making;

Take on a more central role in cities and towns so as to lead development initiatives and ensure basic needs are met;

- Incorporate climate change predictions in planning urban water supply and sanitation and install and maintain, with the participation of a wide range of stakeholders, infrastructure and services that are 'climate-proof';
- Pay special attention to supporting the informal urban sector, vital for a sustainable urban economy;
- Overcome governance fragmentation in public policy and decision-making by linking planning with the activities of other sectors;
- Build staff and institutional capacity to engage in IUWM to ensure they deliver at an optimal level;
- Engineer tariffs, taxes, and subsidies to transfer benefits to vulnerable groups, and ensure pricing policy reflects true costs;
- Consider employing the 'polluter pays' principle to improve the cost-effectiveness of treatment and reuse.

7.2. Integration with RWASA's Vision/Mission

As discussed in Study A under this project, RWASA's current vision includes modernization and compatibility with global scenarios. By adopting implementation of IUWM/WSUD as a policy within its jurisdiction, not only RWASA will achieve modernization and compatibility with global scenarios, the implementation of IUWM/WSUD will directly help the following vision/mission elements of RWASA:-

- modernization;
- achieving compatibility with global scenarios;
- reduction in un-accounted for water;
- reduction in non revenue water;
- rainwater harvesting;
- minimizing blockages and flooding;
- storm water management;
- separation of sewage and storm water; and,
- quality of waste water and its disposal.

Besides helping realize various visions/missions of RWASA, implementation of established principles and practices of WSUD will also critically help the following:

- **Prevention**: Prevention of run-off and pollution
- **Source Control**: Source control of run-off for groundwater recharge
- **Site Control**: Management of storm water towards large soak away infiltration basin for the catchments
- **Integration**: Management of run-off from several sites/areas.

The above mentioned points are discussed separately under various subsections in this chapter.

7.3. WSUD Implementation Strategy for RWASA

Current models of urban planning and water management have already failed or likely to fail from the perspective of cost effectiveness, technical performance, social equity, and environmental sustainability. More is needed than simply improving the performance and efficiency of the component parts of the water system. A paradigm shift is required at the system-wide level. Integrated Water Resources Management (IWRM) provides a framework for interventions over the entire water cycle and a reconsideration of the way water is used (and reused). And IWRM

addresses tradeoffs among water users: agriculture, industry, household, and ecosystems. An integrated approach to urban water resources management calls for new objectives that recognize the mutual benefits of water resources, energy, and land use management. More governments recognise the importance of taking such an approach to address the challenges of cities. There is a growing consensus around the principles of WSUD or IUWM which include the following[24]:

Involvement of all key players: Critical to the success of the IUWM is the early and continuous integration of all stakeholders in the planning, decision making, implementation and monitoring process, in a structured way. Roles and responsibilities need to be clearly defined. The main barriers are institutional because of a highly fragmented division of responsibilities and tasks. Regulatory changes are required to avoid a sector perspective.

Considering the entire water cycle as one system: Water sources, supply, wastewater, and storm water should be contextualized within an urban water framework and a wider basin level catchment area. This allows us to understand the relationship between the components of the urban water system, as well as upstream and downstream relationships and impacts on the ecosystem.

Assessing a portfolio of water sources: A portfolio of options such as surface water, groundwater, rainwater, and storm water as well as less obvious water sources such as black water (wastewater) and grey water (wastewater other than sewage, such as sink drainage or washing machine discharge) should be considered as potential sources. The goal is to diversify sources and increase availability for different uses. When considering the demands for water, it is important to match water of a certain quality to its intended use. Consumer behaviour needs to be taken into consideration in water consumption and waste management as it can affect water resources management.

Maximizing the benefits from wastewater: By employing innovative technologies, water, energy, biogas, and nutrients can be reclaimed from waste streams and reused. Recycling and reuse can be

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[24] Global Water Partnership:
Integrated Urban Water Management, Technical Committee Background Paper 16; 2012
Towards Integrated Urban Water Management, Perspectives Paper; 2011
Managing the Other Side of the Water Cycle: Making Wastewater an Asset, Technical Committee Background Paper 13; 2009
Urban Water and Sanitation Services, an IWRM Approach, Technical Committee Background Paper 11; 2006

fostered by more decentralized systems. Low cost technologies with limited dependence on energy can contribute significantly to improving the sustainability of wastewater systems.

Designing adaptive systems: When developing an WSUD/IUWM strategy, it is important to recognize uncertainties such as climate change and its impacts. There is a need to build flexible systems that cope with uncertainty and are able to adapt to changing conditions. Such systems could be built around the following five main areas:

- **Urban Water Partnerships**: Promoting the involvement of key stakeholders in strategic planning, agreements on water allocations, pollution control measures, as well as in efficient water use, water savings, transparency issues, and a citizen's card system.
- **Urban Water Catchment Management**: Considering the entire water cycle as one system, linking the management of urban water to IWRM Plans in the broader basin context; assessing all water sources availability; assessing water demand and use; providing water fit for different purposes; regulatory changes are required to promote a more integrated approach.
- **Promoting Waste as a Resource**: Maximizing the benefits from wastewater by employing innovative technologies, condominial sewage systems, wetlands, and decentralized wastewater treatment in which water, energy, biogas and nutrients are reclaimed from waste streams and reused locally for productive use, including urban agriculture. Wastewater should not be wasted water!
- **Integrated flood management**: strengthening the resilience to climate change related extreme events and conducting vulnerability assessments.
- **Low cost, high impact solutions**: Systems do not have to be pricey to be effective, as proven by many examples around the world. Many low cost solutions are highly effective and may be used in urban environment

In recent decades, hydrological science and technology have made substantial progress and significant contributions have been made by field hydrologists to the development and management of water resources. So as to facilitate the sharing of hydrological practices among the National Hydrological Services, a technology transfer system known as the Hydrological Operational Multipurpose System (HOMS) was developed by World Meteorological Organization (WMO) and has been in operation since 1981. It offers a simple but effective means of disseminating information on a wide range of proven techniques for the use of hydrologists. HOMS transfers hydrological

technology in the form of separate components. These components can take any form, such as a set of drawings for the construction of hydrological equipment, reports describing a wide variety of hydrological procedures and computer programs covering the processing and storage of hydrological data, as well as modelling and analysis of the processed data. To date, over 180 components have been made available, each operationally used by their originators, thus ensuring that every component serves its purpose and has been proved in practice. These descriptions appear in the HOMS Reference Manual (HRM)[25].

7.3.1. Prevention

One way to identify suitable BMPs for water quality improvement is to describe the target storm water pollutant(s) to be removed. Pollutant particle size grading is a useful description of the pollutant characteristics. For instance, gross pollutants are often described as particulates larger than 5mm (or 5000 microns) while soluble pollutants are described as particles smaller than 0.45 microns. Classifying storm water pollutants this way allows different pollutant types to be matched to BMPs that maximise their removal.

7.3.2. Source Control

The management of storm water runoff in conventional urban developments has been driven by an attitude that reflects the view that storm water runoff has no value as a useful resource, is environmentally benign and adds little to the amenity (aesthetic, recreation, education, etc) of an urban environment. Consequently, conventional urban storm water management has focused on providing highly efficient drainage systems to rapidly collect and remove storm water runoff using a combination of underground pipes and linear “engineered” overland flow paths (often located along the back fence line of properties to keep them out of sight). These systems kept storm water runoff “out of sight” and consequently “out of mind”. The increased rates of storm water runoff associated with conventional urban development coupled with a dramatic increase in storm water runoff volume and associated contaminants such as litter, sediments, heavy metals and nutrients has caused significant degradation of the natural environments.

As part of an emerging new paradigm in urban management, the treatment of storm water runoff is no longer considered in isolation to the broader planning and design of the contributing urban area.

[25] http://www.wmo.int/pages/prog/hwrp/homs/ homs_en.html

Storm water management is considered at all stages of the urban planning and design process to ensure that site planning, architecture, landscape architecture and engineering infrastructure is provided in a manner that supports the improvement of storm water quality and the management of storm water as a valuable resource. Similarly, the storm water treatment system are adapted to the requirements of each of the other urban infrastructure elements in order for the "whole" package to function as an ecologically, socially, and economically sustainable urban system.

The success of WSUD as an urban planning and design paradigm will rest largely on the ability of the urban design industry to provide engaging and informative landscape design solutions within the public realm. The use of innovative landscape elements that show the connectivity between human activity and the urban water streams are increasingly recognised as having a powerful influence on the consciousness of individuals and recognition of their role and responsibility in the protection and enhancement of our natural water resources. By contrast, there is a distinct lack of visual connectivity between human activity, urban water streams, and receiving natural waterways with the conventional "piped" storm water system. Thus within the conventional urban setting it is difficult for individuals to see, and indeed understand, the impact of their actions on the sustainability of our natural water resources. Cooperative collaboration between the urban design professions can achieve "smarter" and more sustainable urban areas where urban landscapes engage, inform, and influence human behaviour for the benefit of the natural environment and the improvement of the social fabric. The following sections present the outcome of recent collaborations between the urban design professions in integration of storm water treatment measures into the built form.

Two of the most common storm water treatment technologies that can be readily integrated into urban design are constructed wetlands and bio retention systems.

Constructed Wetlands The use of constructed wetlands for urban storm water quality improvement is widely adopted in many Australian cities. Research and on-going refinement to practice have provided a sounder basis for sizing constructed wetlands for storm water management and for its integration into landscape design

Bio retention Systems Recent adaptations of swale systems for storm water quality treatment are directed at promoting a higher degree of storm water treatment by facilitating infiltration of storm water through a prescribed soil media. These systems are referred to as bio retention systems where a trench, filled with a "prescribed" soil of known hydraulic conductivity, is used to filter storm water.

Vegetation is a crucial component of bio retention systems. Plants roots support a wide range of micro biota (particularly bacteria and fungi) and influence characteristics of the media for several millimetres around the root (the rhizosphere) and they can significantly increase the physical trapping and biological uptake of nutrients and water by plants. Plant growth also plays an important role in maintaining the structure and hydraulic conductivity of the media. Their growth and death cycle results in macro-pore formation and maintenance, an important function in prevention of clogging of the soil media.

Recent research and monitoring of field applications have demonstrated that they present an effective "soft-technology" for removal of urban storm water pollutants (Davis et al., 2001, Lloyd et al., 2001, Kim et al., 2003). When designed with appropriate soil media and planting, these systems have long-term capacities to assimilate heavy metals washed off urban catchments

7.3.3. Site Control

Recent research into storm water treatment technology has been able to confirm the scalability of storm water treatment technologies such as constructed wetlands and bio retention systems for application in small confined areas. Through close collaboration with landscape architects and urban designers, it has been possible to incorporate many of these technologies into the urban form at a range of spatial scales.

Harvesting of roof storm water runoff can be integrated with building design. This runoff could be treated with bio retention or constructed wetland systems laid out in a roof-garden and delivered to architecturally-designed rainwater tanks that are incorporated into individual apartments for toilet flushing. Contrary to many misconceptions of roof top gardens, the entire roof space does not need to be fitted with storm water treatment measures. Often, the vegetated treatment areas (eg. bio retention systems and constructed wetlands) need only to take-up 2% to 5% of the roof area to adequately treat storm water runoff. A schematic of a building project where roof water is to be treated in a roof garden and stored in architecturally designed storage tanks within individual apartments for reuse in the hot water system.

Public building forecourts and local streetscapes represent the connecting pathways between the buildings where we live and work and the areas of sub-regional and regional public open space where we interact and recreate at a local and regional community scale. In terms of storm water runoff generation, public building forecourts and local streetscapes represent public realm areas located closest to the source of most urban storm water runoff (i.e. from impervious surfaces associated with buildings and road pavements). Integration of storm water management

functionality within landscape elements associated with public building forecourts and local streetscapes allows for a number of key WSUD best management practices to be satisfied, namely: collection and treatment of storm water runoff at its source; first use of storm water runoff for watering the landscape; and visual connectivity between the built form and the urban storm water stream.

7.3.4. Management of Runoff

Precinct scale public open space areas provide an opportunity to integrate storm water collection, treatment and storage/re-use facilities within the overall landscape design of these areas. With competing uses for these spaces the scale and landscape form of the storm water management systems needs to carefully consider the other uses of the park and their potential interaction with the storm water management systems. Issues of public safety and aesthetic amenity are important design considerations requiring site analysis to determine site usage patterns, journeys, site lines, and existing landscape character in order to ensure an appropriate landscape form.

Opportunities for the innovative integration of storm water management functions within contemporary urban landscape designs at a range of scales within the public realm and private buildings were presented in this paper. A shift towards “at source” storm water management systems will further advance the development of innovative on-site, streetscape and precinct scale landscapes incorporating storm water management functionality

7.4. Groundwater Recharge

This study aimed at improved ground water recharge in the study area. It was estimated in the study that there is a huge potential of groundwater exploitation and proper recharge management. The groundwater modelling results combined with data analysis and validation exercises, revealed that all water demands can be met with the groundwater in the study area, if natural recharge zones are properly protected and urban recharge is systematically managed.

All natural water courses and water ways in the area offer excellent storm water collection systems provided by the nature. Most of these stream/water courses can turn into managed recharge systems because there is already sufficient rainwater and storm runoff. It is estimated that the aquifer can store more than 3000 million cubic meter of water within its top 200 m. This capacity, if fully exploited, can provide resilience against long droughts, as 3000 million cubic meter of water is enough to meet over seven years of water demand.

The study has followed the principles of urban storm water management and recommends that rainwater harvesting and managed recharge be planned and implemented at all scales, i.e., domestic, municipal and regional.

Groundwater modelling exercise will be used to fine tune the areas which are most ideal and suitable for building infrastructure for managed recharge to groundwater.

7.4.1. Historical Preview

Significant interest developed during the 1930s, particularly in California and New York, in the use of artificial recharge to conserve or enhance ground-water storage. In California, artificial recharge of alluvial aquifers with storm runoff by use of spreading basins began about the turn of the century, and was a widespread practice by the 1930s. However, I found no record of USGS involvement in related studies during that period. In New York, water levels in a significant area of western Long Island had been drawn down below sea level by the early 1930's due to ground-water pumpage, much of it for air conditioning. The cool ground water was used to cool air in heat exchangers, and then often discharged to waste. Legislation passed in 1933 required that ground water pumped for air conditioning be recharged, either by well injection or through spreading basins. Hydrologic and temperature effects of this recharge were analyzed by Leggette and Brashears (1938), and by Brashears (1941, 1946). Artificial recharge to conserve water was also practiced in several municipalities in northern New Jersey, as described by Barksdale and DeBuchananne (1946)[26].

In the late 1960s, separate considerations led to greatly increased interest in artificial recharge in the States of California, Texas, and New York, all of which heavily involved the USGS in artificial recharge studies. The California Water Plan was approved to import several million acre feet of water from northern to southern California each year, with the plan that much of the imported water be stored in the subsurface through artificial recharge.

Artificial recharge of storm runoff by use of spreading basins has been practiced on Long Island since the 1930s. Aronson and Seaburn (1974) evaluated the performance of the 2,124 spreading basins in existence on Long Island in 1969. Seaburn (1970) and Prill and Aaronson (1973) conducted detailed studies of the operations of three of these basins. Aronson et al. (1979) conducted a study to determine whether existing spreading basins for storm water recharge could serve the dual purpose

[26] See bibliographical notes

of recharging treated sewage effluent. Prill et al. (1979) also constructed a spreading basin at the site of a water treatment plant in central Long Island for additional recharge experiments.

This short historical review suggests that artificial recharge of aquifers is not a new idea. The techniques and BMPs for artificial recharge have evolved over time and can be implemented in RWASA jurisdiction.

7.4.2. Some Examples of Artificial Recharge

Some examples of artificial recharge are given below to make the readers become aware of the practices of artificial recharge.

Dayton, Ohio, USA

Dayton, Ohio, is heavily dependent upon ground water to meet municipal and industrial water-supply needs. Nearly one-fourth of all ground water used in Ohio is withdrawn from wells completed in a sole-source sand and gravel aquifer that underlies the Dayton metropolitan area. Much of the water is pumped from a 30- to 75-foot thick shallow aquifer that underlies the Mad River Valley. To ensure that ground-water levels are maintained high enough to allow for large drawdowns by high-capacity wells, an artificial recharge system has been in place since the 1930's. The source of recharge is stream flow diverted from the Mad River into a series of interconnected infiltration ditches and lagoons that occupy about 20 acres on Rohrers Island.

Figure 29 High-capacity turbine pump installed on a municipal well at Rohrers Island. Recharge lagoon in background

Orlando, Florida, USA

Large volumes of reclaimed water, which has undergone advanced secondary treatment, are reused through land-based applications in a 40-square-mile area near Orlando, Florida. These applications include citrus crop irrigation and artificial recharge to the surficial aquifer through rapid infiltration basins.

Figure 30 Rapid infiltration basins of Water Conserv II facility, Orlando, Florida

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Part II

Environmental and Social Assessment Guidelines and Protocols for WSS&D Schemes

8. Environmental Evaluation

8.1. Project overview

The project area is located in administrative jurisdiction of Tehsil Municipal Administration of Rawalpindi. The City has experienced a rapid increase in population due to rural-urban migration. Unplanned urban growth has been rampant in Rawalpindi, particularly in areas where basic infrastructure facilities are available. The inadequacies of urban services, especially sewerage, drainage and solid waste management have further worsened the quality of life and the environmental conditions of the city.

Currently, no waste water treatment facility available for treatment of raw sewage in Rawalpindi city and raw sewage is directly disposed into storm water drains which ultimately discharge into Lai Nullah which not only contaminate the ground water sources but also is a major cause of environmental degradation of Rawalpindi. Though a Sewage Treatment Plant along with trunk and outfall sewers were planned under the Rawalpindi Environmental Improvement Project (REIP) under ADB Loan No. 2211/2212 for treatment of waste water for the city area but due to land acquisition issues, the said project has been held in abeyance. In order to address the issue of contamination of Rawal Lake, WASA proposed certain actions for rehabilitation of Rawal Lake and up gradation of water treatment plant to make it compatible with the deteriorating quality of raw water of Rawal Lake.

RWASA as being the principal agent of water and sanitation services; planning to create not only the additional sources of water, preserving the existing resources from contamination and misuse but also by providing comprehensive sewage collection and treatment facilities. The long term plan shall focus on efficient provision of water and sanitation services as per best international practices to the satisfaction of the stakeholders and also to make WASA fully corporate and financially self-sustainable organization.

8.2. Scope of Studies

The following major environmental activities will be executed during this study:

- Prepare guidelines and assessment tools for social and environmental assessment of water supply, sewerage and storm water project.

- Conduct intensive training programme for the staff of the WASA to use the guidelines for project planning, implementing and M&E plans.
- Prepare guidelines for the screening of water supply, sewerage and storm water for environmental assessment.
- Prepare Generic Environmental Management Plan for all major water supplies, sewerage and storm water schemes separately. It would also include GEMP for water and waste water treatment plants.

8.3. Environmental Assessment

As a mandatory requirement for the proposed project an Environmental Impact Assessment (EIA) Study of Water Supply, Sewerage and Drainage Schemes under taken by WASA shall be carried to fulfill the local environmental legislative requirements. Following rules and regulations apply and therefore shall be followed while carrying out this study.

a) Punjab Environmental Protection Act 2012 in conformity to Pakistan Environmental Protection Act 1997

This Act provides the framework for implementation of the Pakistan National Conservation Strategy, 1992, ensuring sustainable development, protection and conservation of biodiversity, conservation of renewable and natural resources, and formulation of environmental legislation, establishment of environmental agency(s) to ensure that development is carried out ascertaining sustainability through assessment (EIA / IEE) of projects.

b) Pakistan Environmental Protection Agency (Review of *IEE/EIA)* Regulations, 2000.

Pakistan Environmental Protection Agency, 2000 regulations provide a list of the projects requiring EE. It describes environmental policy and administrative, procedures to be followed for filing of environmental assessment reports by the proponents and its review and approval by the environmental protection agency/department.

c) National Environmental Quality Standards (NEQS), 2000

The Pakistan Environmental Protection Council approved National Environmental Quality Standard (NEQS) in 1993. They were later revised in 1995 and 2000. These NEQS furnish information on the permissible limits for discharges of municipal and industrial effluent parameters and industrial gaseous emissions in order to control environmental pollution.

There is a need to monitor the potential environmental impacts during construction and operation stages. The EE will address all environmental conditions that may be affected by the project implementation. Environmental Management and Monitoring Plan (EMMP) will be prepared in the detailed EE Study to ensure efficient implementation of the suggested mitigation measures. The environmental costs required to mitigate various environmental impacts and EMMP implementation will be estimated in EE to cater this cost in overall project budget.

EIA Objectives:

- To identify and assess any potentially adverse environmental effects of a new development.
- To suggest measures to avoid or reduce adverse impacts.
- To ensure that environmental consequences were taken into account during planning, construction and operational stages.
- To develop environmental management and mitigation plan.

8.4. Study Approach and Methodology

8.4.1. Study Approach

The study will be conducted in accordance with Environmental Protection Agency (EPA), Government of Punjab / Pakistan (GOP) guidelines, 2000. The study will be based on both primary and secondary data. During field surveys public consultation will be conducted. The main purpose of this approach is to obtain a fair impression on the people's perceptions of the project and its environmental impacts.

8.4.2. Methodology

The following methodology (Figure: 1-1) will be adopted for carrying all the EIA Study of the proposed Project:

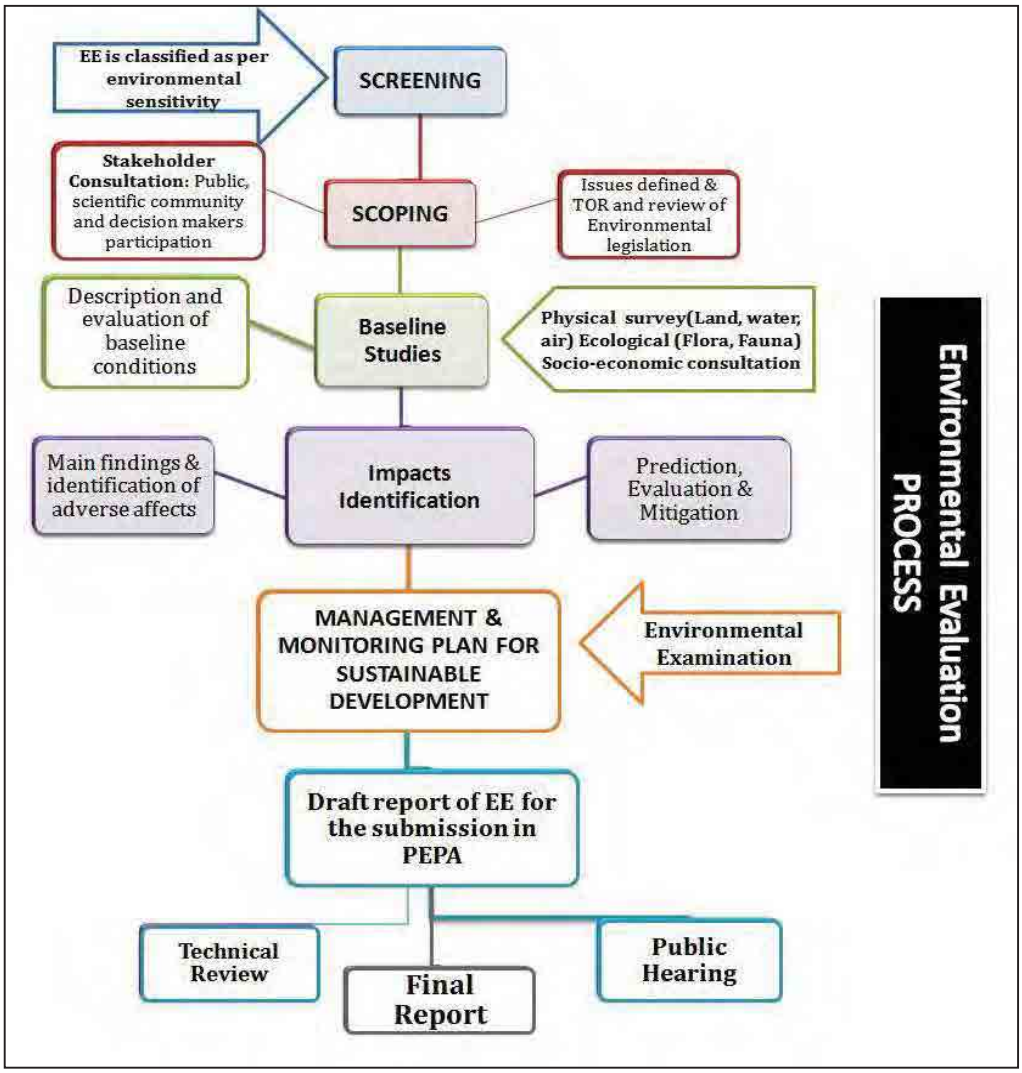


Figure 1-1: Components of EIA

a) Screening of EIA:

The process of an EIA commences at the early stages of the conception and design of the project. The first step of screening is to judge the projection according to the schedules of PEPA, which may decide the fate of the project in IEE or EIA.

Whereas at the final stage of screening the rigorous survey of literature will be conducted to review the relevant legislation.

1. **Screening of water supply and sewerage Scheme, for environmental assessment**

SCHEDULE II (Project required EIA)

F. Water supply and treatment

Water supply schemes and treatment plants with total cost of Rs. 25 million and above may fall under EIA.

2. **Best Management Practices for Storm (BMPS) water drains**

For storm water management no laws and rules are available in Pakistan. After literature review it is recommended that internationally BMPS are followed for storm water drain. Storm water can be used for different purposes, *i.e.*, irrigation, gardening, water reservoirs etc.

b) Orientation or Scoping

Meetings and discussions will be held among the members of the EIA Consulting Team and RWASA members. This activity is aimed at achieving a common ground of understanding of various issues of the study.

c) Planning for Data Collection

Subsequent to the concept clarification and understanding obtained in the preceding step, a detailed data acquisition plan will be developed for the internal use of the EIA Consulting Team. The plan will include identification of specific data requirements and their sources; determined time schedules and responsibilities for their collection and indicated the logistics and other supporting needs for the execution of the data acquisition plan.

d) Data Collection

In this step, primary and secondary data will be collected through field observations, environmental monitoring in the field; concerned departments and published materials to establish base line profile for physical, biological and socio-economic environmental conditions.

- Site Reconnaissance
- Analysis of Maps and Plans
- Review of Literature (Secondary Data / Info)
- Stakeholder Consultation or Public Participation
- Baseline Studies & observation (Primary Data Collection)

- Physical Environment (meteorology and climate, geology and soil, seismology, air and water quality, noise, topography and drainage patterns, hydrology and/or hydraulic regime, surface and ground water and land use).
- Biological/Ecological Environment (protected/endangered flora/fauna of the study area)
- Socio-Economic Environment (settlement pattern, political and administrative setup, population and communities, socioeconomic conditions protective and sensitive areas , archaeological and cultural sites , health and facilities, industrial activities , physical and cultural heritage, utilities, railway links or alignment, tourism facilities and potentials and others).

- Recording of the Local Perception about the project
- Laboratory Analyses (Laboratory certified by the Environmental Protection Agency under Certification of Laboratories Rules 2000).

e) Documentation of the Existing environment

The information about the physiographic, geology, climate, hydrology, drainage, flora and fauna will be gathered in the pre-construction phase.

f) Identification and Evaluation of Environmental Impacts

The impacts of this project on the physical, biological / ecological and socio-economic environment prevalent in the project area will be visualized in the design, construction and operational phases. The issues will then be prioritizing according to their environmental sensitivity.

g) Mitigation Measures and Implementation Methods / Incorporation in Design & Planning Stage

The adequate mitigation measures and implementation mechanisms will be proposed so that the proponent could incorporate them beforehand in the design phase.

h) Preparation of Environmental Management and Monitoring Plan (EMMP)

The Environmental Management and Monitoring Plan (EMMP) will be prepared which will provide the framework for the implementation of the mitigating measures and environmental management and monitoring during the construction and operation phases of the proposed Project.

8.5. Documentation and Report writing

Once the study is completed, the interim sections of the report being compiled by the experts will be integrated to formulate a complete document. The draft report will then be presented to the Project

Proponent for review and comments and then would be finalized for presentation and submission to the Punjab Environmental Protection Agency (PEPA). PEPA after its review and scrutiny will advertise the date of public hearing, after taking feedback of the stakeholders from the public hearing it will again send to PEPA for the final approval.

9. Generic Environmental Monitoring and Management Plan (GEMMP)

The monitoring and management plan during construction stage will be implemented by PMU with assistance of Consultants, while during operation phase WASA will be responsible for the implementation of monitoring and management program. The WASA staff will be trained by the Consultants to perform its environmental monitoring functions. Under the powers conferred to EPD by the 2000 Regulations, the Department may externally monitor various project related activities in order to ensure that the project operations are in compliance with the requirements of applicable National Environmental Legislation.

Environmental Impacts and mitigation measures for water supply and Sewerage water supply Schemes

- Sewerage Scheme Planning
- Water Quality
- Surface Water Quality
- Groundwater
- Flooding
- Geology & Seismicity
- Soils
- Flora and Fauna
- Health and Safety
- Socio-cultural Impacts
- Cumulative Impacts

A generic environmental management plan for water supply, sewerage network and storm water drainage will include the parameters given in the following tables.

Table 3: GEMMP for Sewerage Network

Sr. No	*Monitoring Parameter*	*Monitoring Location*	*Frequency*	*Responsibility*
A. Construction Stage				
1.	Dust	Construction Site, Contractor's Camp Site,	Frequent monitoring throughout the construction activities	PMU/ EPD

2.	Noise	Construction Site and its Surroundings	Monthly throughout the construction activities	PMU/ EPD
3.	Silt Run-off/ Soil Erosion	Borrow Pits, Steep slopes	Throughout the construction activities	PMU/ EPD
4.	Accidental damage to utilities in excavated areas	At the construction Sites	Throughout the construction activities	PMU
5.	Traffic disruptions due to excavations	All roads used by the construction crew	Throughout the construction activities	PMU/ Traffic Police
6.	Disposal of effluents at construction camps	Contractor's Camp Site	Monthly throughout the construction activities	PMU/ EPD
7.	Disposal of Spoil	At Construction and Disposal Sites	Monthly depending upon the construction activities	PMU/ EPD
8.	Health & Safety of Workers	Construction Site, Contractor's Camp Site	Monthly throughout the construction activities	PMU/ EPD
B. Operation Stage				
9.	Health & Safety of Workers	At work place	Monthly	WASA
10.	Blockage of sewer lines	At the place of blockage	Throughout the operation period	WASA

Table 4: GEMMP for Water Supply Network

Sr. No	***Monitoring Parameter***	***Monitoring Location***	***Frequency***	***Responsibility***
A. Construction Stage				
1.	Dust	Construction Site, Contractor's Camp Site,	Frequent monitoring throughout the construction activities	PMU/ EPD
2.	Noise	Construction Site and its Surroundings	Monthly throughout the construction activities	PMU/ EPD
3.	Accidental damage to utilities in excavated areas	At the construction Sites	Throughout the construction activities	PMU
4.	Traffic disruptions due to excavations	All roads used by the construction crew	Throughout the construction activities	PMU/ Traffic Police
5.	Disposal of effluents at construction camps	Contractor's Camp Site	Monthly throughout the construction activities	PMU/ EPD

B. Operation Stage				
6.	Delivery of unsafe water to distribution network	At source and at entry into distribution network	Weekly	WASA
7.	Chlorination	At source in the distribution network	Monthly	WASA

9.1. Best Management Practices for Storm Water Schemes

There are both proven and evolving alternatives to conventional drainage techniques and site designs that can substantially reduce surface runoff quantities and resultant pollutant loadings. These alternative development techniques, commonly called Best Management Practices or BMPs, are aimed at soaking up every drop of rainwater close to where it falls.

Common Goals for BMPS

1. To reduce the amount of impervious surface areas to reduce storm water runoff;
2. To utilize the landscape and soils to naturally move, store and filter storm water runoff before it leaves the development site; and
3. To prevent, control or treat storm water discharges.

Types of Sewer System

Two types of sewer systems are used to convey storm water runoff: separate storm sewers and combined sewers.

1. ***Separate storm sewer systems***

   Convey only storm water runoff. Water conveyed in separate storm sewers is frequently discharged directly to receiving streams without receiving any intentional form of treatment.

2. **In a *combined sewer system***

   Storm water runoff is combined with sanitary sewer flows for conveyance. Flows from combined sewers are treated by sewerage treatment plants prior to discharge to receiving streams. During large rainfall events however, the volume of water conveyed in combined sewers can exceed the storage and treatment capacity of the wastewater treatment system. As a result, discharges of untreated storm water and sanitary wastewater directly to receiving streams can frequently occur in these systems. These types of discharges are known as combined sewer overflows (CSOs).

Principles for BMPs

Typically storm water runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), *coli form* etc. Rapid runoff, even of uncontaminated storm water, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for storm water treatment, the following principles should be applied:

1. Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge;
2. Surface runoff from process areas or potential sources of contamination should be prevented;
3. Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff;
4. Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds);
5. Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present;
6. When water quality criteria permits, storm water should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility;
7. Oil water separators and grease traps should be installed and maintained as appropriate at refuelling facilities, workshops, parking areas, fuel storage and containment areas; and
8. Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Common Practices for BMPs

1. **Vehicle maintenance**

By maintaining your car properly you can prevent oil leaks, heavy metals and toxic materials from travelling from your car onto the street. Rain washes oil and other hazardous chemicals from the street into the nearest storm drain, ultimately draining into the *Nallah*.

2. Lawn and Garden Care

When fertilizing lawns and using other common chemicals, such as pesticides and herbicides, remember you're not just spraying the lawn. When it rains, the rain washes the fertilizers, pesticides and herbicides along the curb and into storm drains, which ultimately carry runoff into the nearest *Nallah*.

In addition to degrading the water quality of our streams and rivers, pesticides can kill living organisms in the stream and fertilizers can cause algal blooms, which hold up our waterways of oxygen that fish need to survive. If you have to use fertilizers, pesticides, and herbicides, carefully read all labels and apply these products sparingly.

3. Vehicle Washing

Car washing is a common routine for residents and street Car washers to earn money. However, most of the time, cars are washed in driveways and parking lots which allow wash water (dirty water) to finds its way to the nearest storm drain.

The wash water often contains pollutants, such as oils and grease, phosphates (from the soap), and heavy metals all of which are unhealthy for people.

4. Tree Planting

Trees are not only a beautiful addition to the landscape, but they also provide invaluable benefits to cities. Mature trees decrease local temperatures. Trees naturally clean the air of pollutants and create a neighbourhood noise buffer.

Trees also improve storm water management, reducing the amount of polluted storm water that normally would go directly into storm drains. Tree roots also allow rainwater to filter back into the soil, recharging the often thirsty water table.

5. Backyard Stream

Establish a streamside (riparian) buffer, a vegetated area along the edge of the stream that protects it from pollution and erosion. This buffer zone absorbs pollutants and nutrients that would otherwise end up running directly into the stream.

Plant material slows runoff and filters out pollutants and sediments. Well-planted streamside buffers are also a great low-cost way to control erosion. While plants slow runoff, filter pollutants, and help control erosion, trees cast shade on the stream, cooling the water, reducing algae growth and improving fish habitat.

6. Contained Planters

Planters reduce impervious cover (impenetrable surfaces, such as concrete sidewalks, parking lots, etc.) by retaining storm water runoff rather than allowing it to directly drain into nearby sewers. Planters offer "green space" in tightly confined urban areas by providing a soil/plant mixture suitable for storm water capture and treatment. They can be used on sidewalks, parking areas, back yards, rooftops and other impervious areas.

7. Rain Barrels

A rain barrel collects and stores storm water runoff from rooftops. By detaining (temporarily holding) the storm water runoff during a rain event, you can help add capacity to the city's sewer system and reduce sewer overflows.

The collected rain water can be reused for irrigation to water lawns, gardens, window boxes or street trees. Rain barrels are effective for storm water management when the stored water is emptied in between storms, making room in the barrel for the next storm.

8. Rain Garden

A rain garden uses native plants and landscaping to soak up rain water (storm water) that flows from downspouts or simply flows over land during a rain event.

The center of the rain garden holds several inches of water, allowing the storm water to slowly seep into the ground instead of flow directly from your roof, yard or driveway into the nearest storm drain.

9. Drainage Swales

A swale is a broad, vegetated channel used for the movement and temporary storage of runoff. Swales also can move a portion of the runoff into the ground and filter out runoff pollutants.

Swales can be effective alternatives to enclosed storm sewers and lined channels, where their only function is to rapidly move runoff from a developed site. On some sites, natural drainage courses may still be present and it is recommended that they be retained as part of the site drainage plan.

In contrast to conventional curb-and-gutter/storm sewer systems, swales can reduce both the rate and volume of storm water runoff on a site. Since this is achieved via absorption of

runoff into the soil, swales in sandy soils will be much more effective than swales in clay soils.

10. Naturalized Detention Basin

Naturalized detention is intended to serve multiple functions, in addition to flood prevention, including pollutant removal and creation of wildlife habitat (where appropriate).

Natural detention basin designs emulate natural lake or wetland systems by utilizing native plants along the water's edge and on side slopes.

The design generally incorporates flat slopes at the edge of the water or wetland, shallow zones of emergent vegetation at the edge of wet basins, and a combination of vegetated and open water areas in wetland basins.

11. Dry Wells

Dry wells are small, excavated pits, filled with stone or gravel that temporarily stores storm water runoff until it infiltrates (soaks) into the surrounding soil.

The storm water can come straight-off of the roof of your house via a downspout that either indirectly or directly connects to the dry well. It can travel indirectly to the dry well through a grassy swale or it can travel directly into the well through a pipe.

Dry wells help protect streams in combined and separate sewer areas. Dry wells also recharge groundwater through infiltration, which leads to more flow in streams during dry weather (when it is not raining) and less stream bank erosion during wet weather (when it is raining).

12. Natural Landscaping

Natural landscaping refers to the use of native vegetation – particularly prairie, wetland and woodland species – on a development. Native vegetation is a low-cost alternative to traditional landscaping that utilizes turf grass and ornamental plantings. A site that is naturally landscaped will produce substantially less storm water runoff than a conventional landscape.

Native vegetation enhances both absorption of rainfall and evaporation of soil moisture due to extensive root systems that extend down 3 to 10 feet or more. In contrast, the root zone of turf grass typically extends only about 3 to 4 inches.

The benefits of natural landscaping are enhanced if runoff from impervious surfaces is routed across native vegetation buffer strips. Natural landscaping reduces pollutants associated with urban runoff. It can be estimated that removal rates for suspended solids and heavy metals (such as cadmium and lead) could be as high as 80 percent and removal rates for nutrients (such as phosphorus and nitrogen) could be as high as 70 percent for a residential development utilizing natural drainage and native landscaped filter strips.

Deep-rooted native plants effectively stabilize soils and prevent erosion. It reduced maintenance needs of natural landscaping not only save money, but also reduces air, water and noise pollution.

10. Institutional Developments and Environmental Training

PMU staff will require training to get proper feedback and expertise in dealing with urban services related engineering matters. In addition, its capacities for environmental and social issues will need to be enhanced. For an effective implementation of an environmental management and monitoring plan, with interaction of other stakeholders, like overlapping state functionaries, and community members, monitoring of the private operations, they will require capacity building. The operations staff of WASA will require technical support and training. In addition, training will also be required to monitor various environmental quality parameters. The proposed training program for different staff with their field of training is given in Table.

Table 5: Training Program for Staff of the WASA

Sr. No.	Persons to be Trained	Duration	Subject
1	Operation and Maintenance Staff of TMA	3 days / year	Occupational Health & Safety Procedures
2	Construction Staff of PMU and Contractor	3 day	Occupational Health & Safety Procedures, implementation of environmental mitigation measures
3	Environmental Monitoring Staff of PMU and TMA	1 week	Sampling, testing and Use of Environmental Monitoring Equipment, Record Keeping

MANAGEMENT AND TRAINING

Institutional support is critical for the successful wastewater utility operation. It begins with appropriate staffing. Recommended team members are:

1. A manager with technical and administrative experience
2. An environmental engineer
3. Supervisors and workers in operations
4. Sewer maintenance and plant maintenance crafts
5. Laboratory directors and technicians; and
6. Support staff in accounting, budgeting, and clerical areas.

The project includes on-site disposal systems, holding tanks or small-diameter sewers with settling tanks, staff will be needed to develop and enforce standards for the facilities, and to inspect and approve installations, and there will have to be provision for on-site system maintenance.

A customer relations unit is essential to receive and investigate customer complaints, provide information to customers, and conduct education programs related to the system's services (e.g., hygiene and sanitation, on-site system upkeep). If the utility is responsible for revenue collection, a billing and collections group will be required. Training should begin before system start-up, with the assistance of a design consultant. Training should include:

1. Operations and maintenance training on the actual equipment
2. Basic familiarization with the system
3. Its relationship to the environment, and
4. Fundamentals of occupational health and safety.

Industrial waste control staff will need training on operation and maintenance of pre-treatment equipment. A start-up plan should be prepared for any new wastewater facility of significant size to ensure that the requirements described above are met. The start-up plan should provide for:

1. Assembling staff
2. Maintenance equipment and spare parts in advance of need
3. Training all personnel, and
4. Establishing revenue sources and budget.

A detail presentation on Environmental and Social Assessment Guidelines and Protocols for WSS&D Schemes is attached as annexure-I.

Part III

Climate Change & Energy Conservation Strategy for RWASA

11. Climate Change

The scope of the study includes:

i) Understand the range of future climate scenarios to help RWASA business planning.

ii) Recommend responses to the projected climate impacts.

iii) Develop a framework for greenhouse gas reduction to deliver RWASA commitment to carbon neutrality.

This strategy should also provide comprehensive framework for reducing greenhouse emissions and achieving carbon neutrality.

Climate change is affecting almost all important sectors including health, agriculture, biodiversity and energy etc. and consequent extreme weather events have gained considerable scientific attention recently due to their potentially catastrophic impacts. Pakistan is also affected by such extreme events e.g. floods of year 2010, 2011 and frequent heat waves.

A change in the statistical distribution of weather patterns when that change lasts for an extended period of time is referred as Climate Change. Worldwide climate change is affecting different fields of life.

Global surface air temperatures have increased by about 0.3^{o}- 0.6^{o}C since the late 19th century and 0.2- 0.3 ^{o}C during last 40 years. Pakistan, as part of South Asia has also observed warming in spite of less discharge of greenhouse gasses as compared to industrialized developed countries. (Pant and Kummar, 1997:18). Temperature in Rawalpindi was decreasing in mean maximum and minimum during 1947-71, after which an increasing trend is observed.

11.1. International Response on Climate Change

- **The 4th Assessment Report of IPCC (2007) indicate that**

Global temperature rises of 2 – 4.5 °C are almost inevitable due to increased concentration of greenhouse gases as caused by human activities (fossil fuel use, land use changes etc.). The above global warming (or in broader term Climate Change) is expected to have serious consequences for:

- Agricultural production
- Biodiversity

- Heath
- Sea Level rise

The United Nations Framework Convention on Climate Change (UNFCCC)

Adopted in June 1992 by over 180 countries at the "Earth Summit" in Rio de Janeiro, Brazil. The Convention was signed by 154 states (including Pakistan) and entered into force on 21st March, 1994. The Convention divides countries into two main groups Annex I (developed) & non- Annex I (developing)

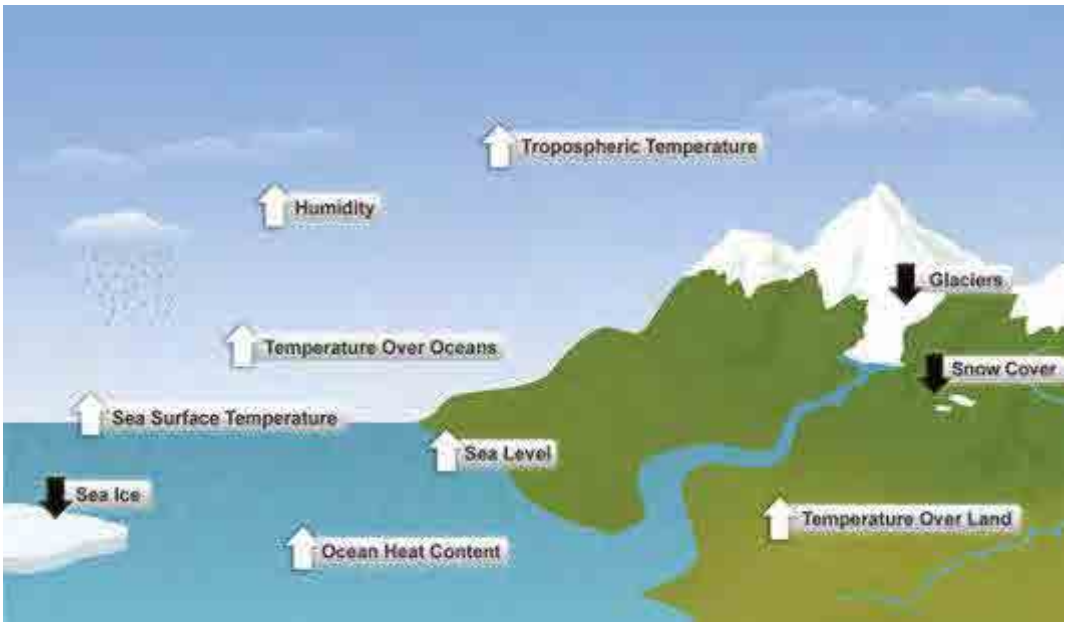
UNFCCC is a non-binding legal framework:

- Aims at stabilization of GHG concentration in the atmosphere at safe level.
- To balance out the response along mitigation and adaptation measures

11.1.1. Factors Affecting Climate Change

Climate change is caused by factors such as

- biotic processes,
- variations in solar radiation received by Earth,
- plate tectonics,
- Volcanic eruptions.
- Certain human activities have also been identified as significant causes of recent climate change, often referred to as "global warming".



Ten indicators for a warming world, Past Decade Warmest on Record According to

Scientists in 48 Countries, NOAA, July 28, 2010

Rawalpindi's weather has historically been known to change rather quickly due to its proximity to Himalayas and the Pir Panjal Range. These mountains not only influence the weather of the city, but also provide great recreation during the hot months. The average low temperature of Rawalpindi is 4.0^{o}C and average high temperature is 20.0^{o}C. The average annual rainfall is abundant at 1,145 mm (45.1 in), most of which falls in the monsoon season. Record rainfall was experienced in the year 2013 at a massive 1,952 mm (76.9 in) mostly due to an unusually wet monsoon season.

Research in the district Rawalpindi shows that abnormal rain patterns in this region during 1996-2005 shapely decline underground water. Rains in this region were intense and quick run-off didn't contribute in the recharge of underground water. Research findings show that approximately 7 to 10 feet of underground water has been reduced every year within 1996-2005. Only in the Gawal Mandi area of district Rawalpindi, underground water depleted from approximately 25 ft. in 1960 to 275 ft. in 2005. This is such an alarming situation, yet remained unfocused by both public and private sector.

11.2. Potential effects of climate change

11.2.1. Decreased precipitation

Impact: Water scarcity, reduced stream flow,

Vulnerable system: Food production, urban green space, Human health, Energy supply

How this could affect a city: Reduced availability of irrigation water and yield decreases, reduced biodiversity and ecosystem services, Malnutrition and increase in waterborne diseases, Disruption of thermal power plant cooling processes

11.2.2. Increased heavy precipitation

Impact: Flooding, Increased erosion and sediment transport

Vulnerable system: Wastewater**,** Transportation, Water supply (reservoirs)

How this could affect a city: Flooding of facilities causing damage and contamination of water bodies, Damage to transport infrastructure, Sedimentation and decrease in water storage capacity and turbidity increase

11.2.3. Higher temperatures

Impact: Reduced water oxygen concentrations and altered mixing, Snow and ice cover change, Increase in bacterial and fungal content of water

Vulnerable system: Water supply (lakes/reservoirs), Water supply (rivers), Water supply infrastructure

How this could affect a city: Reduced water quality for example through algal blooms, increase in treatment requirements, Change in peak flow timing and magnitude, Increase in treatment requirements to remove odour and taste

12. Causes and effects of future climate scenarios

12.1. Population

According to the census of 1998, the population of the 61 UCs under the jurisdiction of RWASA was 1.124 million. The population estimate for 2015 is 1.688 million, and the projected population for 2040 is 2.556 million. Since Carbon dioxide contributes to climate change/global warming, the increase in population makes the problem worse because we breathe out carbon dioxide. More people means more demand for food, more carbon dioxide in the atmosphere, more demand for cars, more demand for homes and they all in somehow or other lead to climate change.

More demand for food will lead to more transportation since movement of goods and services is done by transportation sector. More demand for cars means more pollution in the air and more traffic on the roads which means longer waiting time on the traffic lights and will result more burning of fuel. More demand for homes means cutting down of trees to make way for homes, schools and colleges.

12.2. Earthquake

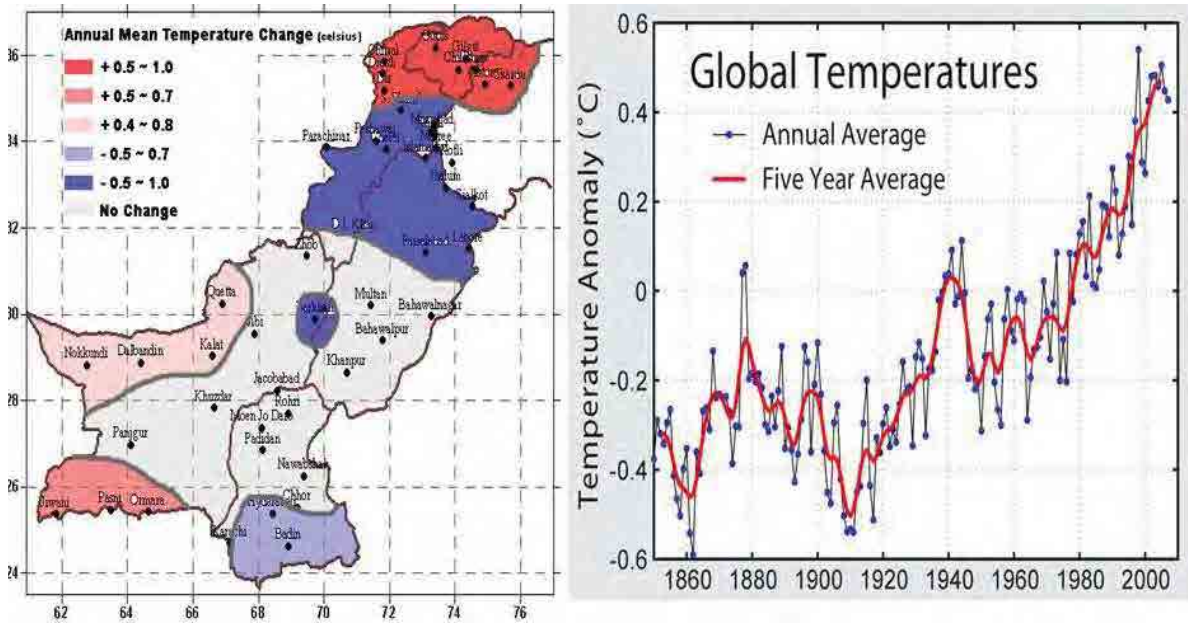
The Seismic zoning maps of Pakistan prepared by different agencies put Islamabad and Rawalpindi in a zone where moderate earthquakes occur. However the seismic record of the area where these two cities/districts are located, including the destruction of Margalla Towers by earthquake of 2005, call for taking the possibility of destructive earthquakes, seriously. Rawalpindi and Islamabad are located in a zone which has a very long documented history of getting affected by earthquakes of varying intensity or magnitudes.

12.3. Temperature

CICERO (2000) projects 0.9 degree C increase in temperature by 2020, by 2050 it would double, 1.8 degree C. The CSIRO9 model predicts 17% increase in wet summer spell in South Asia. (Wigley and Jones, 1985:149-152) showed that a little change in precipitation could affect water supplies considerably.

According to the recent study carried out by the met department, there has been a considerable temperature variation all over the country especially in the Northern Punjab and Potohar, resulting in creating favourable conditions for the extreme weather patterns. The increased temperature

pattern being experienced can be compared with global temperatures (from 1860 – 2000) which is showing the same pattern as observed in Pakistan in the recent years.



The annual Mean Temperature Change in Pakistan and Global Temperature Variation from 1860 - 2000 (Source: Metrological Department of Pakistan and Wikipedia, the free encyclopaedia)

12.4. Rainfall and Flooding

The Lai Nala Basin has a catchment area of about 235 square kilometres. It also includes the twin cities. The basin, on average, receives 600 mm rains during monsoon (July-September) which normally lead to high flood discharge. Most of the catchment area falls in ICT and when rains are particularly heavy, flooding risk intensifies especially for downstream Rawalpindi city. The Lai combined with its tributaries such as

Saidpur Kasi,

Kanitwali Kasi,

Badarwali Kasi

Tenawali Kasi,

Niki Lai,

Dhoke Hassu Nala,

Dhoke Ellahi Bakhash Nala and

PAF Colony Nala joins the main stream of Lai within Rawalpindi City.

According to Rawalpindi's Flood Management Plan 2009, following areas are most vulnerable as they are low lying and located adjacent to Nala Lai:

Dhoke Najju

Zia ul Haq Colony

New Phagwari

Mohallah Raja Sultan

Dhoke Ratta

Ratta Amral

Gawal mandi

Javed Colony

Chamanzar

Tipu Road, and;

Dhoke Ellahi Bakhash

The physical infrastructure of water supply will be negatively affected by flooding, through direct damage to pipelines and facilities, sedimentation of reservoirs as well as overloading of capacity.

As rainfall becomes more intense, surface runoff levels can exceed the capacity of storm water entry points or cause sewer overflows in combined sewer systems. This can cause street flooding, with associated health dangers due to contamination, but can also increase the cost of meeting related regulatory requirements. Combined sewer overflows are a problem linked both to storm water and to wastewater: excess storm water causes overflows, but the conveyance of wastewater by means of combined pipes is also at the root of the problem.

12.5. Pollution

Pollution whether it is vehicular, electrical or industrial is the main contributor to the Climate change /global warming.

Vehicles

Everyday billions of vehicles release various gases into the atmosphere. This causes earth to warm up and increase its average temperature. Automobile Exhaust Burning One Gallon of Gasoline Generates 22 Pounds of Carbon Dioxide When gasoline is burned, the carbon in it combines with oxygen in the air to form carbon dioxide because the oxygen adds weight, and the newly formed carbon dioxide weighs more than the original unburned fuel.

Electricity causes pollution in many ways

Fossil fuels are burnt for e.g. coal is burnt to produce electricity. Coal is the major fuel that is burnt in these power plants. Coal produces around 1.7 times as much carbon dioxide per unit of energy when flamed as does natural gas and 1.25 times as much as oil. Over 75% of the electricity worldwide is produced by burning fossil fuels. Many gases are sent into the air when fossil fuels are burnt of which main is the carbon dioxide gas.

Industries

Industries on the other hand release various gases into the water and air. Carbon dioxide, methane, nitrous oxides are the major greenhouse gases.

12.6. Deforestation

Deforestation is the cutting down of trees and plants to make way for any development activity. Carbon dioxide is the air that our body lets out when we breathe. Trees take in this carbon dioxide and release oxygen that we breathe in. With the cutting down of more and more trees is leading to greater concentration of carbon dioxide in the air.

These forests cover less than five per cent of Pakistan's total area and at current rates; the country's woody biomass will be totally consumed within 10 to 15 years. Forests provide essential ecosystem services for climate stability, watershed protection, soil erosion control, biotic diversity and wildlife habitat. They also provide much needed wood biomass, supplying 32 per cent of Pakistan's total energy needs in the form of fuel wood and timber for construction activities.

This means that it is very important to protect our trees to stop the greenhouse effect, and also so we can breathe and live. Deforestation is blamed for rise in the greenhouse gases present in the atmosphere by cutting or burning them. New development projects, requirement of land for homes and factories, requirement for wood and also soil erosion are the major factors that are causing deforestation, which in turn leading to climate change.

12.7. Water Availability

Due to increase in the temperature the glaciers are melting causing variation in the water availability of the rivers. Further due to change in the rainfall patterns and excessive urbanization the ground water recharge is reducing resulting in depletion of underground water level. Intense rainfall and quick run off is also a cause for less recharge.

Water supply will be reduced by altered precipitation patterns and increased temperatures (which increase evapotranspiration).Reduced winter rainfall will affect the recharge period of groundwater, lakes and reservoirs.

12.8. Water Quality

Due to change in the rainfalls patterns the inflows of the fresh water in the surface water sources is changing and in dry weather the inflows of contaminated water increases causing water quality problems as the mixing of fresh water is not possible in the dry weather.

The increased occurrence and intensity of rainfall events can cause erosion within lake or river catchment areas and raise the turbidity levels of water. This turbidity can affect water quality even if the eroded soil is not particularly polluted.

12.9. Landfills

When we throw garbage out of our house it goes to landfills. Landfills are those big chunks of garbage that you must have seen on some expressway, when you go out of your city that stink. The garbage is then used by big recycling companies to make some useful products out from that garbage. Methane Generated naturally by bacteria ,called methanogens which is habitat in marshes, swamp and wet land soils It also escapes from natural gas deposits Methane gas escapes from garbage landfills and open dumps It also leaks out during mining, extraction and transportation of coal, oil and natural gas.

Most of the time that garbage is burnt which then release some toxic gases into the atmosphere. These enormous amounts of toxic greenhouse gases when go into the atmosphere make global warming worse which is the cause of climate change.

13. Recommended Response

Current water management infrastructure tends to be inflexible to changing circumstances, yet projections of climate change show that variability can change capacity requirements either regionally or across the year. A flexible system is one that is characterized by its ability to adapt to changing requirements. Table below gives some examples of how a flexible urban water system would respond to changing conditions versus how a typical system would do so.

Urban water management aspect	**Non-exhaustive examples of climate change impacts**	**Current system response example**	**Potential responses to changing conditions from a flexible system**
Water supply	Reduced water supply, either seasonally or throughout the year	Increasing water supply through additional infrastructure such as dams, boreholes, desalination facilities or bulk supply transfers	Demand reduction through efficiency increases, active leakage management, behaviour change or pricing policies Sourcing of alternative supplies for non-potable demand: rainwater harvesting or treated wastewater effluent reuse Increasing sustainable storage capacity, for example through Aquifer Storage and Recovery
Wastewater management	Increased inflow of pollution, caused by flooding Flooding of wastewater treatment plants located near rivers or coasts	Improving treatment Technology Construction of protective barriers or lifting of equipment	Control of pollution at source and use of natural treatment techniques Use and appropriate siting of de-centralized natural treatment techniques
Storm water management	Increased storm water flows and combined sewer overflows	Improving and extending the infrastructure conveying storm water away from the city	Attenuation of runoff through the use of Sustainable Urban Drainage Systems options, for example green roofs, porous paving, swales, rainwater harvesting, and detention ponds and basins

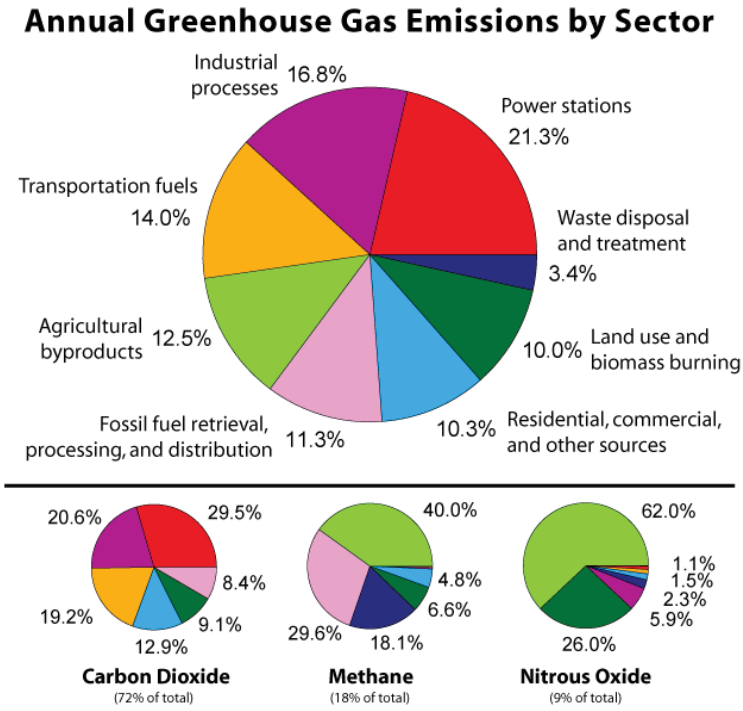
Conventional versus flexible system responses to changing conditions (Source: ICLEI European Secretariat, 2011)

14. Green House Effect

The greenhouse effect is a natural process by which some of the radiant heat from the Sun is captured in the lower atmosphere of the Earth, thus maintaining the temperature of the Earth's surface. Of the 100% light that sun sends to earth, almost 70% sunlight is reflected back into the sky. Only 30% of that sunlight is absorbed by us. The greenhouse effect is nothing but a naturally occurring process designed by nature that aids in heating earth's surface and helps to maintain ecological balance.

The gases that help capture the heat, called "greenhouse gases," include

- Water vapour,
- Carbon dioxide,
- Methane,
- Nitrous oxide, and
- A variety of manufactured chemicals. Some are emitted from natural sources; others are anthropogenic, resulting from human activities.



Source: Green House gas Wikipedia, the free encyclopaedia

14.1. Eligible GHG's Reduction under Kyoto Protocol

The Kyoto Protocol's emissions targets cover the six main GHGs:

S.No.	Name	Formula	GWP (CO2 eq.)
1	Carbon- dioxide	(CO2)	1
2	Methane	(CH4)	21
3	Nitrous oxide	(N2O)	310
4	Per- fluorocarbons	(PFCs)	92,00
5	Hydro- fluorocarbons	(HFCs)	11,700
6	Sulphur hexafluoride	(SF6)	23,900
Sinks (Carbon Sequestration)			

These gases together with water vapours create the natural greenhouse effect. They trap some of the sun's energy and keep the Earth warm enough to sustain life. Different gases have different heat trapping capabilities. Some of them trap more heat than carbon dioxide. Methane is much more effective then carbon dioxide in entrapping heat in the atmosphere. By driving cars, using electricity from coal fired plants and heating up our homes from natural gases, we release carbon dioxide and other heat trapping gases in the atmosphere.

15. Carbon Neutrality

Carbon neutral, also called carbon neutrality is a term used to describe the action of organizations, businesses and individuals taking action to remove as much carbon dioxide from the atmosphere as each put in to it. The overall goal of carbon neutrality is to achieve a zero carbon footprint.

15.1. Strategies for Reducing Municipal Greenhouse Gas Emissions

Best practice strategies for reducing municipal GHG emissions in the categories of buildings, transportation/land-use, energy supply, municipal services and carbon sequestration/offsets are as below:

15.1.1. BUILDINGS

- Reduce Energy Demand
- Utilize Solar Energy
- Ground Source Heat Pumps

15.1.2. TRANSPORTATION / LAND USE

- Appropriate Land Use
- Public Transportation
- Active Transportation
- Deter Automobile Use
- Changing Vehicle Technology

15.1.3. ENERGY SUPPLY

- Electricity from Renewable Sources
- Aquifer and Borehole Energy Storage
- District Heating and Cooling
- Combined Heat and Power

15.1.4. WASTE, WATER & MUNICIPAL SERVICES

- Increased Recycling
- Waste Incineration & Gasification

- Methane Capture
- Water Demand Management

15.1.5. CARBON SEQUESTRATION and OFFSETS

- Urban Agriculture & CO2-enriched Greenhouses
- Urban Forestry
- Geological & Mechanical Sequestration

16. Strategies to be adopted by RWASA

Presently, urban areas of Rawalpindi city are administratively controlled by different organizations/departments such as CDGR, WASA, RDA, TMA Rawal & Potohar Town and Rawalpindi & Chaklala Cantonment Boards. TMA Potohar Town, Cantonment boards, MES and WASA are the main agencies responsible for provision of water supply and sanitation services. However, function of solid waste and storm water drainage even in the WASA Jurisdiction is exclusively performed by CDGR through Rawalpindi Waste Management Company (RWMC). Presently, WASA Rawalpindi is responsible only for provision of water supply and sewerage services in the entire Rawal Town and 15 Union Councils of Potohar Town covering a total population of 1.4 million. With the inclusion of planned/proposed extend jurisdiction of sub urban and peri-urban area; the population is likely to increase to 2.00 million.

When considering which emission reducing actions to adopt, organizations should also consider the potential impacts on the natural environment (e.g. Air quality, water quality, biodiversity) on communities (e.g. health and safety, aesthetics) and on the economy (e.g. employment).The RWASA should implement the following strategies in order to get near to a carbon neutral organization:

16.1.1. Reduce Energy Demand

Pump Houses

Mostly RWASA is involved in construction of pump houses which are used for installation of pumping machinery for tube wells.

- ✓ Energy efficient design should be used

RWASA Offices

- ✓ Energy efficient design should be used
- ✓ refitting of buildings to improve efficiency;
- ✓ Where ever possible Utilize Solar Energy
- ✓ Led lights instead of tube lights should be used

Pumping Machinery

- ✓ Proper design of the machinery be done before installation
- ✓ Energy efficient machinery be used
- ✓ Pumping hours should be restricted to low tariff periods

Water Filter Plant

- ✓ Where ever possible Utilize Solar Energy
- ✓ Led lights instead of tube lights should be used
- ✓ Working hours should be restricted to low tariff periods

16.1.2. Transportation

- ✓ Reduce Un necessary travelling of vehicles
- ✓ Reduce fuel consumption by replacing old vehicles with new technology vehicles
- ✓ Route maps should be provided to the drivers
- ✓ GPS system should be provided in the vehicles for tracking
- ✓ Proper staff should be deployed for monitoring of the vehicles

16.1.3. Communication

Communication is an essential part of climate change initiatives because in the long run efforts to reduce GHG emissions are unlikely to be sustainable if they do not gain acceptance from key stakeholders including customers, staff, suppliers and investors.

Organizations should clearly communicate the following points:

a) Climate change is a significant threat to our prosperity, the welfare of future generations and natural ecosystems.

b) The main means to address climate change is to reduce GHG emissions from fossil fuel combustion and other industrial processes.

c) Combating climate change is everyone's responsibility.

16.1.4. Clean Development Mechanism

CDM is the only instrument that is available for developing countries to assist them in achieving sustainable development and contributing to the ultimate objective of the Convention. It aims to assist Annex-I Parties to implement project activities that reduce (or subject to constraints removes) GHG emissions in non-Annex-I Parties (i.e. most of the developing countries), in return for certified emission reductions (CERs). The CERs generated by such project activities can be used by Annex-I Parties to meet their emissions targets under the Kyoto Protocol.

16.1.4.1. Kyoto Protocol

In order to achieve stabilization of greenhouse gas (GHG) concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, 154 countries, including Pakistan signed the UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC) at the "EARTH SUMMIT" held in RIO DE JANERIO in 1992. The convention contains a non-

leading binding by the industrialized countries for stabilizing their emissions at 1990 levels by 2000 in order to allow ecosystem to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

As is explained in more detail in module 3: "Introduction to UNFCCC", the Kyoto Protocol is an amendment to UNFCCC that sets out specific targets to reduce GHG emissions from UNFCCC Annex I countries (or more correctly, from Kyoto Protocol Annex B countries – these are almost identical, with the exception for the few Annex I countries that have ratified UNFCCC but not the Kyoto protocol).

The Kyoto protocol also provides tools and procedures for countries to work together to achieve the emission reduction targets, instead of each country only trying to achieve the targets on their own in their own country. The three key tools are:

1. International Emission Trading permits countries to transfer parts of their 'allowed emissions' (assigned amount units).

2. Joint Implementation (JI) allows countries to claim credit for emission reduction that arise from investment in other industrialized countries, which result in a transfer of 'emission reduction units' between countries.
3. Clean Development Mechanism (CDM)

16.1.4.2. CDM organization and objectives

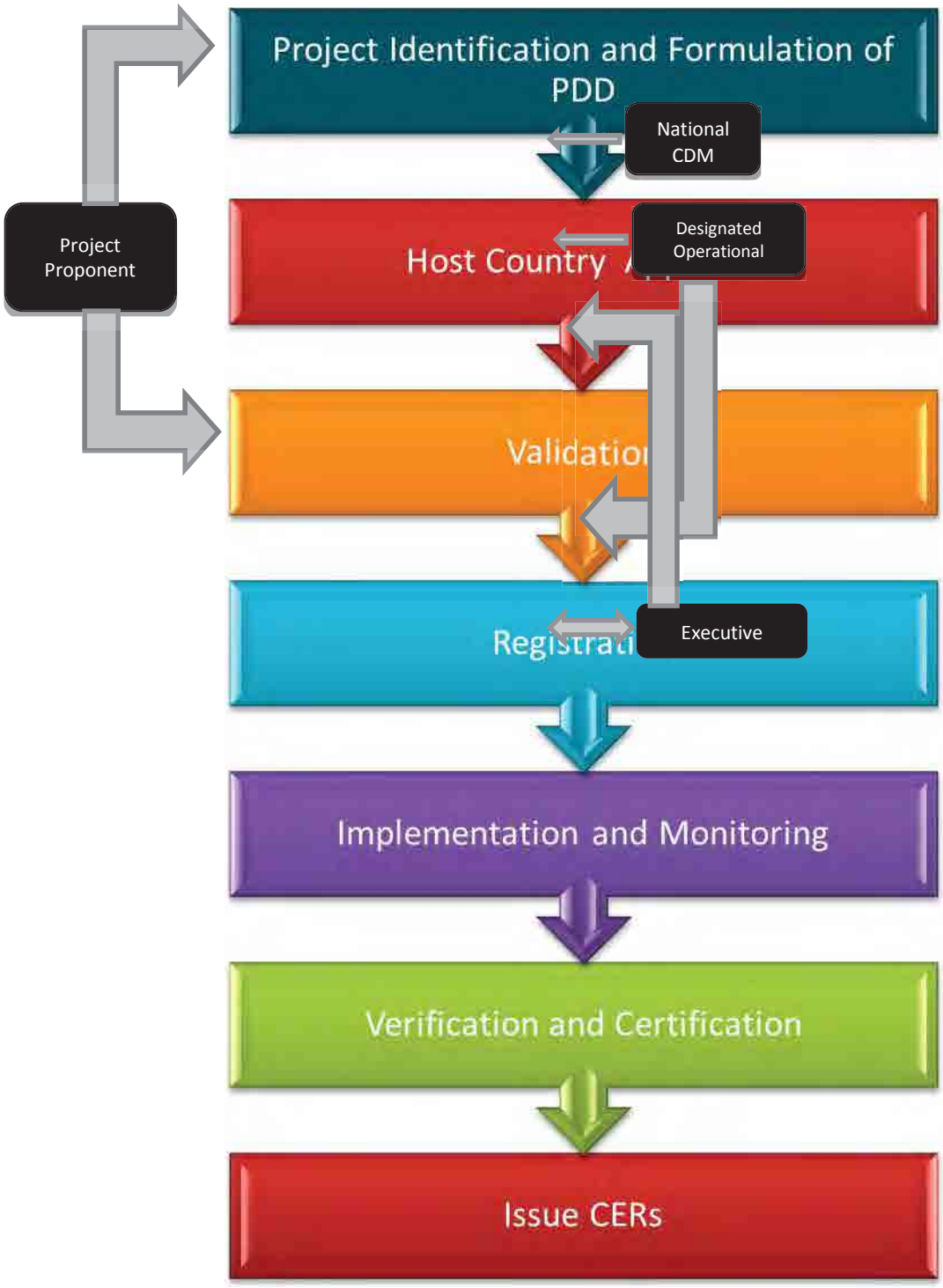
The practical function of CDM is defined in detail in the Kyoto Protocol and in a number of follow-up decisions by COP as well as in supporting documents issued by different bodies in UNFCCC. The most important body is the Executive Board (EB). CDM EB is responsible for further development of CDM rules, and supervising implementation. It is composed of 10 members and ten alternates. They are accountable to report conference of parties (COP). The basic requirements for any CDM project are as follows:

- The project must contribute to sustainable development in the country where the CDM project is implemented.

- Developed countries to support project activities that reduce GHG emissions in the developing countries in return for Certified Emission Reductions (CERs)/ Carbon Credits.

- The CERs generated by such project activities can be used by developed countries as credits to meet their emissions targets under the Protocol.

16.1.4.3. CDM Project Cycle



16.1.4.4. General Criteria for CDM project

Unilateral, bilateral and multilateral CDM projects are allowed in the following sectors (Annex-A):

1. **Energy**

    - Renewable/alternate energy
    - Energy efficiency/ conservation, and
    - Fossil fuel cogeneration

2. **Waste management**

    - Landfill gas capture
    - Solid waste management
    - Recycling
    - Animal/livestock waste;
    - Energy from solid from etc.

3. **Transportation**

    - Alternative fuel vehicle
    - Mass rapid transit system
    - Cleaner engines
    - Compressed natural gas.

4. **Industrial processes**

    - Steel
    - Textile
    - Fertilizer etc.

5. **Land use, land use change and forestry**

    - Watershed management
    - Biodiversity protection
    - Sustainable forest/rangeland management
    - Soil conservation
    - Afforestation and reforestation

6. **Agricultural and livestock practices.**

7. **Any other project resulting in GHG mitigation or carbon sequestration.**

Bibliography

Water Follies; Groundwater Pumping and the Fate of America's Fresh Water by Rober Glennon, (2002),, ISBN 1-55963-400-6, Island Press, Washington DC , USA

Environmental Geology of the Islamabad-Rawalpindi Area, Northern Pakistan. USGS Bulliten No. 2078-G, U.S. Department of State and Government of Pakistan

Australian Groundwater Modeling Guidelines. Waterline Reports Series No. 82. Sinclair Knight Merz and National Centre for Groundwater Research and Training (2012). ISBN: 978-1-921853-91-3. Published by the National Water Commission, Canberra, Australia

Review of groundwater models and modelling methodologies for the Great Artesian Basin by Smith AJ and Welsh WD. A technical report to the Australian Government from the CSIRO Great Artesian Basin Water Resource Assessment

Modeling Water Resources Management at the Basin Level. Research Report 149. International Food Policy Research Institute Washington, D.C.

Guidelines for Conducting Water Resources Assement (1998). ISBN 92-3-103476-6. UNESCO Publishing. France.

Pakistan Economic Survey 2014-15. Chapter 12 Population, Labour Force and Employment.

Adapting Urban Water Systems to Climate Change - A handbook for decision makers at the local level (2011). Published by European Secretariat GmbH Freiburg, Germany

National Water Quality Monitoring Programme. Fifth Monitoring Report 2007. Pakistan Council of Research in Water Resources (PCRWR). Islamabad, Pakistan

Annexure A: Inventory of Tube Wells WASA-RDA

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi.

WASA Rawalpindi

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
Detail List of Tube Wells West Zone, Sector-I UC (1-9)															
1	73-A	1	Choki Muhallah Ratta Amral	318,642	3,720,477	Submersible	8,000	300	25	25	Yes	Yes	No	2004	10
2	74	1	Near Lai Pull Ratta Amral	318,935	3,720,624	Submersible	7,000	210	25	50	Yes	Yes	No	1999	8
3	74-A	1	Chungi Ratta Amral	318,625	3,720,232	Submersible	6,000	260	30	50	Yes	Yes	Yes	1999	17
4	74-B	1	Near Railway Police Line Railway Godaam Road Ratta Amral	318,371	2,720,197	Submersible	8,000	150	30	50	Yes	Yes	Yes	1994	18
5	74-C	1	Near Street no. 22 Ratta Amral	318,685	3,720,249	Submersible			30	50	No	No	No	2014	
6	75	1	Bhusa Godaam	318,347	3,720,814	Submersible	7,000	260	25	50	Yes	Yes	Yes	1992	10
7	75-B	1	Near Girls College Melaad Nager Dhoke Ratta	318,441	3,720,835	Submersible	7,000		25	25	No	No	No	2010	8
8	75-C	1	Kachi Abadi Bhusa Godaam	318,173	3,720,781	Submersible			25	25	No	Yes	No	2014	10

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
9	76-A	1	Near Utility Store Melaad Nager Dhoke Ratta	318,547	3,720,745	Submersible	4,000	270	20	25	No	Yes	No	2004	7
10	76-B	1	Near Pull Dhoke Ratta	318,625	3,720,591	Submersible	5,000	250	25	50	No	Yes	Yes	2002	10
11	77	2	Dhoke Ratta Dispensary	318,603	3,721,013	Submersible	5,000	260	15	50	Yes	Yes	Yes	1988	12
12	78	2	Toheedi Road Dhoke Ratta	318,385	3,721,051	Submersible	6,000	260	25	50	Yes			1988	Abundant
13	78-A	2	Tanga Stand Dhoke Ratta	318,402	3,720,940	Submersible	5,000	260	25	50	No	No	No	1997	8
14	78-B	2	Near scheme No.7 Railway Workshop Road	318,359	3,721,384	Submersible	5,000	270	20	50	Yes	Yes	No	1997	10
15	79-A	2				Submersible	5,000	190	20	50				1998	Abundant
16	79-C	2	Babu Laal Husain Road Dhoke Ratta (Tanki)	318,699	3,721,132	Submersible	7,000	270	25	Public	No	No	Yes	1998	8
17	79-D	2	Near Boys High School Babu Laal Husain Road	318,710	3,721,232	Submersible			20	25	No	No	No	2012	8
18	80-B	2	Ahata Zubair Butt Dhoke Ratta	318,572	3,721,322	Submersible	7,000	260	25	25	Yes	No	No	2005	8
19	78-C	3	Madni Market Railway Workshop Road	318,536	3,721,396	Submersible	5,000	190	20	50	No	No	No	1998	10

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
20	80-A	3	Near Khajur Wala Medan Hazara Colony	318,289	3,721,685	Submersible	6,000		20	25	Open	No	Yes	2004	12
21	81	3	Hazara Colony	318,723	3,721,893	Submersible	7,000	200	20	50	Yes	Yes	No	1984	10
22	81-A	3	Umar Abad Hazara Colony	318,850	3,721,940	Submersible	6,000	260	20	50	Yes	Yes	No	2004	12
23	81-B	3	Madrasa Usmania Hazara Colony	318,827	3,721,432	Submersible			20	50	No	No	No	2007	6
24	81-C	3	Ahata Manzir Hazara Colony	318,908	3,721,572	Submersible			20	50	No	No	No	2012	8
25	82-A	3	Kiran Road Hazara Colony	318,650	3,721,501	Submersible	3,000	270	20	25	No	No	No	2007	12
26	82-B	3	Near Pulli Hazara Colony	318,751	3,721,993	Submersible	5,000		20	50	Yes	No	No	2014	10
27	83	4				Submersible	4,000	170	25	50				1988	Abundant
28	83-A	4	Boring Road (Tanki)	318,075	3,722,228	Submersible	5,000	280	25	25	Yes	Yes	Yes	2008	9
29	84	4				Submersible	5,000	190	25	50				1984	Abundant
30	84-A	4				Submersible	6,000	260	20	25				2005	16

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
31	84-B	4	Khawaja Abad	318,619	3,722,093	Submersible	7,000		25	50	Open	No	No	2010	10
32	84-C	4	Muhallah Farooqia Girls School Dhoke Mangtal	318,178	3,722,051	Submersible	4,000		25	50	Open	No	Yes	2013	10
33	84-D	4	Muhallah Khatekan Dhoke Mangtal	318,207	3,722,209	Submersible	7,000		30	50	Open	No	No	1998	10
34	85	4				Submersible	7,000	160	25	50				1992	Abundant
35	85-A	4	Near Pull Boring Road	318,177	3,722,230	Submersible	7,000	180	30	50	Yes	Yes	No	1998	9
36	87	5	Aalim Abad Dhoke Hasuu	317,404	3,722,259	Submersible	6,000	260	25	50	Yes	Yes	Yes	1990	10
37	87-B	5	Near Graveyard Aalim Abad Dhoke Hasuu	317,488	3,722,230	Submersible	7,000	260	25	50	Yes	Yes	Yes	2007	10
38	87-C	5	Aalim Abad Dhoke Hasuu	317,386	3,722,339	Submersible			25	50	No	No	No	2014	10
39	88	5	Model Colony Dhoke Hasuu	318,004	3,722,500	Submersible	6,000	180	25	50	Yes	Yes	Yes	1991	5
40	88-A	5	Mehar Abad Dhoke Hasuu	317,955	3,722,530	Submersible			30	50	Yes	No	No	2013	8
41	89-A	5	Dhoke Darzian Dhoke Hasuu	317,650	3,722,420	Submersible	6,000	180	25	25	Yes	Yes	Yes	1999	14
42	86	6	Gulshan Data Dhoke Hasuu	317,315	3,722,620	Submersible	6,000	170	30	50	Yes	Yes	Yes	1985	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
43	87-A	6	Waqeel Abad Dhoke Hasuu	317,228	3,722,749	Submersible	5,000	260	25	50	Yes	Yes	Yes	1999	8
44	89	6	Gulshan Fatima Dhoke Hasuu	317,153	3,722,908	Submersible	6,000	180	25	50	Yes	Yes	Yes	1988	12
45	90	6	Near Tawar Aalam Abad Dhoke Hasuu	317,226	3,722,302	Submersible	7,000	290	20	50	Yes	Yes	Yes	1986	10
46	91-B	7	Awan Colony Perwadai	318,161	3,722,563	Submersible	6,000	270	25	50	No	No	No	2007	10
47	91-C	7	Akab Anarkali Hotel Perwadai	318,323	3,722,697	Submersible	5,000	270	30	50	No	No	No	2007	10
48	92	7	Awan Colony Perwadai	318,118	3,722,738	Submersible	6,000	170	25	50	Yes	Yes	No	1995	12
49	143-A	7	Muslim Abad	318,597	3,722,449	Submersible	6,000	180	30	50	Yes	Yes	No	1997	14
50	143-B	7	Quaid Abad (Tanki)	318,772	3,722,333	Submersible	6,000	180	25	50	Yes	Yes	Yes	2007	14
51	143-C	7	Near Chhati Ghali Muslim Abad	318,493	3,722,525	Submersible	6,000	280	30	50	Yes	Yes	No	2007	14
52	91	8	Mehar Colony Perwadai	317,968	3,722,852	Submersible	6,000	180	25	50	Yes	Yes	Yes	1988	8
53	91-A	8	Bokra Road Perwadai	318,078	3,722,852	Submersible	6,000	180	25	50	No	No	Yes	1999	9

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
54	92-A	8	Dhoke Awan Street No 1	317,064	3,723,107	Submersible									
55	92-B	8	Street No. 10 Fuji Colony	317,390	3,723,084	Submersible	5,000	270	25	50	Yes	Yes	Yes	2007	13
56	92-C	8	Street No. 18 Fuji Colony	317,473	3,722,832	Submersible	7,000	280	20	50	Yes	Yes	No	2007	13
57	92-D	8	Near Street No.1 Dhoke Awan Fuji Colony	317,022	3,723,137	Submersible	6,000		25	25	Open	No	No	2014	12
58	93-B	8	Street No. 29 Fuji Colony	317,867	3,723,082	Submersible			25	50	No	No	No	2012	8
59	93	9	Fair Barged Perwadai	318,198	3,722,943	Submersible	6,000	150	20	50	Yes	Yes	Yes	2015	9
60	93-A	9	Near Muhammadia Shopping Center Perwadia (Moru Wala)	318,093	3,723,088	Submersible	6,000	280	20	25	Open	No	No	2005	9
61	94	9	Bus Stand Perwadai (Tanki)	318,494	3,723,069	Submersible	6,000	170	25	50	No	No	No	1989	13
62	94-A	9	Baghish Colony Medan	318,348	3,723,131	Submersible	7,000	260	25	50	Yes	Yes	Yes	1999	11
63	95-A	9	Badar Colony	317,838	3,723,465	Submersible	7,000	260	25	50	Yes	Yes	Yes	2002	13
64	95-B	9	Near Pull Badar Colony	318,104	3,723,744	Submersible			25	25	Open	No	No	2009	

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
65	96	9	Near Ghosia Masjid Banghish Colony	318,171	3,723,315	Submersible	7,000	200	30	50	Yes	Yes	Yes	1994	9
66	96-A	9	Near Imam Bargah Banghish Colony	318,170	3,723,425	Submersible	6,000	240	25	50	Yes	Yes	No	2005	10
67	96-B	9	Park Baghish Colony (Tanki)	318,224	3,723,316	Submersible	6,000	260	20	50	Yes	Yes	No	2005	16
68	97	9	Zia-up-Haq Colony	318,732	3,722,738	Submersible	6,000	160	25	50	Yes	Yes	Yes	1986	2
69	97-A	9	Near Wegen Stand Perwadai	318,532	3,722,788	Submersible	6,000	270	20	50	Yes	Yes	No	2007	9
70	97-B	9	Islam Pura Perwadai	318,644	3,722,782	Submersible			20	50	No	No	No	2013	
Detail List of Tube Wells Khaya Ban-e-Sir Syed Rawalpindi UC (10,11, 12)															
71	102	10	Sector 2 Akab Awan Market	318,558	3,723,918	Submersible	5,000	160	20	50		Yes	No	1988	12
72	102-A	10	Sector 2 Akab Awan Market	318,558	3,723,918	Submersible	8,000	180	20	50		Yes	No	1996	12
73	103	10	Sector 3 Near Baraf Khana Chowk	318,945	3,723,203	Turbine	4,000	160	25	25		Yes	Yes	1980	14
74	160-A	10	Sector 2 Awan Market	318,477	3,723,708	Submersible	10,000	280	25	50		No	No	2013	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
75	164-A	10	Sector 2 Tanki	318,672	3,723,437	Submersible	7,000	240	30	50		Yes	Yes	2002	12
76	164-B	10	Sector 2 Melaad Pak	318,550	3,723,485	Submersible	7,000	180	20	25		Yes	No	2006	12
77	168	10	Sector 2 Allama Iqbal Park	318,366	3,723,585	Submersible	8,000	240	25	25		Yes	Yes	1988	12
78	168-A	10	Sector 2 Disposal No. 2	318,500	3,723,327	Submersible	8,000	280	25			No	No	2014	5
79	103-A	11	Sector 3	318,721	3,723,096	Submersible	8,000	280	25	50		No	No	2012	12
80	103-B	11	Sector 3	319,023	3,723,089	Submersible	6,000	280	25	50		No	No	2013	12
81	162-A	11	Sector B.4 Near Mora Shareef Darbar	319,293	3,722,947	Submersible	7,000	240	20	50		No	Yes	2005	12
82	162-B	11	Sector B.4 Near Mora Shareef Darbar	319,218	3,722,924	Submersible	7,000	280	20	25		Yes	No	2008	12
83	162-C	11	Sector B.4 Near Mora Shareef Darbar	319,343	3,722,781	Submersible	8,000	280	25	50		No	No	2013	12
84	165-A	11	Sector B.4 Near D.H.O	319,020	3,723,295	Submersible	7,000	220	20	50		Yes	No	2009	12
85	166	11	Sector B.4 Ayesha Park	319,278	3,723,109	Submersible	8,000	180	20	50		Yes	Yes	1994	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
86	166-A	11	Sector 3 Muslim Park	319,097	3,722,842	Submersible	6,000	280	30			Yes	Yes	1997	12
87	166-B	11	Sector 3	319,116	3,722,794	Submersible			25	50	No	No	No	2015	
88	167-A	11	Sector 3 Muslim Park	318,897	3,722,752	Submersible	3,000	230	20	50		Yes	Yes	2007	12
89	167-B	11	Sector 3 Girls School	318,935	3,722,650	Submersible	3,500	240	25	50		No	No	2013	12
90	100	12	Khaya Ban-E-Sir Syed	318,703	3,724,138	Submersible	6,000	180	20			Yes	No	1979	12
91	100-A	12	Sector A.4 Dhoke Naju	319,135	3,724,349	Submersible	7,000	250	20	50		Yes	Yes	1999	14
92	101	12	Sector 1 Near Goal Tanki	318,797	3,724,008	Submersible	6,000	150	20	50		Yes	No	1993	12
93	101-A	12	Sector 1 Goal Tanki	318,764	3,723,931	Submersible	7,000	180	30	50		Yes	Yes	1995	12
94	104	12	Sector A.4 Service Road	319,014	3,724,325	Submersible	5,000	180	20	50		Yes	No	1993	12
95	104-A	12	Sector A.4 Main Town	319,367	3,724,521	Submersible	7,000	220	20	25		Yes	No	2008	12
96	104-B	12	Sector A.4 Main Town	319,300	3,723,196	Submersible	8,000	280	25	50		No	No	2013	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
97	105	12	Sector A.4 Near Graveyard	319,117	3,723,768	Submersible	7,000	180	20	50		Yes	Yes	1993	12
98	105-A	12	Sector A.4 Dhoke Naju	319,296	3,723,663	Submersible	3,500	180	20	25		Yes	No	2008	12
99	105-B	12	Sector A.4 Near Noorani Masjid	319,220	3,723,857	Submersible	7,000	280	25	50		No	No	2013	12
100	159-A	12	Sector 01 Near Goal Tanki	318,781	3,723,827	Submersible	7,000	280	25	50		No	No	2013	12
101	163-A	12	Sector A.4 Tanki	319,053	3,723,833	Submersible	7,500	180	25	25		Yes	No	2008	12
102	163-B	12	Sector A.4 Near Masjid Shah Najaf	318,985	3,723,947	Submersible	8,000	280	25	50		No	No	2013	12
-			**Detail List of Tube Wells West Zone -II (UC's 13-20)**												-
103	1-C	13	New Katarian	319,838	3,724,712	Submersible	5,000	240	30	50	No	No	No	2004	8
104	2	13	Katarian	319,717	3,724,758	Submersible	8,000	140	25	50	Yes	Yes	Yes	1992	10
105	5	13	Quaid Park	320,157	3,724,820	Turbine	8,000	140	30	50		Yes	No	1989	7
106	6	13	Chishtia abad	320,401	3,724,440	Turbine	8,000	140	30	50		Yes	No	1990	7

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
107	6-A	13	Hunza Colony	320,232	3,724,683	Submersible	5,000	240	20	50		Yes	No	1996	7
108	108	13	Holly Family	319,655	3,724,095	Submersible	5,000	280	20	50	Yes	No	No	1998	16
109	111-B	13	Holy Family	319,704	3,723,691	Submersible	6,000		25	50	No	No	No	1998	8
110	169	13	Katarian Market	319,918	3,724,382	Submersible	8,000	240	30	50	No	No	Yes	2009	10
111	1	14	Katarian Market	319,987	3,724,438	Submersible	8,000	140	30	50	Yes	Yes	No	1987	8
112	1-A	14	New parian	319,855	3,724,314	Submersible	7,000	240	30	25	Yes	Yes	No	2004	8
113	1-B	14	Katarian Market	319,908	3,724,471	Submersible	5,000	240	20	50	No	No	No	2004	8
114	106	14	Muhallah R Sultan	319,629	3,723,298	Turbine	8,000	140	30	50	No	No	Yes	1988	15
115	108-A	14	Holly Family	319,654	3,723,863	Submersible	5,000	130	25	50	Yes	Yes	No	1988	12
116	108-B	14	Holly Family Road Ghosia Masjid	319,707	3,724,303	Submersible	8,000		30	50	No	No	No	2013	8
117	3	15	Katarian Chungi	319,915	3,724,862	Submersible	8,000	280	25	50	Yes	Yes	No	1998	10

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
118	4	15	Chenar Park	320,114	3,724,643	Turbine	7,000	150	25	50	Yes	Yes	Yes	1981	12
119	109	15	TMA Nursery	320,159	3,722,843	Submersible	7,000	140	25	50	No	No	No	1985	5
120	109-A	15	TMA Nursery	320,197	3,723,076	Turbine	7,000		25	50	yes	Yes	No	1975	5
121	110	15	Jamia Park	320,123	3,722,940	Turbine	7,000	140	30	50	Yes	No	Yes	1987	8
122	110-B	15	Dispensary			Submersible	5,000	240	20	50		Yes	No	2003	7
123	111	15	Holly Family	320,013	3,723,633	Submersible	6,000	210	30	50	Yes	No	No	2010	8
124	111-A	15	RDA R.Sultan	319,953	3,723,331	Submersible	8,000	240	40	50	Yes	Yes	Yes	1988	9
125	112-B	15	Safaid Tanki	320,241	3,723,248	turbine	5,000	240	20	50	Yes	Yes	No	2004	8
126	107	16	Phagwari	319,114	3,723,409	Submersible	5,000	280	20	25	Yes	Yes	No	2004	10
127	107-A	16	Commerce College	319,420	3,723,408	Submersible	5,000	240	25	50	Yes	Yes	Yes	2004	15
128	107-B	16	Near Commerce College	319,442	3,723,200	Submersible	7,000		25	100	No	No	No	2012	14

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
129	110-A	16	Abbasia Masjid			Turbine	7,000	130	60	50		Yes	No	1988	5
130	147	16	Eid Gah	319,818	3,722,782	Submersible	5,000	240	25	50		Yes	No	2003	9
131	147-A	16	Eid Gah	319,595	3,722,570	Submersible	5,000	240	25	50		Yes	Yes	2003	9
132	147-B	16	Eid Gah	319,858	3,722,886	Submersible	5,000	240	25	50		Yes	Yes	2003	9
133	12	17	Pindora			Turbine	6,000	150	30	50		Yes	No	1985	11
134	13	17	Pindora	320,848	3,724,939	Submersible	10,000	240	40	50		Yes	No	1985	14
135	13-A	17	Pindora	321,220	3,724,966	Submersible	5,000	240	25	50		Yes	No	2001	8
136	13-B	17	Pindora			Submersible	5,000	280	25	50			No	2007	8
137	13-C	17	Benazir Chowk PD			Submersible	7,000	250	25	50		No	No	2009	7
138	6-B	18	Milia Park	320,112	3,724,309	Submersible	5,000	240	20	50	Yes	Yes	No	2010	7
139	7	18	Pindora Chungi	320,520	3,725,242	Turbine	8,000	130	30	50		Yes	No	1986	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
140	7-A	18	Pindora Maka CNG			Submersible	5,000	280	20	50		Yes	No	2006	10
141	8	18	Punlic Park	321,439	3,724,865	Submersible	8,000	140	25	50	No	No	No	2014	7
142	8-A	18	Double Road	321,465	3,725,142	Submersible	5,000	280	25	50	No	Yes	No	2007	6
143	10	18	Gulshan Dadan	322,126	3,725,492	Submersible	9,000	280	25	50	No	No	No	1988	10
144	11	18	Dh. Babu Irfan	321,337	3,725,587	Turbine	8,000	140	30	50		Yes	Yes	1989	11
145	11-A	18	Mehmood abad	320,940	3,725,434	Submersible	7,000	240	30	50		Yes	No	1994	11
146	11-B	18	IGP Road			Submersible	5,000	240	20	50				2003	11
147	14	19	Siddique Chowk	320,472	3,724,377	Turbine	7,000	160	25	50		Yes	No	1986	9
148	14-A	19	7Th Road			Submersible	5,000	240	20	50		No	Yes	2002	8
149	115-A	19	Degree College	320,442	3,723,685	Submersible	5,000	240	25	50	No	No	No	2005	6
150	116	19	Masjid Al Furqan	321,311	3,724,078	Submersible	8,000	140	40	50	Yes	Yes	Yes	1990	8

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
151	116-A	19	D-Block	321,133	3,724,094	Submersible	5,000	240	40	50	Yes	Yes	No	2002	9
152	117	19	DSP Office	320,794	3,723,974	Turbine	11,000	140	40	50	Yes	Yes	Yes	1988	8
153	117-A	19	DSP Office	320,743	3,723,910	Submersible	5,000	240	20	50	No	No	No	2009	8
154	119	19	Siddique Chowk			Turbine	10,000	20	25	W		No	No	1988	15
155	119-A	19	Muzaffar Masjid	320,561	3,723,976	Submersible	6,000		25	50	Yes	Yes	Yes	2011	8
156	120	19	Siddique Chowk			Turbine	10,000	20	30	W		No	No	1988	15
157	124	19	Ali Masjid	320,573	3,723,481	Submersible	7,000	140	40	50	Yes	Yes	No	2011	9
158	121	20	C Market	321,196	3,723,644	Submersible	8,000	240	40	Public	No	Yes	No	1986	13
159	122	20	C Market	321,141	3,723,503	Submersible	8,000	240	20	50	Yes	Yes	No	1989	12
160	125	20	Muslim H School	320,578	3,722,855	Turbine	6,000	140	30	50	Yes	Yes	Yes	1986	6
161	125-A	20	Muslim H School	320,356	3,723,012	Submersible	5,000	240	20	50	Yes	Yes	No	2004	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
162	126	20	Asghar Mall Sch	320,864	3,722,811	Submersible	7,000	140	25	50	Yes	Yes	No	1988	12
163	126-A	20	Johar Abad	321,023	3,722,792	Submersible	7,000	130	25	50	No	No	Yes	1990	7
164	126-B	20	Asghar Mall Sch	320,933	3,722,672	Submersible	8,000		25	50	No	No	No	2015	8
165	127	20	Kali Tanki	320,412	3,723,276	Submersible	10,000	150	30	200	No	No	No	1985	16
166	128	20	Kali Tanki	320,349	3,723,343	Submersible	10,000	130	30	200	No	No	No	1985	16
167	129	20	Kali Tanki	320,391	3,723,341	Submersible	10,000	130	30	200	Yes	No	No	1984	
168	129-A	20	Kali Tanki	320,304	3,723,284	Submersible	12,000	240	40	200	No	No	No	1992	16
169	130	20	Asghar Mall Sch	320,786	3,722,577	Submersible	6,000	130	25	30	Yes	Yes	No	1988	6
	Detail List of Tube Wells East Zone -1 + Sohan														
170	15	21	New DPS Shamas abad	322,265	3,725,147	Submersible	5,000	270	25	50	Yes	Yes	Yes	2004	10
171	15-A	21	Near Blind School Shamasabad	322,476	3,725,094	Submersible	5,000	270	25	50	Yes	Yes	Yes	2000	10

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
172	15-B	21	G Girls College Shamasabad	322,653	3,724,984	Submersible	8,000	180	25	50	No	Yes	No	2013	10
173	15-D	21	Main Bazar Dh. Kala Khan	322,705	3,725,188	Submersible	5,000	290	25	50	No	No	No	2012	8
174	18	21	Madina Town DH.Kala Khan	322,354	3,725,460	Submersible	7,000	230	25	50	No	No	No	1986	7
175	18-A	21	Near Ohjri Camp	322,367	3,725,542	Submersible	6,000	240	25	50	Yes	No	Yes	2003	12
176	17	21	Near High Way	323,152	3,725,485	Submersible	8,000	290	30	50	Yes	Yes	No	1988	12
177	17-A	21	Awan Colony Dh. Kala Khan	328,821	3,725,506	Submersible	5,000	240	25	50	No	No	No	2006	8
178	17-C	21	Near Raja Tajamal House	322,905	3,725,515	Submersible	5,000	290	25	50	No	No	No	1986	Abundant
179	18-B	21	Near Raja Tajamal House	322,930	3,725,544	Submersible	10,000	180	30	50	Open	No	No	2013	10
180	18-C	21	Gulistan e Jinnah	322,562	3,726,064	Submersible	8,000	180	25	50	No	No	No	2013	8
181	15-C	22	Taxi Stand DH. Kala Khan	322,754	3,724,971	Submersible	8,000	290	25	50	Open	No	No	2012	10
182	16	22	Qayyum abad Dh. Kala Khan	323,003	3,725,034	Submersible	9,000	190	30	50	Yes	Yes	Yes	1984	13

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
183	16-A	22	Murree Hazara Colony	323,381	3,725,037	Submersible	8,000	160	30	50	Yes	Yes	Yes	1988	12
184	16-B	22	Farooq E Azam Road	323,040	3,724,540	Submersible	8,000	180	30	50	No	No	No	2013	7
185	17-D	22	Jinnah Town Dh. Kala Khan	323,245	3,725,251	Submersible	5,000	290	25	50	No	No	No	2012	12
186	24-C	22	Model Colony Dh. Kala Khan	323,209	3,724,710	Submersible	8,000	240	25	50	Yes	Yes	Yes	2005	11
187	7	23	A-Block Gunj Bakhsh Road	321,993	3,724,375	Submersible	5,000		25	50	Yes	Yes	Yes	2000	9
188	7-A	23	A-Block Gunj Bakhsh Road	322,039	3,724,332	Submersible	5,000	270	25	50	Yes	Yes	Yes	2000	9
189	19	23	Kiyani Bazar	322,300	3,724,223	Submersible	9,000	240	25	50	No	Yes	No	1996	8
190	19-B	23	Magistrate Colony	321,991	3,723,739	Submersible	9,000	280	25	50	No	No	No	2012	10
191	20	23	Dh. Piracha OHR	322,182	3,723,906	Submersible	5,000	220	25	50	Yes	Yes	No	1990	10
192	174	23	Dh. Kashmiri an	322,811	3,724,236	Turbine	8,000	160	30	50	Yes	Yes	Yes	1992	12
193	175	23	Bilal Colony Service Road	322,522	3,724,711	Submersible	9,000	180	30	50	Yes	Yes	No	1988	13

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
194	175-A	23	Bilal Colony	322,694	3,724,501	Submersible	5,000	250	25	50	Yes	Yes	Yes	2006	11
195	17-B	24	Ali Abad	322,685	3,723,872	Submersible	8,000	180	30	50	Yes	Yes	Yes	1992	10
196	23	24	DK PunNoo	322,805	3,723,592	Turbine	8,000	180	25	50	Yes	Yes	Yes	1992	9
197	23-A	24	Dh. Ali Akbar	323,134	3,723,751	Submersible	8,000	270	25	50	No	No	No	2013	6
198	24	24	Ilyas Town Khana Kak	323,295	3,724,240	Submersible	5,000		25	50	Yes	Yes	No	2006	11
199	24-A	24	Khana Kak	323,645	3,724,185	Submersible	9,000	260	25	50	Yes	Yes	No	1992	14
200	24-B	24	Ilyas Town Khana Kak	323,649	3,724,122	Submersible	5,000	230	25	50	Yes	Yes	Yes	1992	14
201	24-D	24	Shair Ahmad Rd Khana kak	323,368	3,723,971	Submersible	8,000	180	25	50	No	No	No	2013	6
202	25	24	Khajoor Wali Gali	322,767	3,723,601	Turbine	9,000	170	25	50	Yes	Yes	Yes	1993	9
203	19-A	25	Shaheen Colony	322,161	3,723,702	Submersible	5,000	290	25	50	No	No	No	2010	10
204	25-A	25	Muhallah Choudrian S/Road	322,535	3,723,815	Submersible	5,000	200	25	50	No	No	No	2006	11

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
205	26	25	Sadiq abad Muhammadi Masjid	322,251	3,723,447	Submersible	8,000	180	25	50	Yes	Yes	Yes	1994	14
206	26-A	25	Ghazali Road	321,918	3,723,443	Submersible			25	50	No	No	No	2014	10
207	21	26	A-Block 6th Road	321,859	3,724,037	Submersible	5,000		40	100	No	Yes	No	2004	12
208	22	26	A-Block 6th Road	321,841	3,724,049	Turbine	8,000		40	100	No	No	No	2004	12
209	35	26	Afandi Colony	321,851	3,722,838	Submersible	6,000		30	50	Yes	Yes	No	2006	10
210	35-A	26	Afandi Colony	321,998	3,722,812	Submersible	6,000		30	50	Yes	Yes	Yes	2011	10
211	36	26	C-Block	321,788	3,723,052	Submersible			30	50	Yes	Yes	Yes	1995	10
212	36-A	26	Bangreel Masjid	322,228	3,723,258	Submersible			25	50	Yes	Yes	No	2004	8
213	36-B	26	C-Block D. Kaku Shah	321,585	3,722,811	Submersible			25	50	No	Yes	No	2000	10
214	170	26	Arshi Masjid	321,675	3,723,402	Submersible	6,000		25	50	No	Yes	No	2013	12
215	27	27	Muhammedi colony muslim town	323,371	3,723,092	Submersible	7,500		25	50	Yes	Yes	Yes	1987	16

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
216	27-A	27	Mohammedi colony	323,268	3,723,574	Submersible	5,000		30	50	Yes	Yes	No	1986	16
217	28	27	Azher Satti Plat	323,012	3,723,081	Submersible	6,000		25	50	Yes	Yes	Yes	2007	10
218	28-A	27	Haji chowk muslim town	323,160	3,723,153	Submersible	6,000		25	50	Yes	Yes	No	2013	12
219	28-B	27	Osmani Masjid Muslim Town	322,952	3,722,790	Submersible			25	50	No	No	No	1998	16
220	29	27	Muslim town behind PAF flates	323,375	3,723,147	Turbine									
221	29-A	27	Capt Riaz Mehmood	323,084	3,723,042	Submersible			25	50	No	No	No	2012	6
222	New -4	27	Yousif colony muslim town	323,232	3,723,932	Submersible			25	50	No	No	No	2014	7
223	188	27	Haji chowk muslim town street No.10	322,767	3,722,853	Submersible			25	50	No	No	No	2008	10
224	31	28	Muslim town streer No.2-B	322,404	3,722,530	Submersible	7,000		25	50	Yes	Yes	Yes	1985	18
225	31-A	28	Raja qadeer street	322,055	3,722,649	Submersible	6,000		25	50	Yes	Yes	Yes	2004	10
226	30	28	Service road muslim town	322,641	3,722,423	Submersible	5,000		30	50	Yes	Yes	Yes	1988	15
227	30-A	28	Front area of azam hotel chaudhery street	322,665	3,722,931	Submersible	6,000		25	50	Yes	No	No	2003	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
228	31-B	28	Gali No. 05	322,569	3,722,666	Submersible			25	50	No	No	No	2013	8
229	31-C	28	Gali No. 03 Muslim Town(New)	322,512	3,722,864	Submersible			25	50	No	No	No	2014	8
230	32	29	Bahari colony tanki	323,170	3,722,679	Submersible	5,000		25		Open	Yes	Yes	2014	12
231	32-A	29	Allah wala chowk near chongi No.8 M.Town	323,199	3,722,402	Submersible	7,000		25	50	Yes	Yes	No	2005	14
232	32-B	29	Behari Colony Park	323,292	3,722,721	Submersible	6,000		25	50	Open	No	No	2009	10
233	33-C	29	Khurram Colony	323,040	3,722,264	Submersible	4,000		20	50	Yes	Yes	Yes	2011	14
234	32-D	29	Khuram Colony Near Zahid KS.	323,148	3,722,128	Submersible			25	50	Open	No	No	2014	6
235	33	29	Masjid sultan muslim town	323,226	3,722,332	Turbine	6,000		25	50	Yes	Yes	No	1988	11
236	33-A	29	Khurram colony street No.28	322,941	3,722,096	Submersible	5,000		25	50	Open	No	No	1999	12
237	34	29	Khurram Colony	322,965	3,722,497	Submersible			25	50	No	No	No	2013	13
238	New -5	29	Khurram colony chungi No.8 muslim town	323,043	3,722,321	Submersible									
239	37	30	Kuri road chah sultan	321,397	3,722,396	Submersible	8,000		25	50	No	No	Yes	2009	12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
240	40	30	Chamrah godam	321,521	3,721,883	Submersible	6,000		20	50	No	Yes	No	1988	10
241	New -20	30	Ammarpura Chowk	321,057	3,722,108	Submersible									
242	37-A	30	Raja Israr	321,615	3,722,214	Submersible	6,000		25	50	No	No	No	2011	11
243	38	30	Amur Pura	321,081	3,722,127	Submersible	6,000		25	50	No	Yes	No	2007	12
244	38-A	30	Amur Pura	321,249	3,722,153	Submersible	6,000		25	50	No	No	Yes	2011	12
245	39	31	Bund khana road	321,665	3,722,217	Submersible	7,000		25	50	No	Yes	No	1985	11
246	39-A	31	Tamasab abad	321,898	3,721,938	Submersible	6,000		20	50	No	Yes	Yes	2006	10
247	45	31	Hukam Dad Muhallah	321,669	3,721,660	Submersible	7,000		25	50	Yes	Yes	No	2004	12
248	45-A	31	Dhok hukam dad	321,324	3,721,455	Submersible	6,000		25	50	No	No	Yes	2007	10
249	45-B	31	New Ishtiaq Mirza House	321,580	3,721,425	Submersible	6,000		20	50	Open	No	No	2012	12
250	New -18	31		321,340	3,721,435	Submersible									
251	37-B	31	Lala Israr	321,743	3,722,068	Submersible	6,000		25	50	No	No	No	2013	4

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
252	43	32	Waris Khan Sarfraz Road	320,741	3,721,629	Submersible	6,000		25	50	Yes	Yes	Yes	1988	12
253	44	32	Dhoke Hukam Daad	321,329	3,721,641	Submersible	5,000		25	50	Yes	Yes	No	1986	12
254	42	32	Ammar pura	321,086	3,721,755	Submersible	5,000		25	50	No	No	No	2012	12
255	43-A	32	Zuffar-Ul-Haq Road	320,899	3,721,536	Submersible	6,000		15	50	Yes	No	Yes	2012	10
256	43-B	32	Waris Khan Sarfraz Road	320,740	3,721,555	Submersible	6,000		25	50	Open	No	No	2013	10
257	44-A	32	Muhallah New Amar Pura	321,406	3,721,731	Submersible	5,000		25	50	No	No	No	2010	10
258	1	Sohan	Sohan Village	323,939	3,726,204	Submersible	16,000	130	40	200	Yes	Yes	Yes	2012	10
259	1-A	Sohan	Sohan Village	323,916	3,726,287	Submersible	16,000	150	40	200	Yes	Yes	No	2010	6
260	2	Sohan	Sohan Village	324,009	3,726,080	Submersible	16,000	100	40	200	Yes	Yes	No	1973	6
261	4	Sohan	Sohan Village	323,991	3,726,327	Submersible	16,000	140	40	200	Yes	Yes	No	1973	6
262	7	Sohan	Sohan Village	324,066	3,725,923	Submersible	16,000	150	40	50	Yes	Yes	No	2000	6
263	8	Sohan	Sohan Village	324,273	3,725,884	Submersible	16,000	150	40	50	Yes	Yes	No	2000	6

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
264	9	Sohan	Sohan Village	324,226	3,725,743	Submersible	16,000	150	40	50	Yes	Yes	No	2000	6
265	10	Sohan	Sohan Village	324,179	3,726,097	Submersible	16,000	150	40	50	Yes	Yes	No	2000	6
266	11	Sohan	Sohan Village	324,245	3,726,094	Submersible	16,000	150	50	50	Yes	Yes	No	2000	6
267	12	Sohan	Sohan Village	324,298	3,726,121	Submersible	16,000	150	40	50	Yes	Yes	No	2000	6
268	5	Sohan	Sohan Village	323,787	3,726,205	No	No	No	No	50	Yes	No	No	1973	Abundant
269	6	Sohan	Sohan Village	323,660	3,726,414	No	No	No	No	50	Yes	No	No	1973	Abundant
	Detail List of Tube Wells Zone East-I, UC (33, 34, 35)														-
270	131	33	Kohati Bazar	320,541	3,722,167	Submersible	6,000	210	25	50	Yes	Yes	Yes	1992	3
271	131-A	33	Mohallah Feroozpura	320,755	3,722,248		6,000	270	25	50	No	Yes	Yes	1988	6
272	132	33	Kohati Bazar	320,515	3,722,080	Turbine	7,000	190	25	50	Yes	Yes	Yes	1999	6
273	133	33	Banni Chowk	320,244	3,721,878	Submersible	7,000	320	25	50	No	Yes	Yes	2015	4

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
274	133-B	33	Angat Pura Near Sheikh Tikka	320,180	3,722,387	Submersible	7,000	260	25	50	No	No	No	2012	6
275	148-B	33	Asghar Mall Road Near Hayat Wali Clinic	320,656	3,722,517	Submersible	6,000	270	25	50	Open	No	No	2012	4
276	148	34	Abdul Rauf S/O Shahzada Khan (R) 0300-5209352	320,236	3,722,133	Submersible	5,000	270	30	50	Yes	Yes	Yes	1990	6
277	148-A	34	Mohalla Hari Pura	320,224	3,722,126	Submersible	5,000	240	25	50	Yes	No	Yes	1985	6
278	154	35	Doshera Ground	319,591	3,722,291	**Abundant**									
279	154-B	35	Eid Gah Scheme	319,709	3,722,355						Open			2007	
280	154-C	35	Dusra Ground	319,604	3,722,262			370						2007	8
281	155	35	Imam Bargh Road	319,958	3,722,171			300							4
282	155-A	35	Janglaat Road	320,100	3,722,129	Submersible	4,000	240	20	50	Yes	Yes	Yes	2004	4
	Detail List of Tube Wells West Zone, Sector-I UC (35-38)														
283	71	36	Near Dispensary Mohan Pura	319,337	3,720,386	Submersible	6,000	250	25	50	Yes	Yes	Yes	1995	4

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284	71-A	36	Arjun Nagar	319,318	3,720,052	Turbine	6,000	180	30	50	Yes	Yes	No	1998	3
285	72-A	36	Girls College Mohan Pura	319,253	3,720,615	Submersible	7,000	260	25	50	Yes	Yes	Yes	2001	12
286	140	37	Gulshan Abad Akaal Garr	319,243	3,721,820	Submersible	5,000	260	25	50				1991	12
287	142	37	Murgi Mandi Bhagh Sardraa	319,357	3,722,060	Submersible	6,000	260	20	50				1995	7
288	142-A	37	Kashmiri Colony Bhagh Sardraa	319,247	3,721,954	Submersible	7,000	270	20	25				2007	6
289	143	37	Safdar Abad Girls High School	318,909	3,721,995	Submersible	7,000	190	20	50	Yes	Yes	No	1986	8
290	144-A	37	Near Nullah Lai Safdar Abad	319,081	3,722,015	Submersible			20	50	No	No	No	2013	6
291	145	37				Submersible	5,000	250	20	50				1988	Abundant
292	145-A	37	Zayarat Buduh Shah Bhagh Sardraa	319,315	3,722,134	Submersible									
293	146	37	shagufta Colony Dhoke Dalal	319,067	3,722,380	Turbine	6,000	190	25	50	Yes	Yes	No	1989	10
294	146-A	37	Near Graveyard Dhoke Dalal	319,349	3,722,521	Submersible	7,000	260	20	50	Yes	Yes	No	2007	8

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
295	72-B	38	Sagri Scheme Akab Nawlti Cinema	319,103	3,720,879	Submersible	6,000	260	20	25	Yes	Yes	No	2007	6
296	140-A	38	Tire Bazar Near Khursheed Cinema	319,558	3,721,400	Submersible	5,000	190	30	25				1999	4
297	140-B	38	Near Police Station Gang Mandi	319,123	3,721,401	Submersible	6,000	270	20	50				2007	8
298	141	38	Ghaznawi Road Bhagh Sardraa	319,525	3,721,729	Submersible	6,000	170	40	50				1989	12
299	141-A	38	Near Nullah Lai Muhallah Akaal Garr	319,101	3,721,838	Submersible									
	Detail List of Tube Wells Zone East-I, UC (39-46)														-
300	135-A	39	Committee Chowk				3,500		25						6
301	136-A	39	Chatia Hatia	320,218	3,721,160	Submersible	5,000	240	25	50	No	Yes	Yes	2003	12
302	151	39	Bhabra Bazar	320,244	3,721,351	Submersible	6,000	260	25	50	No	Yes	Yes	1986	12
303	152-A	39	Landa Bazar	320,081	3,721,131	Submersible	6,000	260	20	50	No	No	No	2005	12
304	137-A	40	Klam Bazar	319,814	3,721,441	Submersible	7,000	260	25	20	No	No	No	2005	18

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
305	138-A	40	Prona Qalia	319,814	3,721,441	Submersible	2,000	250	25	25	Yes	No	Yes	1999	4
306	138-B	40	Bhabra Bazar	320,073	3,721,426	Submersible	7,000	280	25	25	No	No	No	2008	16
307	152	40	Lal Havailee	319,862	3,721,200	Submersible	5,000		20	25	No	Yes	No	1984	12
308	152-B	40	Mission School Raja Bazar	319,750	3,721,035	Submersible	6,500	280	25	50	Yes	No	No	2010	7
309	133-A	41	Said Pur Gate	320,182	3,721,854	Submersible	7,000		25	25	No	No	No	1998	10
310	150	41	Shah Nazar Pull	319,842	3,721,684	Submersible	7,000	260	25	50	No	Yes	Yes	1988	11
311	150-A	41	Mohallah Naharia	320,084	3,721,735	Submersible	6,000	260	20	25	Open	Yes	Yes	2010	4
312	46	42	Millat Colony	320,889	3,721,129	Submersible	6,000	260	25	50	Yes	Yes	Yes	1988	14
313	46-B	42	Zafar UL Haq Road	320,599	3,721,231	Submersible	6,000	260	25	50	No	Yes	Yes	2007	12
314	50-A	42	Rawal Hotal	320,728	3,720,919	Submersible	7,000	220	25	25	No	No	Yes	2015	8
315	52-A	42	Umer Road	320,772	3,720,533	Submersible	6,000	250	25	25	No	No	No	1990	16

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316	56-A	42	Dh. Elahi Bakhsh	320,901	3,720,713	Submersible	5,000	240	25	50	Yes	Yes	No	2001	12
317	56-B	42	Shah De Talian	320,624	3,720,633	Submersible	7,000	270	25	50	No	No	No	2005	12
318	47-A	43	Qasim Abad	321,166	3,721,022	Submersible	6,000	240	20	50	No	No	No	2010	16
319	48-A	43	Talab Tailian	321,022	3,721,317	Submersible	8,000	250	25	50	Yes	Yes	Yes	1992	14
320	51	43	National Town Dhoke Khaba	321,668	3,721,001	Submersible	6,000	250	30	50	Yes	Yes	No	1985	10
321	51-A	43	National Town Dhoke Khaba	321,592	3,720,815	Submersible	6,000	270	25	50	Yes	Yes	No	2007	10
322	53	43	Qasim Abad	321,712	3,721,233	Submersible	6,000	300	25	50	Yes	Yes	No	1988	12
323	53-A	43	Qasim Abad	321,392	3,721,261	Submersible	6,000	290	25	50	Yes	Yes	Yes	2005	12
324	54-B	43	Gullberg Town	321,691	3,720,615	Submersible	5,000		25	25	Open	No	No	2007	5
325	47	44	Zeenat Sikandria School	321,071	3,720,980	Submersible	4,000	240	25	50	Yes	Yes	Yes	1988	14
326	50-B	44	Bilal Masjid Umer Road	320,914	3,720,883	Submersible	4,000		25	50	No	No	No	2007	8
327	52	44	Dhoke Elahi Bakhsh	321,032	3,720,410	Submersible	6,000	270	25	25	No	Yes	Yes	2014	14

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
328	52-B	44	Bilal Masjid Umer Road	321,072	3,720,283	Submersible	6,000	270	25	50	No	No	No	2012	14
329	54	44	Dhoke Farman Ali	321,499	3,720,372	Submersible	5,000	290	25	50	Yes	Yes	No	1990	Abundant
330	54-A	44	Dhoke Farman Ali	321,582	3,720,581	Submersible	6,000	270	25	25	Open	No	No	2007	15
331	54-C	44	Fazal Abad Gali No.3	321,364	3,721,507	Submersible	7,000	270	25	50	No	No	No	2012	15
332	58	45	Ariya Mohalla	321,012	3,720,204	Submersible	7,000	240	30	50	Yes	Yes	Yes	1995	14
333	58-B	45	Islamia High School	320,665	3,719,950	Submersible	8,000	260	25	50	Yes	No	No	2008	4
334	60	45	Ghalla Godam	321,147	3,719,727		6,000	300	25						10
335	60-A	45	Nighat Abad	321,119	3,719,308		6,000	260	25						12
336	60-B	45	Moti Mehal	320,678	3,719,638		5,000	260	25						12
337	60-C	45	Milad Chowk Chaman Zar Colony	320,912	3,719,387		6,000	280	25						8
338	61	45	Hakeem Abid	321,438	3,720,167		6,000	270	25						12
339	61-A	45	Muslim Colony	321,167	3,720,055		7,000	260	25						12

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
340	61-B	45	Muslim Colony	321,327	3,719,975		6,000	270	25						10
341	61-C	45	Javed Colony Tipu Road				6,000	270	25						10
342	67	45	Civil Line	320,736	3,718,341	Submersible	6,000	280	30	50	Open	No	No	2014	8
343	67-A	45	New Civil Line	320,658	3,718,691	Submersible	6,000	270	25	50	No	No	No	2012	10
344	62	46	Complaint Office Liaquat Bagh				8,000		25						
345	62-A	46	Opp . Garden College Liaqat Road	320,281	3,720,290	Submersible	7,000		25	50	Open	No	Yes	2001	16
346	64	46	Near TMA Office Liaquat Road	320,152	3,720,336	Submersible	6,000	260	25	50	Yes	Yes	Yes	1983	18
347	64-A	46	DAV College Road	320,115	3,720,670	Submersible	7,000	290	20	50	No	Yes	Yes	1999	14
348	64-B	46	Near Moti Masjid Liaquat Road	319,937	3,720,577	Submersible	6,000	240	25	25	Yes	Yes	Yes	2004	13
349	64-C	46	College Chowk	320,206	3,720,773	Submersible	7,000	290	20	25	No	No	Yes	2012	12
350	69	46	Chachi Mohallah Tanki	320,366	3,720,805	Submersible	7,000	260	25	100	Yes	Yes	Yes	1994	12
351	69-A	46	Muree Road	320,521	3,720,479	Submersible	6,000	300	25	50	Yes	Yes	Yes	2007	16

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
352	70	46	Fowara Chowk	319,624	3,720,847	Submersible	7,000		25	50	No	No	No	1992	14
353	70-A	46	Usman Pura	319,622	3,720,561	Submersible	7,000	270	25	50	Yes	Yes	Yes	1992	10
354	70-D	46	Nia Mohallah	320,022	3,720,859	Submersible	7,000	290	20	50	No	No	Yes	2012	12
LIST OF TUBEWELLS IN NEWLY ADDED UC'S															-
355	Nil	74	Nemat Muhallah Haroon Chowk Shakrial	323,366	3,723,717	Submersible			15	50	Yes	No	Yes	2007	12
356	Nil	75	Muhallah Islam Nagar Near Al-Ghani Service Station	324,356	3,723,432	Submersible			25	30	Steel Cage	No	No	2004	14
357	Nil	75	Said Pur Town Shakrial	324,307	3,723,507	Submersible			15	25	Yes	No	No	2003	13
358	Nil	76	AlNoor Colony Sector-I Satti CNG	324,042	3,722,542	Submersible			30	50	Steel Cage	No	No	2007	10
359	Nil	76	Abdullah Masjid Street Gali No.2	324,265	3,722,784	Submersible			30	25	Steel Cage	No	No	2013	12
360	Nil	76	Raja Town Tarali Adda	324,399	3,722,745	Turbine			30	25	No	No	No	2010	13
361	Nil	76	Masjid Saida Ayisha Anwar Colony	324,433	3,722,876	Submersible			30	50	Yes	No	No	2006	13
362	Nil	76	Wasa Complaint Office AlNoor Colony	324,227	3,722,474	Turbine			30	50	Yes	No	Yes	1993	16

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
363	Nil	76	Mir Pur Housing Scheme III AlNoor Colony	324,465	3,722,452	Submersible			30	50	Yes	No	No	2004	12
364	Nil	76	Pir Jamsheed Colony Jandad Town	324,542	3,722,181	Turbine			30	50	Yes	No	No	1994	16
365	Nil	77	New Abadi Dhoke Ganghal Graveyard	324,844	3,721,597	Submersible			20	25	No	No	No	2004	16
366	Nil	77	Dhoke Lalihal	325,295	3,721,046	Submersible			20	50	Yes	No	No	1999	8
367	Nil	77	Azeem Town Dhoke Lalihal	325,469	3,721,002	Submersible			30	50	Yes	No	No	1989	4
368	Nil	77	Gulzar e Qaid	326,131	3,719,502	Turbine			25	25	Steel Cage	No	No	2006	16
369	Nil	78	Shaheen Town	325,629	3,720,675	Submersible			25	25	Yes	No	No	2005	16
370	Nil	78	Gangal West	325,506	3,720,625	Submersible			20	25	Yes	No	No	2006	16
371	Nil	78	Chaklala Scheme	324,364	3,719,654	Submersible			20	50	Yes	No	No	2007	16
372	Nil	79	Ghosia Colony	324,573	3,719,285	Submersible				25	Yes	No	No	2009	
373	Nil	79	New Afzal Town Gali No.02	324,189	3,718,357	Submersible			25	25	No	No	No	2007	16
374	Nil	ISB	Gouri Town Phase III Gali No 2	326,258	3,721,248	Submersible			25	25	Yes	No	No	2006	16

Sr. No.	TW. No.	UC. No.	Location	Easting (m)	Northing (m)	Pump Type	Discharge (Gln)	Pump Setting (ft)	Motor (BHP)	Transformer (KVA)	Pump House	Chlori -nator	Filtration Plant	Year of Construction	Total Pumping Hours
375	Nil	ISB	Gangal East	326,151	3,721,121	Turbine			50	100	Yes	Yes	No	2002	16
376	Nil	ISB	Gangal East-II	366,086	3,721,219	Submersible				100	Yes	No	No	2004	

Annexure B: Inventory of Filtration Plants

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi

Survey Data of Filtration Plant WASA Rawalpindi

Sr. No.	UC No.	TW No.	Location	Easting (m)	Northing (m)
1	1	74-A	Chungi Ratta Amral	0318585	3720236
2	1	75	Bhusa Godaam	0318345	3720812
3	1	75-C	Kachi Abadi Bhusa Godaam	0318175	3720780
4	1	76-B	Near Pull Dhoke Ratta	0318589	3720658
5	2	77	Dhoke Ratta Dispensary	0318597	3721013
6	2	78	Toheedi Road Dhoke Ratta	0318379	3721054
7	2	79-C	Babu Laal Husain Road Dhoke Ratta (Tanki)	0318718	3721148
8	3	80-A	Near Khajur Wala Medan Hazara Colony	0318354	3721724
9	4	83-A	Boring Road (Tanki)	0318052	3722215
10	4	84-C	Muhallah Farooqia Girls School Dhoke Mangtal	0318177	3722055
11	5	87	Aalim Abad Dhoke Hasuu	0317418	3722260
12	5	87-B	Near Graveyard Aalim Abad Dhoke Hasuu	0317488	3722226
13	5	88	Model Colony Dhoke Hasuu	0318002	3722497
14	5	89-A	Dhoke Darzian Dhoke Hasuu	3176666	3722400
15	6	86	Gulshan Data Dhoke Hasuu	0317318	3722629
16	6	87-A	Waqeel Abad Dhoke Hasuu	0317205	3722753
17	6	89	Gulshan Fatima Dhoke Hasuu	0317053	3722876
18	6	90	Near Tawar Aalam Abad Dhoke Hasuu	0317222	3722313
19	7	143-B	Quaid Abad	0318773	3722335
20	8	91	Mehar Colony Perwadai	0317966	3722844
21	8	91-A	Bokra Road Perwadai	0318084	3722860
22	8	92-B	Street No. 10 Fuji Colony	0317396	3723086

Sr. No.	UC No.	TW No.	Location	Easting (m)	Northing (m)
23	9	93	Fair Barged Perwadai	0318190	3722395
24	9	94-A	Baghish Colony Medan	0318349	3723130
25	9	95-A	Badar Colony	0317829	3723446
26	9	96	Near Ghosia Masjid Banghish Colony	0318161	3723306
27	9	97	Zia-up-Haq Colony	0318738	3722743
28	13	2	Katarian	0319717	3724754
29	13	6	Chishtia abad	0320356	3724511
30	13	169	Katarian Market	0319923	3724385
31	14	106	Muhallah R Sultan	0319627	3723292
32	15	4	Qaid Azam Park	0320111	3724640
33	15	110	Jamia Park	0320121	3722932
34	15	111-A	RDA R.Sultan	0319939	3723328
35	16	107-A	Commerce College	0319419	3723409
36	16	147-A	Eid Gah	0319847	3722893
37	17	13	Pindora	0320849	3724911
38	18	11	Dh. Babu Irfan	0321292	3725529
39	19	14-A	7Th Road	0321078	3724548
40	19	116	Masjid Al Furqan	0321311	3724075
41	19	117	DSP Office	0320799	3723978
42	19	119-A	Muzaffar Masjid	0320571	3723984
43	20	121	Commercial Market	0321192	3723647
44	20	125	Muslim H School	0320574	3722836
45	20	126-A	Johar Abad	0321016	3722797
46	21	15	New DPS Shamasabad	0322413	3725132
47	21	15-A	Near Blind School Shamasabad	0322478	3725089

Sr. No.	UC No.	TW No.	Location	Easting (m)	Northing (m)
48	21	18-A	Near Ohjri Camp	0322361	3725545
49	22	16	Qayyum abad Dh. Kala Khan	0323002	3724801
50	22	16-A	Murree Hazara Colony	0323385	3725034
51	22	24-A	Model Colony Dh. Kala Khan	0323208	3724705
52	23	7	A-Block Gunj Bakhsh Road	0322002	3724382
53	23	174	Dh. Kashmiri an	0322811	3724236
54	23	175-A	Bilal Colony	0322689	3724509
55	24	17-B	Ali Abad	0322689	3723876
56	24	23	DK Punnoo	0322805	3723606
57	24	24-B	Khana Kak	0323646	3724127
58	24	25	Khajoor Wali Gali	0322700	3723551
59	25	26	Sadiq abad Muhammadi Masjid	0322249	3723448
60	26	36	C-Block	0321764	3723003
61	27	27	Melaad Chowk Muhammadi Colony Muslim Town	0323012	3723371
62	27	28	Azher Satti Plat	0320017	3723093
63	27	29	Muslim Town Near PAF flats	0323371	3723095
64	28	30	Pepsi Depu	0322641	3722420
65	28	31	Gali No. 02	0322405	3722530
66	28	31-A	Doctor Qadeer Street	0322054	3722652
67	29	32	Behari Colony Tanki	0323187	3722665
68	29	33-B	Khurram Colony	0323041	3722263
69	30	37	Chah Sultan	0321397	3722400
70	30	38-A	Amur Pura	0321231	3722152
71	31	39	Rawal Road	0321903	3721939
72	31	45-A	G. Factory 1	0321293	3721416

Sr. No.	UC No.	TW No.	Location	Easting (m)	Northing (m)
73	32	43	Waris Khan Sarfraz Road	0320735	3721627
74	32	43-A	Zuffar-Ul-Haq Road	0320913	3721537
75	33	133	Banni Chowk	0320254	3721881
76	33	131	Kohati Bazar	0320541	3722169
77	33	131-A	Mohallah Feroozpura	0320695	3722216
78	33	132	Kohati Bazar	0320516	3722076
79	34	148	Muhallah Kartar Pura Near Police Station Banni	0320246	3722135
80	34	155-A	Janglaat Road	0320107	3722127
81	35	154-C	Bagh Sardaran	0319607	3722280
82	36	71	Near Dispensary Mohan Pura	0319333	3720384
83	36	72-A	Girls College Mohan Pura	0319258	3720576
84	39	136-A	Chitian Hatian	0320219	3721164
85	39	151	Bhabra Bazar	0320257	3721345
86	40	138-A	Prona Qalia	0319814	3721441
87	41	150	Shah Nazar Pull	0319845	3721684
88	41	150-A	Mohallah Naharia	0320090	3721736
89	42	46	Millat Colony	0320891	3721116
90	42	46-B	Zafar-UL-Haq Road	0320593	3721227
91	43	48-A	Talab Tailian	0321025	3721317
92	43	53-A	Qasim Abad	0321395	3721252
93	44	47	Zeenat Sikandria School	0321082	3720982
94	44	52	Dh. Elahi Bakhsh	0321024	3720406
95	45	58	Ariya Mohalla	0321022	3720201
96	46	64	Near TMA Office Liaquat Road	0320165	3720350
97	46	64-A	DAV College Road	0320086	3720637

Sr. No.	UC No.	TW No.	Location	Easting (m)	Northing (m)
98	46	64-B	Near Moti Masjid Liaquat Road	0319978	3720610
99	46	64-C	College Chowk	0320207	3720774
100	46	69	Chachi Mohallah Tanki	0320365	3720816
101	46	69-A	Muree Road	0320516	3720471
102	46	70-A	Usman Pura	0319623	3720562
103	46	70-D	Nia Mohallah	0320034	3720826

Annexure C: Inventory of Overhead Tank

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi

Survey Data of Over Head Reservoirs WASA Rawalpindi

Sr. No.	UC No.	Filling Source	Location	Easting (m)	Northing (m)	Capacity (Gallons)
1	3	Tube Well No.74-A	Chungi Ratta Amral	0318626	3720233	
2	4		Borian Road Dhoke Matkial	0318068	3722215	100,000
3	7	Tube Well No.143-A , 143-B , 143-C	Quaid Abad	0318774	3722333	
4	9	Tube Well No 94	Bus Stand Pir wadhai	0318471	3723058	20,000
5	9		Park Bangish Colony	0318226	3723334	
6	11	Tube Well No. 166-A	Complaints Office WASA Muhammadi Chowk	0319119	3722818	50,000
7	12	Tube Well No. 162-A,162-B	Sector 4-B Near Mohra Shareef	0319267	3722844	50,000
8	12	Tube Well No. 101-A	Sector-I Goal Tanki	0318774	3723932	50,000
9	12	Tube Well No. 163-A	Sector 4-A Near Sadiq Akbar Masjid	0319066	3723846	25,000
10	12	Tube Well No. 164-A	Sector-II Ground	0318660	3723456	50,000
11	15	Tube Well No.112-B	Safaid Tanki	0320222	3723231	
12	19	Sump Well 119,120	Post Graduate College Satellite Town	0320454	3724194	
13	20	Supply from Rawal Dam	Commercial Market	0321220	3723608	50,000
14	20		Asghar Mall Sch	0320877	3722801	
15	20	Tube Well No.129-A	Kali Tanki	0320405	3723283	
16	21	Supply from Khan Pur Dam	Shamas abad Complaint Office	0322092	3725096	250,000
17	22	12 No. Tube Wells of Sohan Village	Farooq E Azam Road	0323219	3724156	100,000
18	23	Tube Well No 20	Dh. Piracha OHR	0322192	3723907	250,000
19	32	Tube Well No 44-A	New Amar Pura	0321412	3721730	
20	33		Circular Road	0320502	3721599	50,000
21	35	Supply from Rawal Dam	Bagh Sardaran	0319478	3722031	250,000
22	36	Tube Well No. 72-A	Mohan Pura Goal Chowk New Scheme	0319267	3720555	

Sr. No.	UC No.	Filling Source	Location	Easting (m)	Northing (m)	Capacity (Gallons)
23	38		Akal Garh Gulshan Abad	0319257	3721706	50,000
24	40	Tube Well No 138	Prona Qalia	0319814	3721441	50,000
25	44	Tube Well No. 52	Dh. Elahi Bakhsh	0321033	3720407	50,000
26	45	Abundant	Civil Line	0320728	3718353	
27	46	Tube Well No 69	Chachi Mohallah Children Park	0320387	3720807	50,000
28	46	From OHR of Safaid Tanki Said Pur Road	Chachi Mohallah Children Park	0320392	3720818	250,000
29	46		Liaquat Bagh WASA Complain Office	0320316	3720260	50,000
30	77		Dhoke Lalihal	0325283	3721034	
31	77		Gulzar-e-Qaid	0326270	3719278	50,000

Annexure D: Inventory of Sump Well

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi				
Survey Data of Sump Well WASA Rawalpindi				
Sr. No.	**UC No.**	**Easting (m)**	**Northing (m)**	**Location**
1	4	0318072	3722219	Borian Road Dhoke Matkial
2	19	0320453	3724248	Post Graduate College Satellite Town
3	19	0320452	3724251	Post Graduate College Satellite Town
4	19	0320447	3724222	Post Graduate College Satellite Town
5	20	0320890	3723763	Children Park
6	22	0323199	3724181	Farooq E Azam Road
7	35	0319475	3722030	Bagh Sardaran
8	77	0326131	3719502	Gulzar-e-Qaid

Annexure E: CDA Recreational Areas Pollution

Sr.No	Site Name	Total Area (Acres)	No. of Visitors	Count (Persons)	No. of Toilets	No. of Toilet Users	Count (Persons)	Sewage Disposal	Solid Waste Disposal	Remarks
1	**Valley Park, Salgiran**	3	Normal Days	100	9	Normal Days	50-60	Soakage Pit (10'x12'x15')	In to Filth depot of TMA	Over all satisfactory
			Weekend	400		Weekend	100-120			
			Events	1200		Events	200-250			
2	**Chahtar Park, Chahtar**	14	Normal Days	150	30	Normal Days	50-55	Soakage Pit, 2 No. (14'x11'x10')	Burning along Kurang River.	Over all not satisfactory
			Weekend	200		Weekend	65-75			
			Events	400		Events	100-110			
3	**Shahdra Picnic Point**	9.375	Normal Days	150-160	4	Normal Days	25-35	Soakage Pit (11'x8'x9')	Burning.	No proper disposal of sewage.
			Weekend	400-450		Weekend	40-50			
			Events	600-650		Events	60-70			
4	**Lake View Park**	160	Normal Days	8000-10000	44	Normal Days	1200-1400	Into Septic Tanks	CDA Liabilty.	Satisfactory
			Weekend	15000-20,000		Weekend	1600-1700			
			Events	25,000-30,000		Events	2000-2200			

Annexure F: Sources of Pollution on Upstream of Rawal Lake

Summary of Point Pollution Source Identification Survey

S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
1	329867	3732675	Kurang River	Natural Drainage	Bani Gala area adjacent to Rawal lake	Causeway on Kurang Nullah near residential area of Bani Gala	This point is on Kurang River .At this point velocity by floating method for finding out discharge has been taken.
2	330740	3734421	Barakahu	Sewer	Disposal of sewer line and 2 No open drains into Shahdra River.	Main road ,Bridge near Police check post on Murree road , Barakahu	This Point is on Shahdra Nullah near police Check post Bara kahu. At this point Disposal of several no. of sewer lines disposing into Shahdra River has been observed.
3	331096	3737802	Shahdra River	Natural Drainage	Point taken to identify the Shahdra River	Near to start point of Shahdra River	This point is on Shahdra River at this point velocity by floating method for finding out discharge has been taken.
4	328201	3732566	Kurang River	Natural Drainage	Intersection Point of Kurang River and Rawal Lake.	Bani Gala Area, Opposite to Lake View Park	This is the Intersection point of Rawal lake and Kurang River. This point is about 3 km away form Residential area of Bani Gala. The area between this point and Bani Gala is cultivated land
5	328633	3732386	Kurang River	Natural Drainage	Bani Gala area	Bani Gala Area	This Point is also on Kurang River, 2 km away from Residential Area of Bani Gala.
6	329265	3732406	Kurang River	Natural Drainage	Kurang bridge between Bani Gala and Barakahu	Kurang Bridge between Bani Gala and Barakahu.	At this point velocity by floating method for finding out discharge has been taken.
7	328385	3731800	Bani Galla	Sewer	Kurgan River	Bani Gala residential area	House sewer directly disposing into Kurang River
8	327921	3730465	Bani Galla	Sewer	Bani Gala area adjacent to Rawal lake near boating point	Bani Gala residential area	House sewer directly disposing into Kurang River
9	330823	3732955	Kurang River	Natural Drainage	Intersection point of Kurang and Shahdra River.	Intersection of Kurang River and Rawal lake.	Intersection Point
10	331125	3733162	Kurang River	Sewer	Drain disposing sewage and Drainage Water directly into Kurang River.	Bani Gala residential area	Direct disposal into Kurang River.
11	331199	3733336	Shahdra River	Sewer	Drain directly falling into Shahdra River.	Toheed abad	Direct disposal into Shahdra River.
12	330733	3733521	Barakahu	Sewer	6'' Dia sewer line directly disposing into Nullah.	On Shahdra River	Direct disposal into Shahdra River.
13	330904	3733831	Shahdra River	Sewer	18'' Dia sewer line is directly falling into Shahdra River.	Toheed abad	Direct disposal into Shahdra River.

S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
14	331912	3734143	Kurang River	Sewer	Several no. of sewer and Drainage lines is directly dropped in Kurang River.	Bani Gala area	Direct disposal into Kurang River.
15	332690	3735220	Barakahu	Sewer	Main drain collecting sewage of certain colonies situated nearby.	Barakahu residential area	Drain collecting sewage of Barakahu Area.
16	332180	3735747	Shahdra	Sewer	Disposal point of Margallah valley area.	Shahdra River	Disposal point of Margallah Valley.
17	330826	3734566	Barakahu	Sewer	Main Disposal point of whole area of Mangoo Town, Barakahu.	Opposite to bridge on Main Murree road Barakahu	Intersection point of Nullah coming from residential area of Mangoo Town and Shahdra River, the Nullah coming from Mangoo Town collecting the sewage and drainage water of area of Mangoo town.
18	330752	3734512	Barakahu	Sewer	Main Disposal point of whole area of Mangoo Town on Shahdra River.	Near Grid station (twotwo0.Kv)	Direct disposal into Shahdra River.
19	330587	3734511	Barakahu	Sewer	Main Disposal point of residential area of Mangoo Town.	Opposite to bridge on Main Murree road	Disposal of sewage and drainage water of adjacent area is directly into Shahdra River through a sewer line of 8'' Dia
20	330435	3734542	Barakahu	Sewer	Intersection point of Nullahs coming from Mohallah sayydan and Shahdra Nullah.	Near Marble factory	Storm water drain carrying sewage is disposing into Shahdra River.
21	332003	3733638	Kurang River	Sewer	Open drain of Sanjiali area	Opposite of Poultry farm	Nullah coming from residential area of Sangjani which drops into Nullah coming from area of Phulgiran and finally it dropped into Kurang River .At this point disposal of contaminated water of poultry farm is also into Nullah.
22	331477	3733453	Kurang River	Natural Drainage	Intersection point of Kurang Nullah and Nullah coming from Phulgiran residential area.	Near Poultry farm	This is the intersection point of Kurang Nullah and the Nullah coming from sanjali,seri chowk
23	331995	3736407	Barakahu	Sewer	Disposal point of dhoke chohdrian ban.	Near Main market of dhoke Chohdrian ban	This point is in the area of dhoke chohdrian ban, The width of drain is 12' and depth is up to 6', it is a covered drain collecting the sewage and drainage water of adjacent residential area of dhoke chohdrian

S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
24	332348	3735891	Barakahu	Sewer	Disposal point of Mohallah Qazi abad and some area of Mohallah noor pur.	Mohallah Qazi abad	This point is in the area of Mohallah Qazi abad .The Disposal of sewage and drainage water of adjacent area of Mohallah Qazi abad into this Nullah that dropped finally in Kurang River
25	332314	3735281	Barakahu	Sewer	Disposal of sewage and Drainage Water.	(Near Al-Fallah National school System) Barakahu	This point is in the area of Bhera sayydan, At this point flow of sewage and drainage water of adjacent residential area is towards the Nullah coming from katchi abadi in Barakahu which meets Kurang River
26	332464	3735303	Barakahu	Sewer	Junction point of Nullahs coming from Mohallah Qazi abad.	Near The Educator school ,Main road ,Barakahu	Intersection point of both Nullahs coming from kachi abadi and from Mohallah Qazi abad.
27	330750	3734696	Barakahu	Sewer	Disposal of Sewage Water	Near market of Mangoo Town	This point is in the area of Mangoo Town, Barakahu. Drain collecting the sewage of adjacent residential area
28	330745	3734700	Barakahu	Sewer	Main drain of Mangoo Town.	Near Jamia Masjid AL-Jawad ,Mangoo Town	Drain of Mangoo Town, the sewage and drainage water is disposing into drain.
29	330743	3734848	Barakahu	Sewer	Disposal of Sewage Water	On chowk of Col. Aman-U-Allah Road	This point on Main chowk of Mangoo Town and col. Aman -U-Allah road .Drain collecting sewage of adjacent area
30	330367	3735261	Barakahu	Sewer	Disposal of Sewage Water	Opposite to Grid station	18'' Dia sewer line coming from physic department directly disposing into Shahdra River
31	330696	3734770	Barakahu	Sewer	Main drain of Mangoo Town.	F.G Boys secondary school , near marble factory	Nullah carrying sewage and drainage water of Mangoo Town area.
32	330366	3735259	Barakahu	Drainage Water	Disposal of the sewage into septic tanks in hafiz bad ,Barakahu	Near F.G Girls primary school, on Main Kyani road	Area of hafizabad. 80% Disposal of sewage into septic tanks, Size of septic tank is ''Depth = 12' , length = 10' , width = 8'
33	330338	3734964	Barakahu	Sewer	Disposal of sewer line directly into Nullah	Near Poultry farm, Margallah valley	Disposal of sewage of this area is directly into Shahdra River.
34	331046	3735004	Shahdra	Sewer	House sewer is directly disposing into Nullah	Near Grid Station	9'' Dia sewer line is directly disposing into Nullah of adjacent residential area.

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35	330350	3734599	Shahdra	Sewer	House sewer is directly disposing into Nullah	Near Grid Station	9'' Dia sewer line is directly disposing into Nullah of adjacent area.
36	330741	3734846	Barakahu	Sewer	Main Disposal point ,disposing of sewage and Drainage Water of Mohallah sayydan	Back side of Army camp	Disposal of sewage of Mohallah Sayydan is into open plot
37	330876	3735961	Shahdra River	Natural Drainage	This is newly developing society	Along Shahdra River	Newly developing society. No sewerage network in this area
38	330466	3735766	Shahdra River	Natural Drainage	Main drain collecting storm Water of area Kot Hathyal and finally disposed into Shahdra River	Shahdra River	Storm water drain, disposal of sewage into septic tanks in this area.
39	330460	3735767	Shahdra River	Natural Drainage	On Shahdra River opposite to physic department	On Shahdra River opposite to Physic Department	The disposal of sewage and drainage of Kot Hathyal residential area is into septic tanks and soakage pits . Average Size of septic tank is, depth 12', width 8' and length is 10'
40	330384	3735830	Shahdra River	Sewer	Main Disposal point of whole physic department.	On Shahdra River opposite to Physic Department	Direct disposal into Shahdra River through 18'' Dia sewer line.
41	330908	3735005	Barakahu	Sewer	Drain of Mohallah sayydan along Gillani Road	Start point of drain on Gillani road	Disposal of sewage and drainage water of Mohallah sayydan into drain of Gillani Road
42	330897	3734881	Barakahu	Sewer	Gillani Road in Mohallah sayydan.	Gillani road in Mohallah sayydan	Gillani road in Mohallah sayydan, The disposal of sewage and drainage water of Mohallah sayydan is in open plot
43	325224	3735482	Bari Imam	Sewer	The whole sewage and drainage Water of Bari Imam Shrine is directly into this Nullah at this point	Main drain, back side of Bari Imam shrine, This drain is passing from shrine area.	Main drain collecting sewage of Bari Imam shrine. Several no. of sewer lines disposing directly into Nullah. Flow measurement of nullah at this point.
44	325529	3735390	Bari Imam	Sewer	Disposal of sewer lines into Nullah of Mohallah pathi and Mohallah mitaha shahi	Near Sultan model school, back side of Bari Imam shrine	8'' and 15'' Dia sewer lines directly falling into Nullah
45	325591	3735256	Bari Imam	Sewer	Drain collecting sewage and drainage Water of adjacent area	Bridge on Main Bari Imam road	15'' and 20'' Dia sewer lines directly dropping into Nullah at this point .Flow measurement of Nullah at this point.
46	325593	3735244	Bari Imam	Sewer	Disposal of sewage and Drainage Water of adjacent area directly into Nullah	Before intersection point of both Nullahs on university road	Before intersection point of both tributaries of Bari Imam nullah, Flow measurement of nullah at this point.

S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
47	325592	3735161	Bari Imam	Sewer	Nullah coming from Bari Imam Shrine areas and another Nullah coming from Quaid-e-Azam University also collecting sewage of Bari Imam area	Before intersection point of both Nullah	Flow measurement of nullah at this point.
48	325537	3735173	Bari Imam	Sewer	Disposal point of adjacent areas	Before intersection point of another Nullah coming from Bari Imam	Sewer line of residential area adjacent to Nullah directly falling in Nullah
49	325316	3735296	Bari Imam	Sewer	Disposal of adjacent areas is directly into Nullah	Drain of Bari Imam area	18'' Dia sewer line directly disposing into Nullah .Flow measurement of Nullah.
50	325513	3735412	Bari Imam	Sewer	Main drain collecting sewage and drainage Water of Bari Imam shrine and adjacent areas	Drain coming from Bari Imam area	2 No . 9'' Dia of sewer lines directly falling into Nullah. Flow measurement of nullah at this point.
51	325521	3735473	Bari Imam	Sewer	Intersection point of Nullah coming from lohe-e-dandi and Nullah coming from back side of Quaid-e-Azam University	Service station along University road	Flow measurement of nullah at this point. Direct disposal into nullah at this point.
52	327331	3733736	Bari Imam	Sewer	Main Nullah coming from Quaid -e-Azam University	University road ,Near Diplomatic shuttle service stop	Disposal of sewage and drainage water of diplomatic shuttle service office into adjacent Nullah of Quaid-e-Azam University
53	327469	3733225	Bari Imam	Sewer	Main Nullah coming from Quaid -e-Azam University	Main Murree Road.	Disposal of drainage and sewage water of adjacent area into Nullah which finally drop into Rawal lake
54	326670	3732754	Bari Imam	Sewer	Main Nullah coming from Quaid -e-Azam University	Main Murree road	Nullah coming from Quid-e-Azam University collecting sewage and drainage water of adjacent area
55	332559	3734605	Kurang River	Sewer	Disposal is directly into Nullah coming from area of Shahpur.	Kurang River.	Direct disposal into nullah.
56	332320	3735275	Barakahu	Sewer	Disposal point of Bhera sayydan, Barakahu	Near Main road Bhera sayydan	This point is in the area of Bhera sayydan. The Disposal of sewage and drainage water of adjacent residential area of Bhera sayydan is directly into the Nullah through 24''Dia sewer line.
57	326678	3732703	Bari Imam	Sewer	Nullah collecting sewage of adjacent areas of Quid-e-Azam University	Main Murree road near Rawal lake	Nullah coming from quid-a-Azam University collecting sewage and drainage water of adjacent area. Flow measurements of Nullah

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58	325454	3734182	Bari Imam	Natural Drainage	Adjacent to Diplomatic Enclave	Adjacent to main road of Diplomatic Enclave	From this point Nullah enter in the boundary of Diplomatic Enclave
59	325655	3734414	Bari Imam	Sewer	Direct disposal into nullah.	Adjacent residential area of narrollah	9'' Dia sewer line is directly disposing into Nullah, Also 12'' Dia sewer line falling into Nullah, moreover Disposal of wet manure of animals is also into Nullah
60	325614	3734735	Bari Imam	Natural Drainage	Point taken to identify the Nullah route	Near residential area of Jub, Aspalal	Flow measurement of Nullah.
61	325530	3735476	Bari Imam	Sewer	Direct disposal into nullah.	Nullah coming from Bari Imam	Flow measurements of Nullah.6''and 9'' Dia pipes directly disposing sewage into Nullah
62	330998	3734548	Barakahu	Sewer	Disposal point of area along Kyani road .	Mohallah sayydan near Main Murree road	The disposal of sewage and drainage water is into drain along Kyani road
63	330853	3734497	Barakahu	Sewer	Disposal point of area along Kyani road .	Near Marble factory at Col. Amman-U-Allah road.	Drain along Murree road collecting sewage and drainage water of army camp and adjacent areas and finally dropped into Shahdra River
64	330993	3734562	Barakahu	Sewer	Drain along Main Murree road collecting sewage of army camp.	Near Army camp, Main Murree road	Drain carrying sewage and drainage water is disposing in to Shahdra River
65	331442	3734788	Barakahu	Sewer	Main Nullah collecting sewage of Kyani road and Simly road area.	Main Murree road, near Simly road stop	Covered drain carrying sewage of area along Simly road
66	331380	3734818	Barakahu	Sewer	Disposal of the open drain into open plot adjacent to this area.	Along Murree road, Barakahu	Drain along Kyani road ,collecting sewage and drainage water of adjacent areas
67	331249	3734887	Barakahu	Sewer	Disposal of sewage and Drainage Water of adjacent streets into this drain.	Main Kyani road	Drain along Kyani Road of depth 2' and width is 3.5'.
68	330993	3735042	Barakahu	Sewer	Disposal of sewage and Drainage Water of adjacent streets into this drain.	Main Kyani road. Near Jamie Masjid	Drain along Kyani Road of depth 2' and width is 3.5'.
69	330884	3735098	Barakahu	Sewer	Start point of the drain along Kyani road.	Main Kyani road.	Drain along Kyani Road of depth 2' and width is 3.5'.
70	328715	3735357	Bari Imam	Sewer	Disposal of this Nullah is into Main Nullah of Quaid-e-Azam University.	Quaid-e-Azam University Area.	Disposal of one hostel of Quid Azam University is directly into this Nullah.
71	328686	3735914	Bari Imam	Sewer	Start point of Quaid-e-Azam University Nullah	University area near Admin block.	Drain collecting sewage of nearest admin block of University is directly falling into Nullah ,Point on collected near admin block

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72	328440	3735684	Bari Imam	Sewer	Disposal of sewage of hostels of Quaid-e-Azam University is directly into Nullah.	Quaid-e-Azam University area	Disposal is directly into Nullah through on open drain coming from hostel.
73	328316	3735385	Bari Imam	Natural Drainage	Intersection point of both Nullahs coming from Quaid-e-Azam University.	Near university road	Intersection point of two nullahs.
74	328312	3735456	Bari Imam	Sewer	Disposal of sewage of Quaid-e-Azam University directly into this Nullah.	Main Quaid-e-Azam University Road	Point on Main road of Quid-e-Azam University, Flow measurement at this point.
75	328198	3735476	Bari Imam	Sewer	Nullah collecting sewage of Quaid-e-Azam University, and dropped in Main Nullah.	Main Quaid-e-Azam University Road.	Disposal of sewage and drainage water into Quid-e-Azam University nullah, Flow measurement at this Point
76	327577	3734114	Bari Imam	Sewer	Nullah collecting sewage of Quaid-e-Azam University, and dropped in Main Nullah.	Adjacent to boundary wall of China Embassy	Near the boundary of China Embassy and residential area of mal pur. Flow measurements at this point.
77	327397	3733985	Bari Imam	Natural Drainage	Nullah coming from Quaid-e-Azam University and Mal residential area	In front of China Embassy boundary wall	Adjacent to China Embassy Area
78	327354	3733775	Bari Imam	Sewer	Nullah coming from Quaid-e-Azam University.	Near Diplomatic Shuttle Service Sop.	Disposal of drain along University road into Nullah near this point, width of drain along University road = 5' depth = 4'.Flow measurements of Nullah at this point.
79	328426	3735738	Bari Imam	Sewer	Main Nullah collecting sewage and Drainage of Quid-e-Azam University area	University Area	Nullah of Quaid-e-Azam University.
80	326014	3732603	Bari Imam	Sewer	Intersection point	Adjacent to Lake View Park	Intersection point of Bari Imam Nullah and Rawal Lake.
81	326005	3732597	Bari Imam	Sewer	Nullah coming from residential area of Bari Imam and collecting sewage of diplomatic enclave	Bari imam Nullah	Flow measurement of nullah at this Point
82	324821	3735731	Bari Imam	Sewer	Nullah enters in the boundary of Bari Imam shrine	Bari Imam Shrine	6'' and 18'' Dia sewer lines are directly disposing into Nullah
83	324843	3735820	Bari Imam	Sewer	Sewer line directly disposing into Nullah	Bari imam Nullah	9'' sewer line directly disposing into Nullah.A drain of adjacent area is directly disposing into Nullah

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84	324832	3735894	Bari Imam	Sewer	Open drain and 9'' sewer pipe directly disposing into Nullah at this point	Bari imam Nullah	Solid Waste and house sewer directly disposing into nullah.
85	324765	3735962	Bari Imam	Sewer	Open drain is directly disposing into Nullah of adjacent residential area	Bari imam Nullah	Sewer line is directly falling in Nullah at this point.
86	324926	3735991	Bari Imam	Sewer, Solid Waste	Disposal of Solid Waste and house sewer directly into Nullah.	Bari imam Nullah	9'' sewer dropping into Nullah
87	324914	3736097	Bari Imam	Sewer, Solid Waste	From this point up to the Bari Imam Main road Disposal of sewage of adjacent area is directly into Nullah	Bari imam Nullah	Flow measurement of Nullah at this point. Disposal of Solid Waste into Nullah
88	325478	3736716	Bari Imam	Sewer	Disposal of sewage of Water supply colony directly into Nullah at this point.	Near filtration plant adjacent to water supply colony.	12'' Dia sewer line of Waste supply colony of filtration plant is directly dropping into Nullah at this point
89	325138	3736424	Bari Imam	Natural Drainage	Nullah coming from lohe-e-dandi, Bari Imam	Near Main road going to lohe e dandi	Disposal of sewage and drainage of adjacent house long the Nullah near this point is directly into Nullah mostly Disposal of adjacent area is into their land flow measurement of Nullah at this point
90	325425	3736770	Bari Imam	Natural Drainage	Supply to secretariat block from filtration plant	Filtration plant	Supply to secretariat block A,B,C from this filtration plant
91	325417	3736833	Bari Imam	Sewer	Near Filtration plant	Intersection point of both Nullahs, near water supply colony	Flow measurement of Nullah at this point. 6''Dia sewer line is directly disposing into Nullah at this point
92	325474	3737109	Bari Imam	Natural Drainage	Near to start point of Bari Imam Nullah	Near the way going to Bari Imam Chilla gah	Near to start point of Bari Imam Nullah. Flow measurement of Nullah at this point
93	324629	3734912	Bari Imam	Sewer	Disposal of sewage and Drainage of nearest area	Rangers Camp	Direct disposal into Nullah of Ranger camp
94	324628	3734913	Bari Imam	Sewer	Main Disposal point of Rangers camp.	Rangers Camp	Open drain collecting sewage of adjacent area directly disposing into Nullah at this point.
95	324615	3735084	Bari Imam	Sewer	Start of Residential area along Nullah from this point.	Adjacent to boundary wall of Army camp	Open drain collecting sewage of adjacent area directly disposing into Nullah at this point.
96	324528	3735241	Bari Imam	Sewer	Nullah Coming from Ratta Hotar.	On Main road of Prime Minister Secretariat.	Direct disposal into Nullah.

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97	323906	3735778	Bari Imam	Stream Water	Flow of Water and Natural Drainage.	Adjacent to Main road Rangers Camp.	Nullah coming from Ratta hotar
98	323913	3736241	Bari Imam	Stream Water	Point taken to identify the Nullah route	Adjacent to Houses along Nullah.	Point is taken for identification of nullah route.
99	323912	3736357	Bari Imam	Stream Water	Point taken to identify the Nullah route	Ratta Hotar Residential Area along road	Point is taken for identification of nullah route.
100	323888	3736556	Bari Imam	Stream Water	Point taken to identify the Nullah route	Adjacent to Dargah, Ratta Hotar	Flow measurement of Nullah at this point
101	323837	3736881	Bari Imam	Stream Water	Point taken to identify the Nullah route	Nullah Near Residential Area of Ratta Hotar	Flow measurement of Nullah at this point.
102	327495	3733196	Bari Imam	Natural Drainage	Point taken to identify the Nullah route	Adjacent Main Murree Road	Point on Nullah coming from area of Malpur.
103	327492	3734143	Bari Imam	Natural Drainage	Nullah dropping in Rawal Lake	Near Main Murree Road	Flow measurement of Nullah at this point
104	327456	3733050	Bari Imam	Sewer	Point taken to identify the Nullah route	Point adjacent to boundary wall of Lake view park.	Nullah Coming from area of Mal pur and finally dropping into Rawal Lake.
105	325788	3735601	Bari Imam	Stream Water	Point taken to identify the Nullah route	Adjacent to Masjid of staff colony along of Quid-e-Azam University	Disposal of sewage water of adjacent area of Quaid Azam University is directly into Nullah
106	326067	3735643	Bari Imam	Stream Water	Point along the Nullah of Quaid-e-Azam University.	Adjacent to nursery of Quid-e-Azam University	Flow measurement of Nullah at this point.
107	326774	3735939	Bari Imam	Stream Water	Water is not polluted.	Back side of Quid-e-Azam University	Flow measurement of Nullah at this point.
108	327308	3736291	Bari Imam	Stream Water	Point taken to identify the Nullah route	Along road towards Ramli Village	Flow measurement of Nullah at this point.
109	327119	3736982	Bari Imam	Stream Water	Point taken to identify the Nullah route	Along road towards Ramli Village	Flow measurement of Nullah at this point.
110	327155	3737185	Bari Imam	Stream Water	Point taken to identify the Nullah route	Along road towards Ramli Village	Flow measurement of Nullah at this point
111	327299	3738034	Bari Imam	Stream Water	House sewer is directly disposing into Nullah	Ramli area , Intersection point of two Nullahs	Intersection point of two nullahs.
112	327667	3738317	Bari Imam	Stream Water	Water of Nullah is not polluted at this point.	Near to start point of nullah	Point taken for identification of nullah route.
113	325091	3733781	Bari Imam	Sewer	Nullah enters into diplomatic enclave area and intersecting with Nullah coming from Bari Imam	Adjacent to diplomatic enclave boundary	Disposal of Storm water drain along road into Nullah at this point
114	325114	3733854	Bari Imam	Sewer	House sewer is directly disposing into Nullah	Near diplomatic enclave boundary	No considerable Flow in nullah at this point.

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115	325076	3733954	Bari Imam	Natural Drainage	Nullah coming from Ratta Hotar and storm Water drain along Main road.	Intersection point	Intersection point of two Nullahs
116	324917	3734190	Bari Imam	Solid Waste	Disposal of Solid Waste is directly into Nullah.	Adjacent to katchi abadi of Bari Imam	Nullah coming from Rata Hotar area.
117	324850	3734401	Bari Imam	Sewer	Disposal of sewer and Solid waste of adjacent area is directly in to Nullah.	On bridge adjacent to Katchi abadi of Bari Imam	9'' and 18'' dia sewer lines directly disposing into Nullah
118	324769	3734416	Bari Imam	Sewer	House sewer is directly disposing into Nullah	Katchi abadi on one side of Nullah and Main road to diplomatic enclave on other side	2 no . 24'' dia sewer lines of Malikabad dropping into Nullah at this point.
119	324760	3734489	Bari Imam	Sewer	Nullah coming from Ratta Hotar	Katchi abadi of Bari Imam adjacent to Nullah	3'' & 6'' Dia sewer lines directly falling into Nullah.
120	324747	3734628	Bari Imam	Sewer	Nullah coming from Ratta Hotar through Rangers Area.	Main road to Bari Imam ,near culvert	Drain of adjacent residential area directly disposing into Nullah.
121	334511	3736068	Kurang River	Natural Drainage	Intersection point of 2 Nullahs .(Nullah coming from Satramile and Kurang)	Phulgiran	Drain carrying sewage and drainage water of Satramile and cheena colony is disposing in to Kurang River at this point
122	333696	3735882	Kurang River	Natural Drainage	Point taken to identify the Nullah route	Kurang River ,Phulgiran area (Kurang Valley)	Disposal of drainage water of Kurang valley is into Kurang River at this point
123	334515	3736070	Kurang River	Natural Drainage	Point taken to identify the Nullah route	Kurang River ,Phulgiran area (Kurang Valley)	For identification of nullah route.
124	332957	3735451	Kurang River	Natural Drainage	Point taken to identify the Nullah route	Kurang River, Phulgiran village	Disposal of drainage water into Kurang River at this point
125	328034	3735558	Bari Imam	Sewer	Start point of Quaid-e-Azam University Nullah, Main Disposal point	Near hostels of Quaid Azam University	Disposal of sewage and drainage water of hostel into Nullah of University
126	334900	3737346	Satra Mile	Sewer	Disposal is directly into Nullah at this point of sewage and Drainage Water of adjacent area	Satramile (Cheena Colony)	18'' Dia sewer line is directly dropping into Nullah of adjacent area.
127	334741	3737471	Satra Mile	Sewer	Disposal of adjacent areas is directly into Nullah	Satramile (Cheena Colony)	A drain of adjacent area is directly falling into Nullah. Flow measurement of Nullah at this point.
128	334645	3737536	Satra Mile	Drainage Water	Drain of adjacent area is directly dropping into Nullah	Start of residential area along Nullah cheena colony	A drain of adjacent area coming sewer is directly disposing of adjacent colony into Nullah

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129	334606	3737857	Satra Mile	Stream Water	Water of Nullah is not polluted at this point.	Adjacent to PTCL office (satellite earth station)	Flow measurement of Nullah at this point
130	334616	3737795	Satra Mile	Stream Water	Point taken to identify the Nullah route	Adjacent to PTCL office (satellite earth station)	Point taken for identification of nullah route.
131	334630	3738219	Satra Mile	Stream Water	Intersection point of 2 Nullahs	Satramile Area	Flow measurement of Nullah at this point.
132	334328	3738463	Satra Mile	Stream Water	Intersection point of 2 Nullahs near Darbar	Near darbar (Satramile)	Intersection point of two nullahs.
133	334256	3738750	Satra Mile	Stream Water	Adjacent to Darbar and residential area	Satramile Area near start Point of Nullah	For identification of nullah route.
134	325209	3735461	Bari Imam	Sewer	To check the septic tank of Bari Imam shrine	Bari Imam Shrine	52 wash rooms on male side, 48 on female side. Size of septic tank on male side which is under construction size is L = 40 ft , W = 20 ft. D 10 ft.
135	334827	3736324	JanDiala	Sewer	Newly developing society along the Nullah disposing their sewer line directly into Nullah.	Near the intersection point of Kurang River and Satramile Nullah.	Point in Jandiala area before intersection point of Kurang River and Nullah coming from Satramile.
136	334898	3736471	Satra Mile	Sewer	Main polluted point on the Nullah coming from Satramile	Jandiala Village	A drain of width 3'-4' carrying sewage of Jandiala area is directly disposing into Nullah at this point.
137	335010	3736560	Satra Mile	Solid Waste	Disposal of Solid Waste and Drainage Water directly into Nullah	Jandiala Village	Adjacent areas directly disposing their Solid Waste and sewage into Nullah
138	335197	3736683	Satra Mile	Sewer	Near road of Jandiala Village. The adjacent house is directly disposing their sewage and drainage water into Nullah	Jandiala Village	Adjacent areas are directly disposing their sewage and Solid Waste into Nullah.
139	334311	3736705	Satra Mile	Solid Waste	To identify the Nullah. Solid Waste is directly disposing into Nullah at this point	Satramile Area	Adjacent areas along Nullah is directly disposing their sewage and Solid Waste into Nullah
140	335195	3736958	Satra Mile	Natural Drainage	Point taken to identify the Nullah route	Satramile Area	Flow measurement of Nullah at this point. Disposal of Solid Waste of adjacent area is into Nullah at this point.
141	335227	3737173	Satra Mile	Sewer	Nullah collecting sewage of adjacent area is directly disposing into Nullah at this point coming from Satramile.	Satramile Area	Disposal of Solid Waste is directly into Nullah

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142	335086	3737193	Satra Mile	Solid Waste	Solid Waste of adjacent area is directly Disposed into Nullah.	Main Murree road,	Nullah coming from Satramile.
143	335020	3737194	Satra Mile	Solid Waste	Storm Water drain along Murree road and Solid Waste is disposing into Nullah at this point.	Main Murree road, culvert at this point.	Storm water drain along Murree road is falling into Nullah at this point. Sewer line of adjacent petrol pump is directly disposing into nullah.
144	333606	3736084	Shahpur	Natural Drainage	Intersection Point	Intersection point of Kurang River and Nullah.	Kurang Valley, Shah pur area. Intersection point of Kurang River and Nullah coming from Satramile and shah pur.
145	333643	3736156	Shahpur	Sewer	Adjacent house directly disposing into Nullah at this point	Intersection point of Kurang River and Nullah of Satramile area.	Adjacent house directly disposing into Nullah
146	333721	3736278	Shahpur	Solid Waste	Drain collecting sewage and Drainage Water from adjacent area is directly disposing into Nullah at this point.	Main Murree road, culvert at this point.	Disposal of Solid Waste and storm water drain into nullah.
147	333718	3736400	Shahpur	Solid Waste	Disposal of Solid Waste and storm Water drain directly into Nullah.	Main Murree Road, Culvert at this point.	Disposal of Solid Waste directly into Nullah. Storm water drain is disposing into Nullah at this point.
148	333657	3736663	kurang River	Natural Drainage	Point taken to identify the Nullah route	No residential area along Nullah at this point.	Flow measurement of Nullah at this point.
149	333596	3736751	kurang River	Natural Drainage	Point taken to identify the Nullah route	No residential area along Nullah at this point.	No considerable flow of Nullah at this point. Point taken to identify the Nullah.
150	324086	3735591	Bari Imam	Stream Water	Adjacent to Main road, culvert at this point	Road along Residential Area of Ratta Hotar	Adjacent to boundary of Rangers camp.
151	323778	3737038	Bari Imam	Stream Water	From this point there is no residential area along Nullah.	Road along Residential Area of Ratta Hotar	Flow measurement of Nullah at this point
152	325614	3734735	Bari Imam	Sewer	Point before American Embassy	Adjacent residential area of narrollah ,and Noori Bagh near Masjid	Open drains are disposing sewage of adjacent area into Nullah. Flow measurement of Nullah.
153	326028	3732557	Bari Imam	Sewer	Nullah collecting the sewage and drainage Water of Bari Imam area	Main Murree road.	Nullah coming from Bari Imam and dropped in Rawal lake
154	331199	3735092	Barakahu	Sewer	Main drain coming from Kot Hathyal collecting sewage of 8.no Mohallahs of Kot Hathyal.	Adjacent to the plaza one side and cultivated lands on other side	This is the end point of the Nullah collecting the drainage and sewage of Kot Hathyal
155	331117	3735172	Barakahu	Sewer	Disposal of adjacent houses directly into drain through sewer network.	Adjacent to the plaza one side and cultivated lands on other side	Nullah collecting the sewage of Kot Hathyal

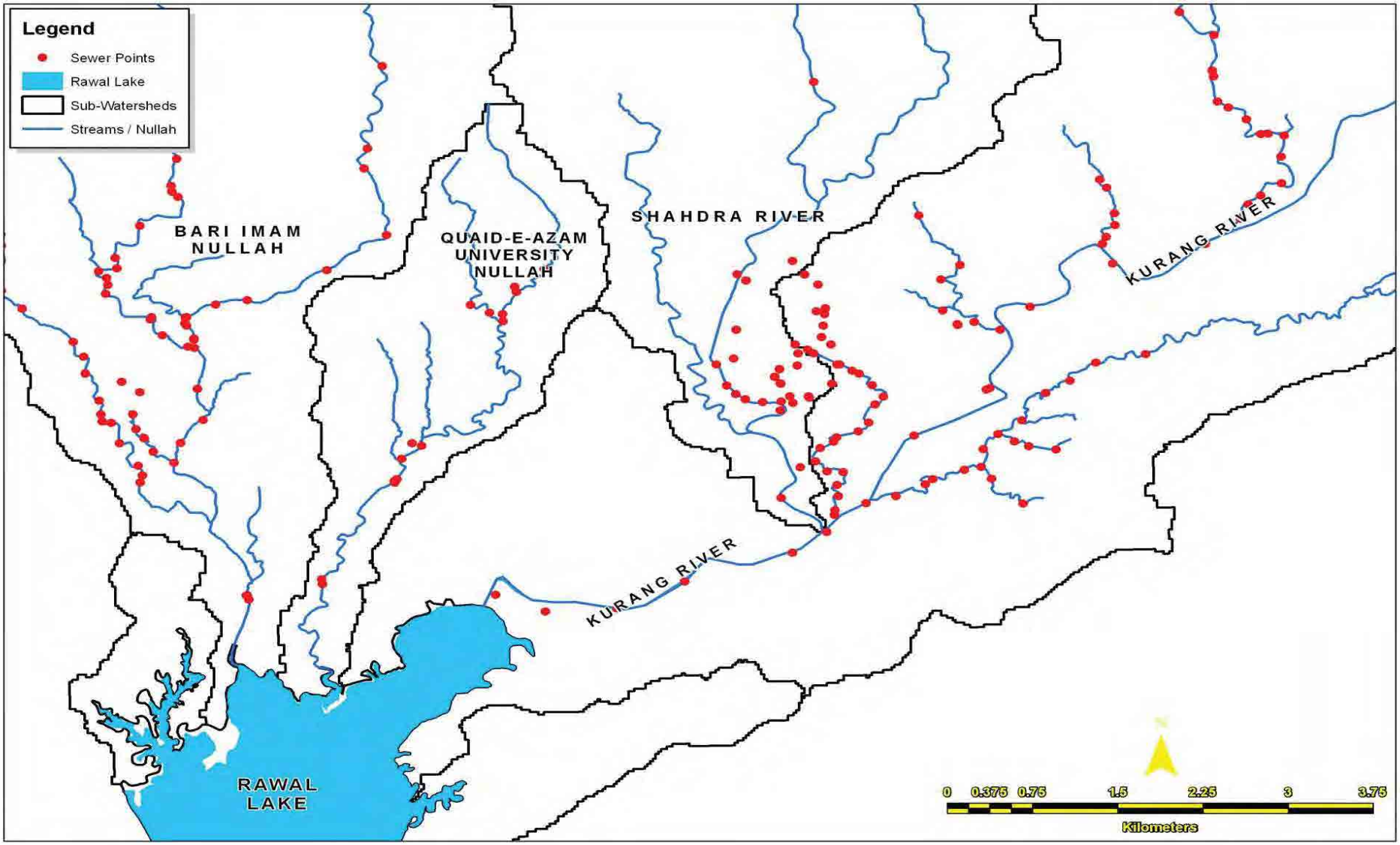
S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
156	331134	3735288	Barakahu	Sewer	Main drain collecting sewage of mostly area of Kot Hathyal also collecting sewage of some area of ahmed Town	Cultivated lands both sides	Drain collecting the sewage of Mohallah mohri and Mohallah rajgan
157	331077	3735438	Barakahu	Sewer	Disposal point of sewage and Drainage of Mohallah Malik abad	Near Masjid Mohallah malik abad	End point of drain coming from Mohallah malik abad, it meets with drain coming from Mohallah mohri, Kot Hathyal.
158	330979	3735816	Barakahu	Sewer	Disposal of many link streets is into this drain	Near abbaasi chowk ,Mohallah mohri ,Kot Hathyal	This is the start point of drain of Mohallah mohri, the whole streets along this drain is disposing its sewage into this drain which is finally disposing into open plot adjacent to graveyard
159	331096	3735713	Barakahu	Sewer	Drain collecting sewage and drainage of Mohallah mohri	Back side Grave yard	This point is on the drain coming from mohri Town.
160	331156	3735467	Barakahu	Sewer	Drain collecting swage and Drainage of residential area of Kot Hathyal	Adjacent to Ahmad Town road	This point is on drain coming from mohri Town
161	331147	3735405	Barakahu	Sewer	Main Disposal point of residential area of Kot Hathyal, Mohallah rajgan ,and Mohallah malik abad and Nullah coming from Mohallah mohri	Adjacent to ahmad Town road	Intersection point of Nullahs of Mohallah Malik abad and Mohallah rajgan
162	331201	3734687	Barakahu	Sewer	Main Disposal point of residential area of Kot Hathyal, Mohallah mohri Town	Adjacent to Grave yard near ahmad Town road	Main road of ahmad Town. The drain collecting the sewage and drainage water of residential area of ahmad Town
163	332555	3734606	Shahdra River	Sewer	House sewer is directly disposing into Nullah	Near Grid Station	Disposal of sewage is directly into Nullah of adjacent house.
164	337271	3737793	kurang River	Natural Drainage	Point taken to identify the Nullah route	Kurang divided into two branches (Along Angoori Road)	Flow measurement at this point.
165	331553	3734666	Barakahu	Solid Waste	Disposal of Solid Waste is directly into Nullah at this point	Madina Town (Barakahu)	Disposal of solid waste is directly into nullah.
166	331652	3734547	Barakahu	Sewer	18'' Dia sewer line is directly dropping into Nullah at this point	Madina Town (Barakahu)	15''& 12'' Dia sewer lines is directly dropping into Nullah. Adjacent area of Madina Town is directly disposing their Solid Waste into Nullah at this point

S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
167	331201	3733385	Barakahu	Sewer	Sewer line directly disposing into Nullah	Dhoke Mohri near intersection point	Nullah collecting sewage, drainage water and Solid Waste of Madina Town, Dhoke Mohri ,UC Nain Sukh and disposing into Kurang River
168	331237	3733531	Barakahu	Sewer	Disposal of sewage Water directly into Nullah	UC Nain Sukh Dhoke Mohri, Barakahu	Disposal of sewage water directly into Nullah. Also mostly area of dhoke Mohri is disposing their drainage water into Nullah
169	331227	3733642	Barakahu	Solid Waste	Disposal of solid waste	Dhoke Mohri (Barakahu)	Drain of adjacent area is directly dropping into Nullah
170	331282	3733777	Barakahu	Solid Waste	Disposal of Solid Waste and Drainage Water directly into Nullah	Musawat welfare society, Nain Sukh	Disposal of Solid Waste and drainage water directly into Nullah. Disposing of Solid Waste.6" Dia pipe of drainage water is directly dropping into Nullah
171	331143	3733788	Barakahu	Solid Waste	Disposal of Solid Waste and Drainage Water directly into Nullah	Musawat welfare society	Houses along Nullah is directly disposing there drainage water and Solid Waste into Nullah
172	331040	3733892	Barakahu	Sewer	18'' Dia line of sewage is directly falling into Shahdra River	Mohri Town, Haji Hameed road	Disposal of solid waste and a open drain into Nullah at this point
173	331085	3734026	Barakahu	Solid Waste	Disposal of Solid Waste and drainage pipe directly into Nullah	Nain Sukh Town, Barakahu	Disposal of Solid Waste directly into Nullah
174	331202	3734091	Barakahu	Solid Waste	Disposal of Solid Waste and Drainage Water directly into Nullah	Nain Sukh Town	Disposal of Solid Waste is directly into Nullah. 9'' Sewer is directly falling into Nullah at this point
175	331233	3734135	Barakahu	Solid Waste	Disposal of Solid Waste directly into Nullah	Al-jannat welfare Society. Nain Sukh Town	9'' Dia sewer line of adjacent house is directly dropping into Nullah.
176	331424	3734194	Barakahu	Sewer	Disposal of Solid Waste, Sewage pipe directly into Nullah.	Nain Sukh Town , Barakahu .Haji hameed road	Disposal of solid waste and a open drain into Nullah at this point
177	331515	3734281	Barakahu	Sewer	Disposal of Solid Waste, Sewage and drainage pipe directly into Nullah.	Madina Town (Barakahu)	Solid Waste directly disposed into Nullah .9'' Dia sewer line of adjacent house is directly falling into Nullah
178	331575	3734469	Barakahu	Sewer	Disposal of Solid Waste, Sewage and drainage pipe directly into Nullah.	Barakahu (Toheed abad) M.D.F School	Solid Waste directly disposed into Nullah .9'' Dia sewer line of adjacent house is directly falling into Nullah
179	325392	3733977	Bari Imam	Sewer	Intersection point	Intersection point of Nullah Bari Imam and Nullah coming from Labor Colony	This is the intersection point of Nullahs carrying Solid Waste and sewage.

S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
180	325107	3734712	Bari Imam	Sewer	Drain carrying sewage and drainage Water of adjacent area is dropping into Main Nullah of Muslims Colony	Labor Colony, Bari Imam	Nullah carrying Solid Waste and sewage.
181	324948	3734822	Bari Imam	Sewer	Disposal of Solid Waste, and drainage Water into Nullah, observation and pictures of septic tank	Start point of Nullah of Labor Colony .	Disposal of Solid Waste of adjacent areas is directly into Nullah
182	325041	3734482	Bari Imam	Sewer	Disposal of Solid Waste, and drainage Water into Nullah	Labor Colony, Bari Imam	2 No. open drains of adjacent areas directly falling into Nullah .Drain collecting sewage of adjacent areas is directly disposing into Nullah at this point
183	325065	3734331	Bari Imam	Sewer	Excavation of soakage pit is in progress for Disposal of sewage and Drainage Water of adjacent residential area	Labor Colony (Bari Imam)	Also disposal of Solid Waste of Katchi Abadi of Labor Colony is directly into Nullah
184	325135	3734235	Bari Imam	Sewer	Disposal of Solid Waste into Nullah at this point	Labor Colony (Bari Imam)	Disposal of Solid Waste and sewage is directly into Nullah. This Nullah finally disposed into Main Nullah coming from Bari Imam.
185	325136	3734238	Bari Imam	Solid Waste	Disposal of Solid Waste is directly into Nullah at this point	Labor Colony Bari Imam	Disposal Solid Waste by adjacent residential area is directly into Nullah
186	325214	3734095	Bari Imam	Solid Waste	Disposal of Solid Waste into Nullah.	Labor Colony Bari Imam	Disposal of solid waste of adjacent area is directly into Nullah.
187	333527	3734864	Phulgiran	Sewer	9'' Dia sewer line is directly disposing in to Nullah	Phulgiran	Direct disposal into nullah.
188	333967	3734943	Phulgiran	Natural Drainage	Point taken to identify the Nullah route	Phulgiran	For identification of nullah route.
189	333081	3734569	Phulgiran	Solid Waste	Disposal of Solid Waste	Near Poultry farm Phulgiran	Disposal of solid waste into nullah.
190	332865	3734280	Prince Road	Solid Waste	Disposal of Solid Waste	Intersection point of two Nullahs, Spring valley Nullah and coming from Phulgiran	Disposal of solid waste into nullah.
191	332653	3734146	Phulgiran	Sewer	24'' Dia sewer line is directly disposing into Nullah coming from spring valley	Phulgiran (Spring Valley)	Disposing of sewage water of adjacent house is directly into Nullah
192	332798	3734066	Spring Valley	Sewer	Sewer line directly disposing into Nullah	Spring Valley	Direct disposal of sewer line into nullah.

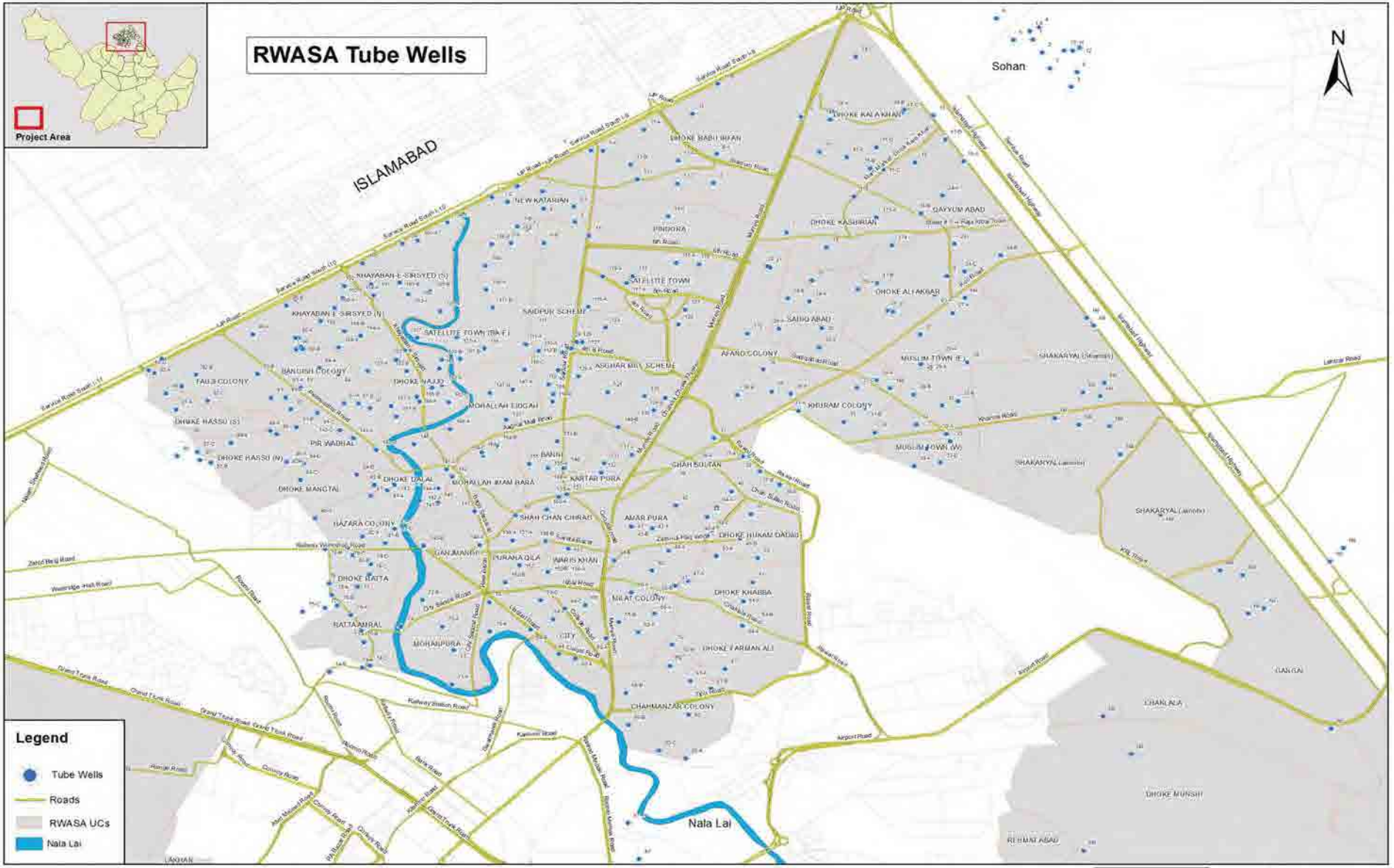
S.No	Easting	Northing	Area	Sample Type	Point Significance	Identification Mark	General Remarks
193	332923	3734015	Spring Valley	Solid Waste	Disposal of Solid Waste directly into Nullah	Spring Valley	Disposal of solid waste into nullah.
194	333159	3733976	Spring Valley	Sewer	Sewer line directly disposing into Nullah	Spring Valley. Junction point of Nullahs	Direct disposal of sewer line into nullah.
195	332521	3733991	Phulgiran	Sewer	Disposal of Solid Waster and sewage Water directly into Nullah	Phulgiran	Disposal of solid waste into nullah.
196	332500	3733809	Miran Town	Sewer	Sewer line directly disposing into Nullah	Intersection point of Miran Town,Sanjialian Nullah	9'' Dia of sewer line disposing into Nullah
197	332351	3733784	Prince Road	Sewer	House sewer is directly disposing into Nullah	Sanjialian (Prince Road)	Direct disposal into nullah of a house sewer.
198	332586	3733684	Miran Town	Sewer	House sewer is directly disposing into Nullah	Miran Town (Sanjialian)	Disposal of adjacent area is directly into Nullah
199	332862	3733425	Mohra Town	Sewer	Disposal of house sewer is directly into Nullah.	Miran Town (Sanjialian).No sewer scheme in newly developing society	Near to start point of Nullah of Mohra Town, Sanjiali
200	332069	3733691	Prince Road	Sewer	Direct disposal into Nullah	Prince road	Direct disposal of sewer line into nullah.
201	331743	3733520	Sanjiali	Natural Drainage	Point taken to identify the Nullah route	Opposite to Poultry farms	For identification of nullah route.

Annexure G: Rawal Lake Upstream Sewerage Entry Points


Legend
Sewer Points
Rawal Lake
Sub-Watersheds
Streams / Nullah
BARI IMAM NULLAH
QUAID-E-AZAM UNIVERSITY NULLAH
SHAHDRA RIVER
KURANG RIVER
KURANG RIVER
RAWAL LAKE
0 0.375 0.75 1.5 2.25 3 3.75
Kilometers

Annexure H: GIS Mapping of RWASA Assets

1. **Tube Wells**
2. **Over Head Reservoir's**
3. **Filtration Plants**
4. **Water Supply Network**



CLIENT: WATER AND SANITATION AGENCY (WASA) RAWALPINDI DEVELOPMENT AUTHORITY (RDA)	PROJECT: Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi	Map Code:3040120015	Disclaimer: Sources of information presented in this map is Based on data provided by WASA, RDA and other Sources.	Scale 0 1 Kilometers	Date Created
		Map version 02			12 June 2015

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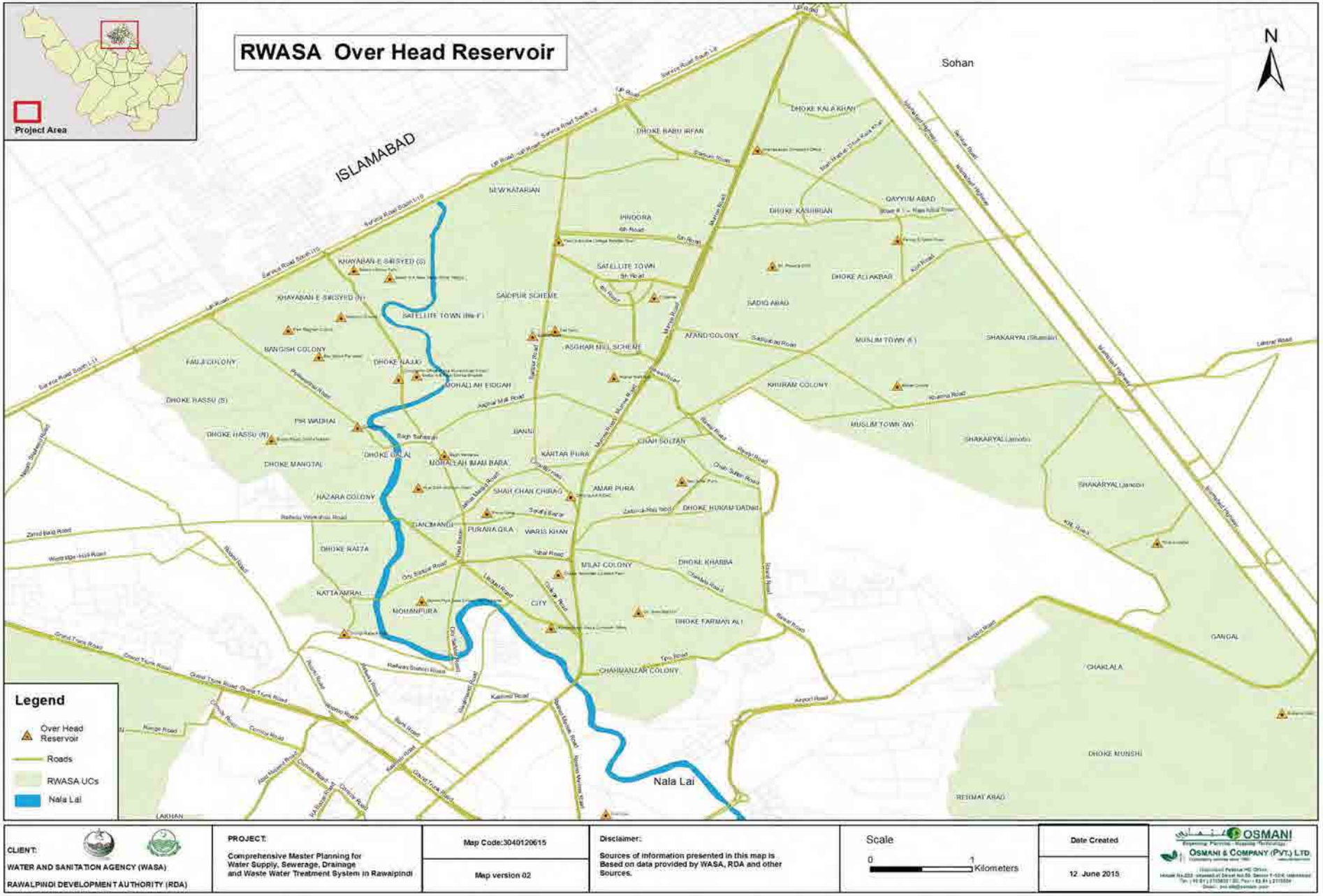
RWASA Over Head Reservoir
Project Area
N
Sohan
ISLAMABAD
Legend
Over Head Reservoir
Roads
RWASA UCs
Nala Lai
Nala Lai
CLIENT:
WATER AND SANITATION AGENCY (WASA)
RAWALPINDI DEVELOPMENT AUTHORITY (RDA)
PROJECT:
Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi
Map Code:3040120615
Map version 02
Disclaimer:
Sources of information presented in this map is Based on data provided by WASA, RDA and other Sources.
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Kilometers
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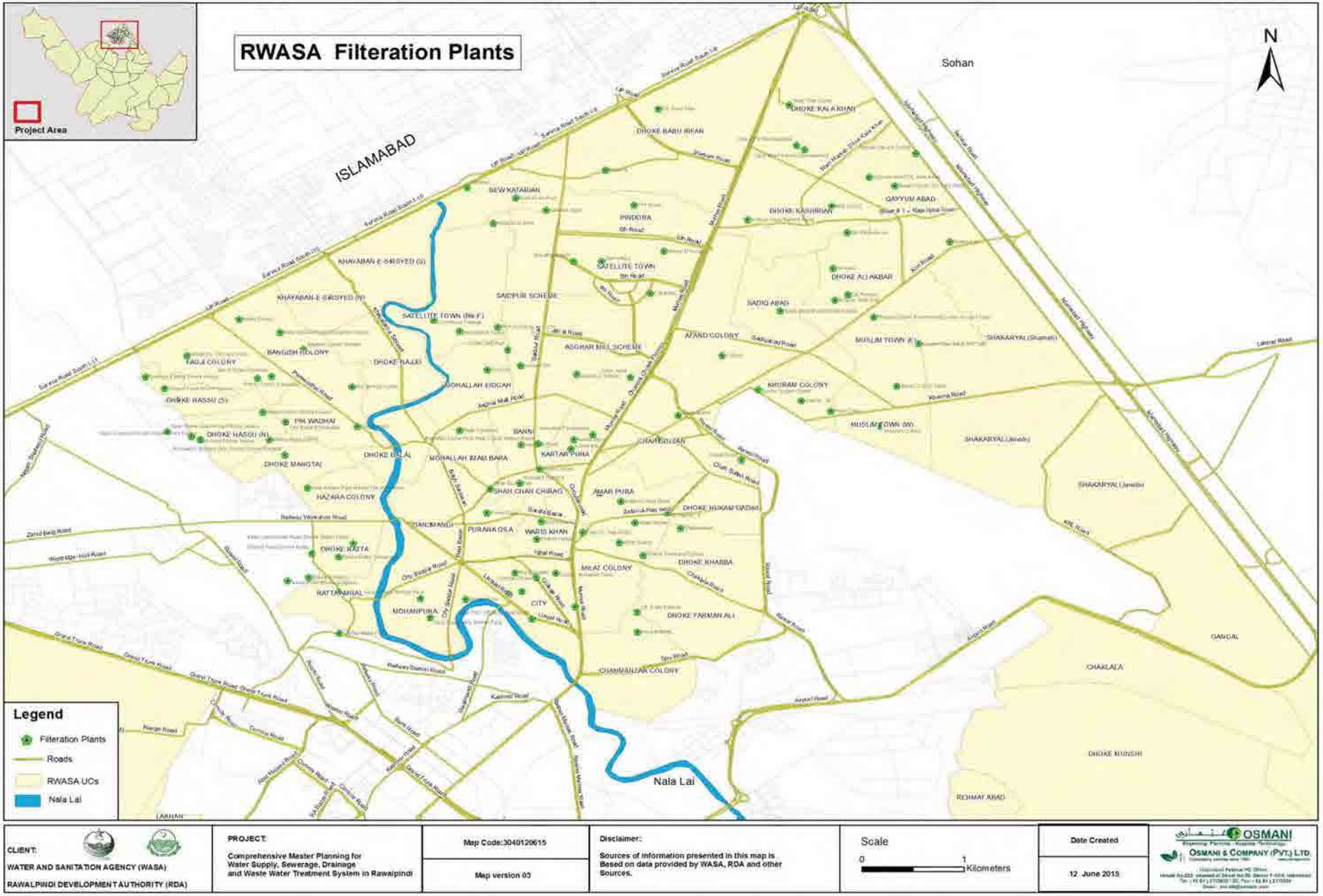
RWASA Filteration Plants
Project Area
N
ISLAMABAD
Sohan
Legend
Filteration Plants
Roads
RWASA UCs
Nala Lai
Nala Lai
CLIENT:
WATER AND SANITATION AGENCY (WASA)
RAWALPINDI DEVELOPMENT AUTHORITY (RDA)
PROJECT:
Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi
Map Code:3040120615
Map version 03
Disclaimer:
Sources of information presented in this map is Based on data provided by WASA, RDA and other Sources.
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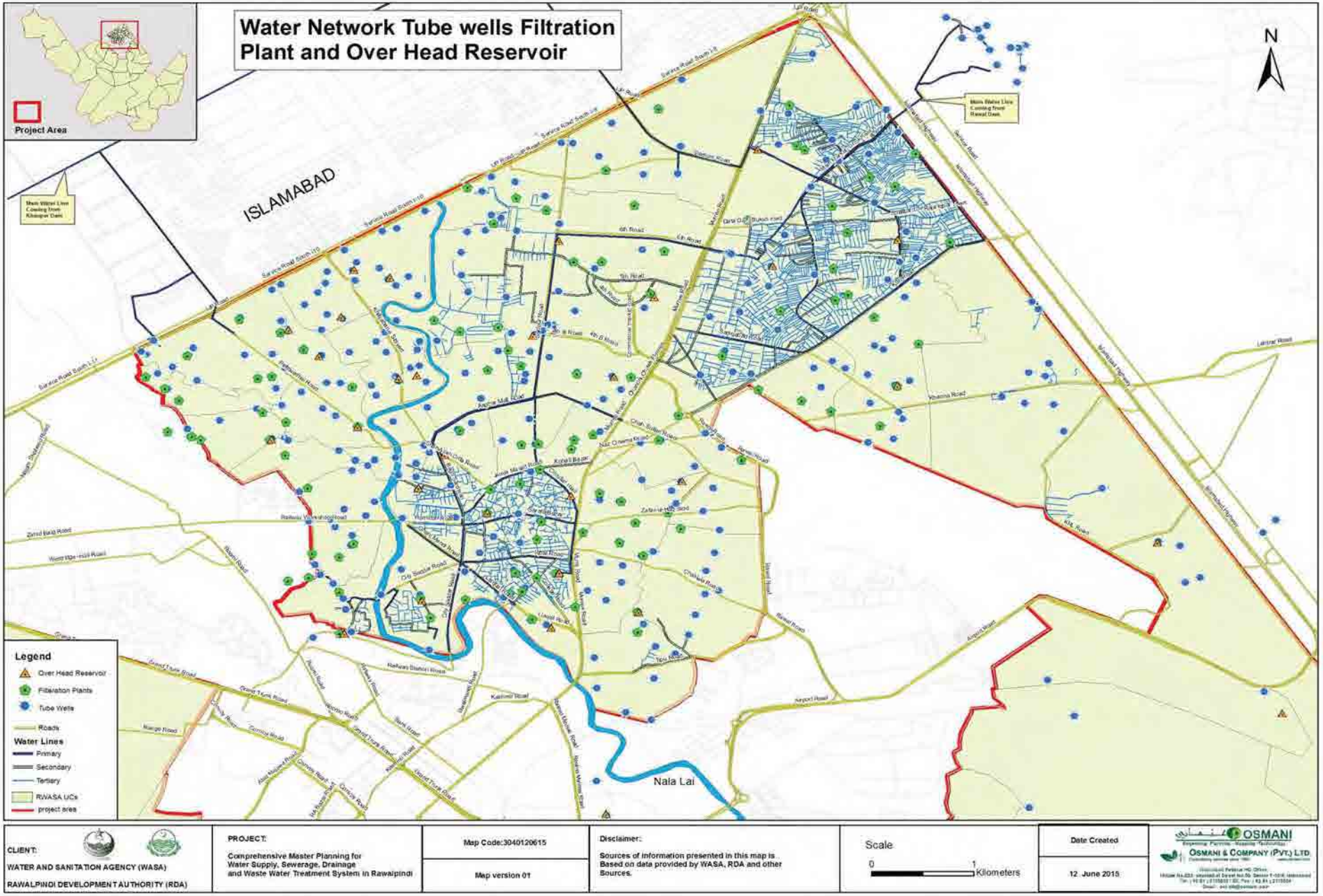
Water Network Tube wells Filtration Plant and Over Head Reservoir
Project Area
ISLAMABAD
N
Nala Lai
Legend
Over Head Reservoir
Filtration Plants
Tube Wells
Roads
Water Lines
Primary
Secondary
Tertiary
RWASA UCs
project area
CLIENT:
WATER AND SANITATION AGENCY (WASA)
RAWALPINDI DEVELOPMENT AUTHORITY (RDA)
PROJECT:
Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi
Map Code:3040120615
Map version 01
Disclaimer:
Sources of information presented in this map is Based on data provided by WASA, RDA and other Sources.
Scale
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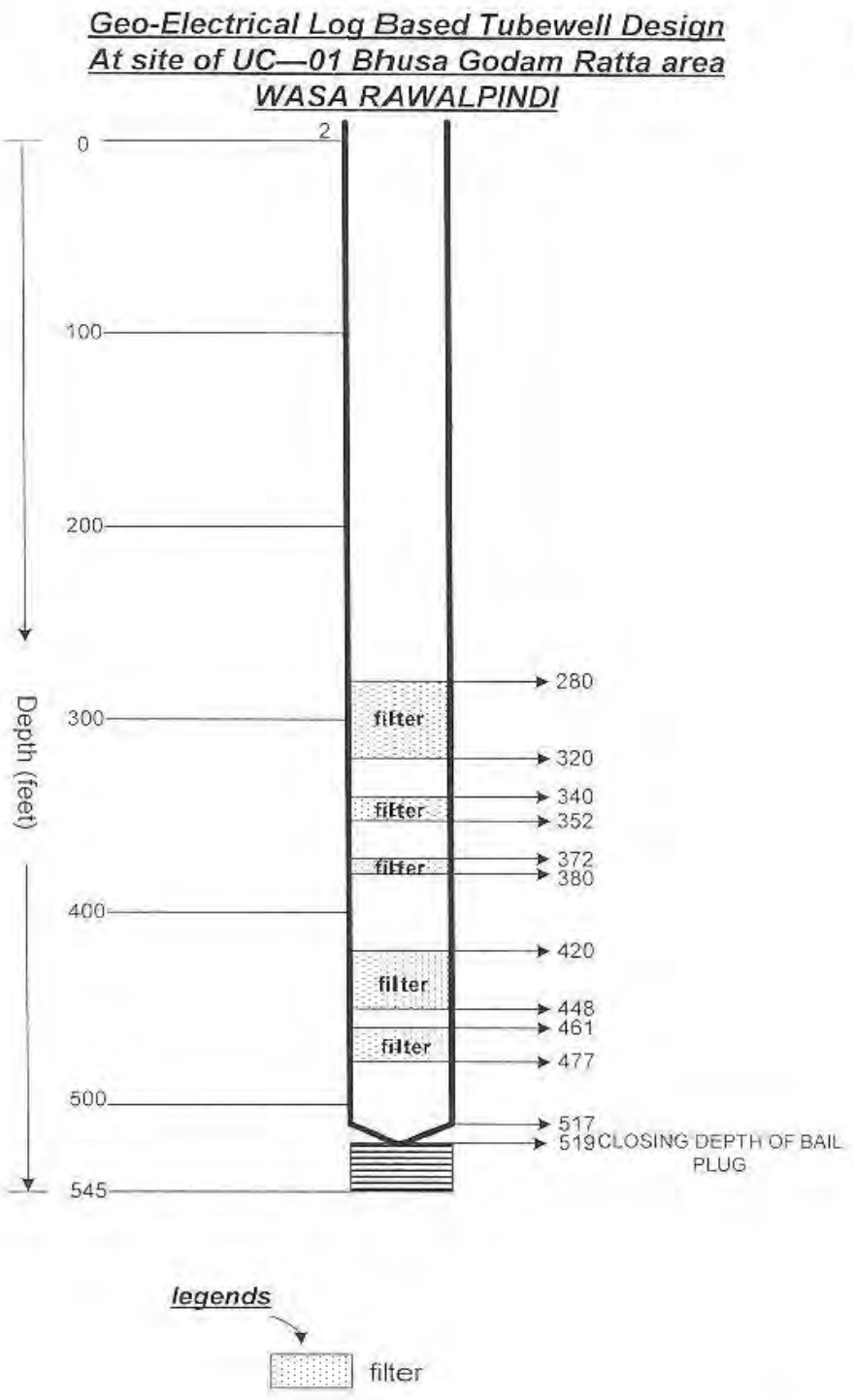
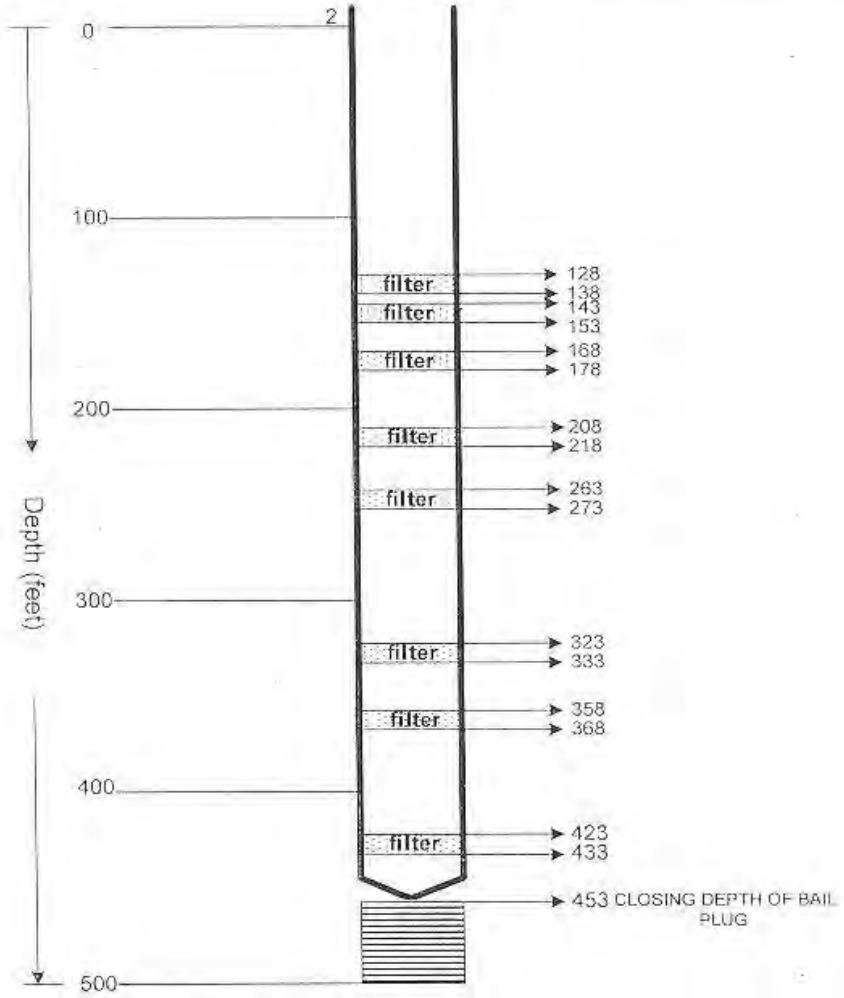
Date Created
12 June 2015
OSMANI
OSMANI & COMPANY (PVT.) LTD.

Annexure I: Bore logs and Wells Detials from Zahid et., al.


Geo-Electrical Log Based Tubewell Design
At site of UC—01 Bhusa Godam Ratta area
WASA RAWALPINDI
2
0
100
200
300
400
500
545
Depth (feet)
filter
filter
filter
filter
filter
280
320
340
352
372
380
420
448
461
477
517
519
CLOSING DEPTH OF BAIL PLUG
legends
filter

GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN WASA RWP WATER SUPPLY WELL FOR UC--22 AREA RAWALPINDI

AB



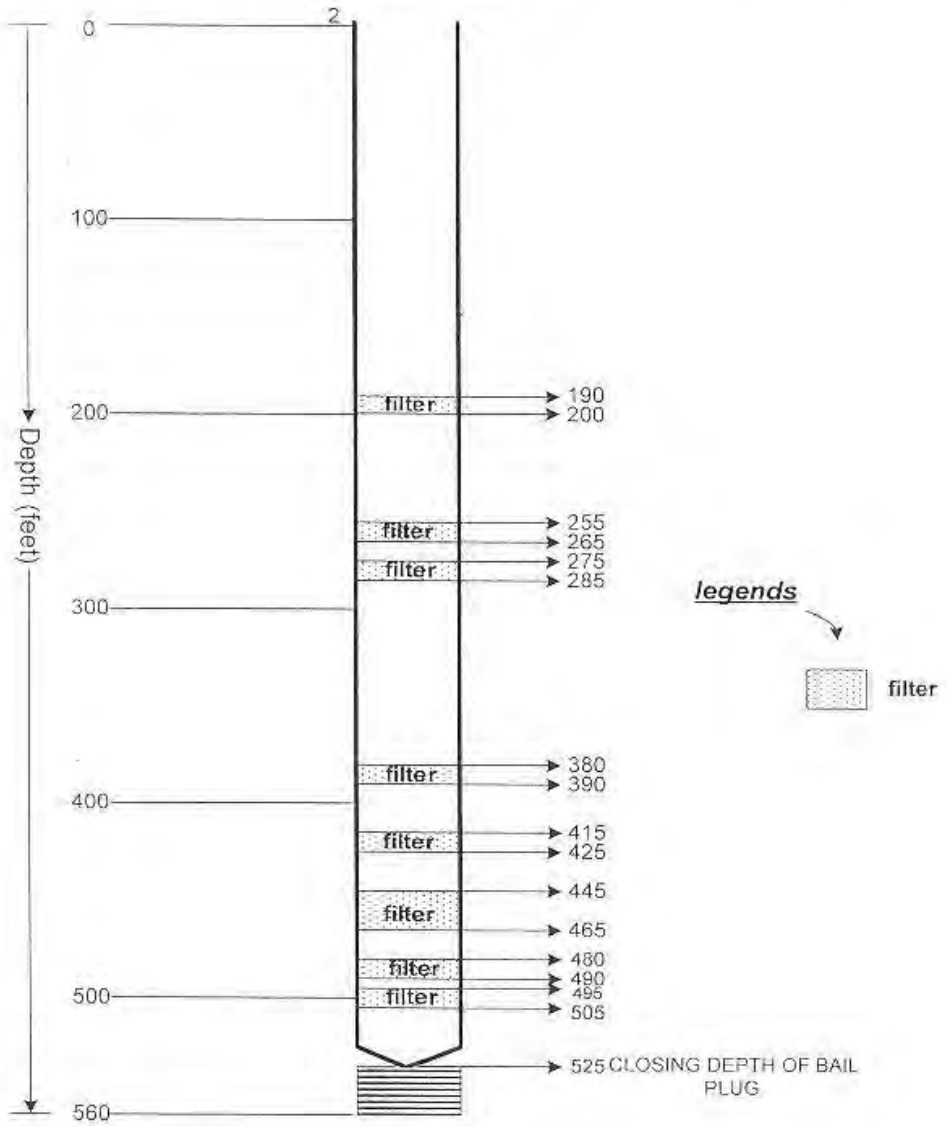
legends

FILTER

INTERPRETED LITHLOGICAL COLUMN

Ac

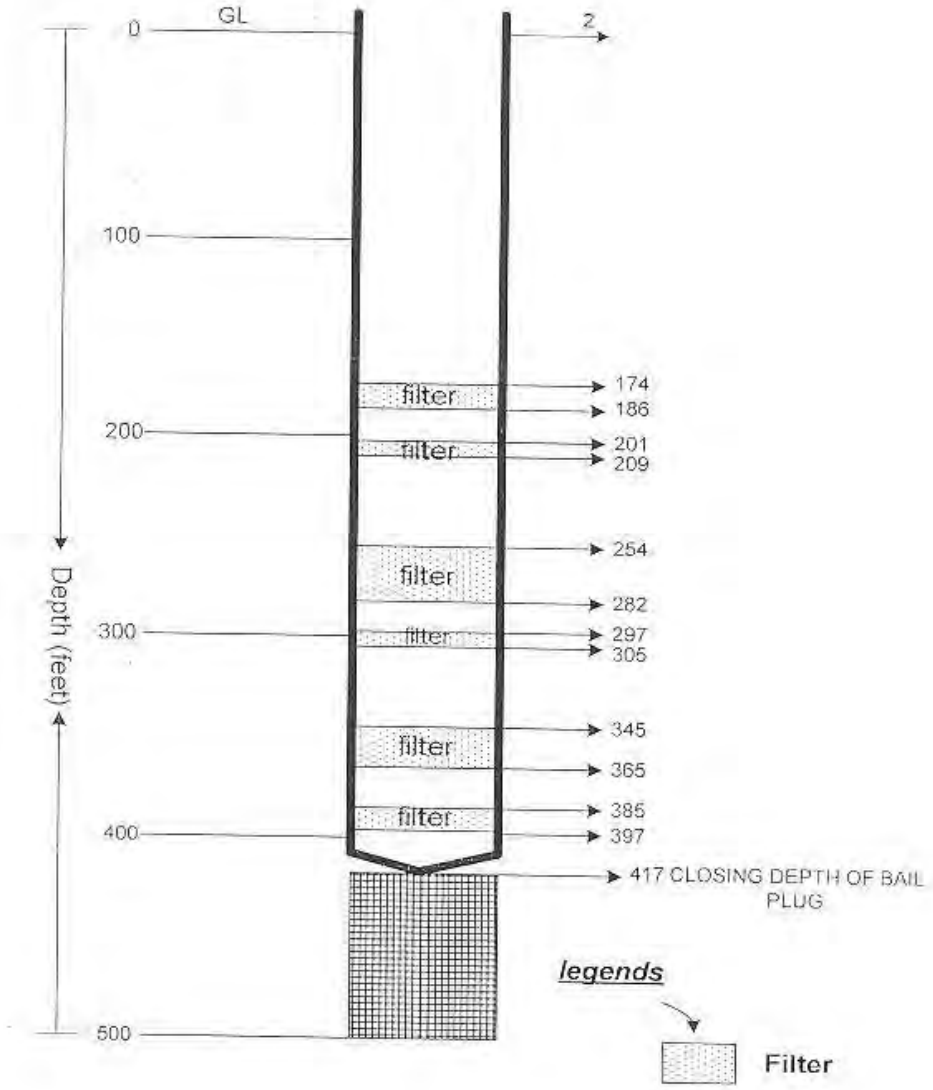
of water well at site of WASA in Magistrate Colony area
RAWALPINDI



AD

GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN

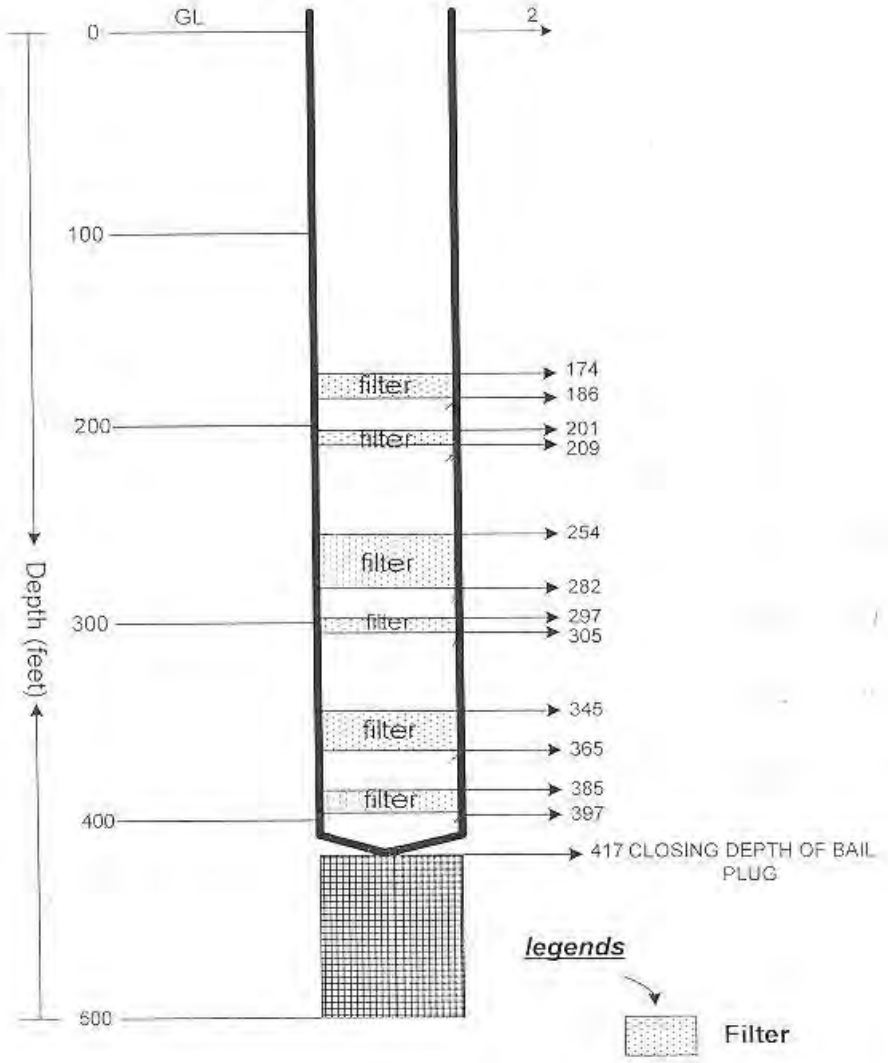
WASA, Rwp Water Supply Scheme Khuram Colony area Rawalpindi

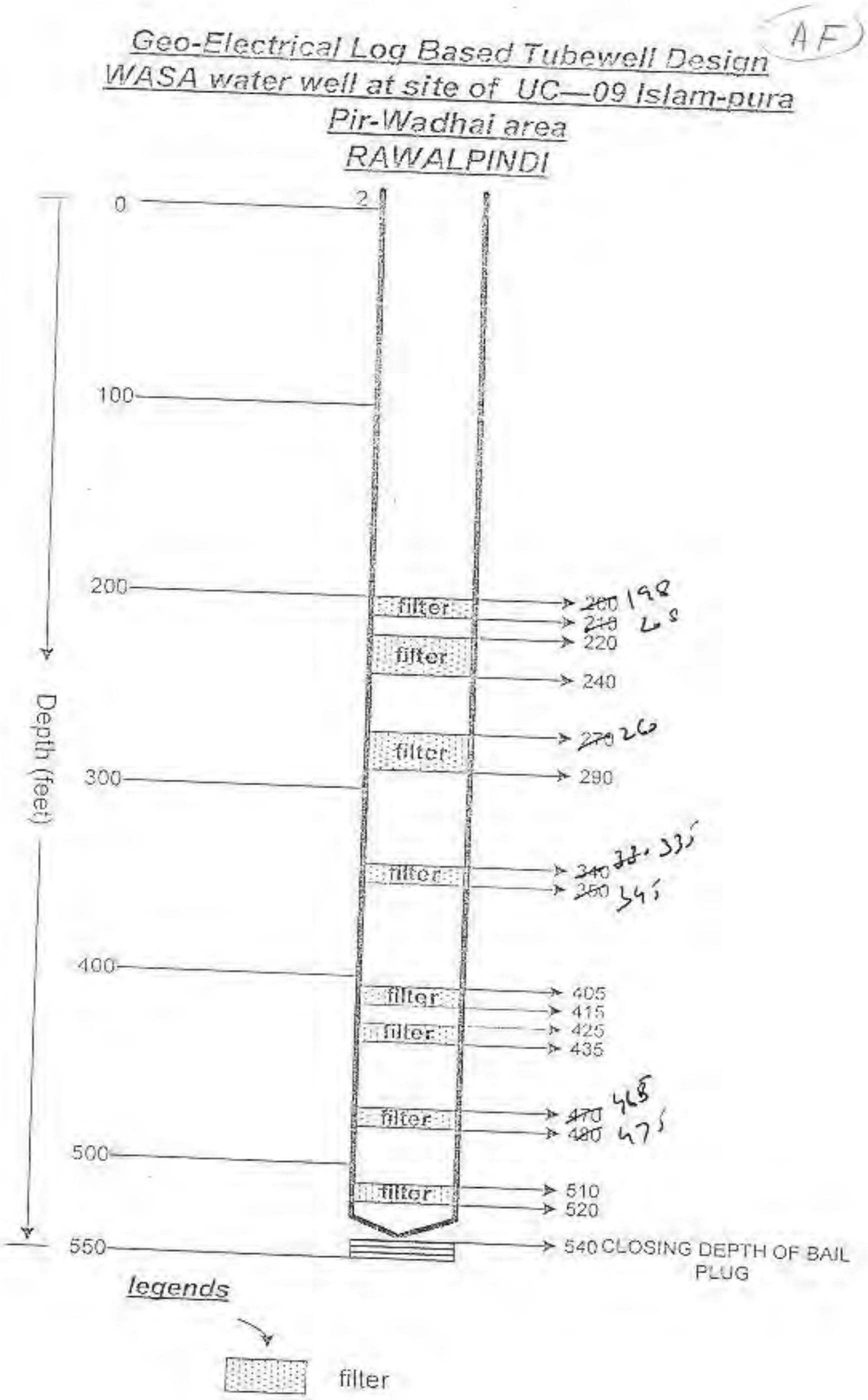


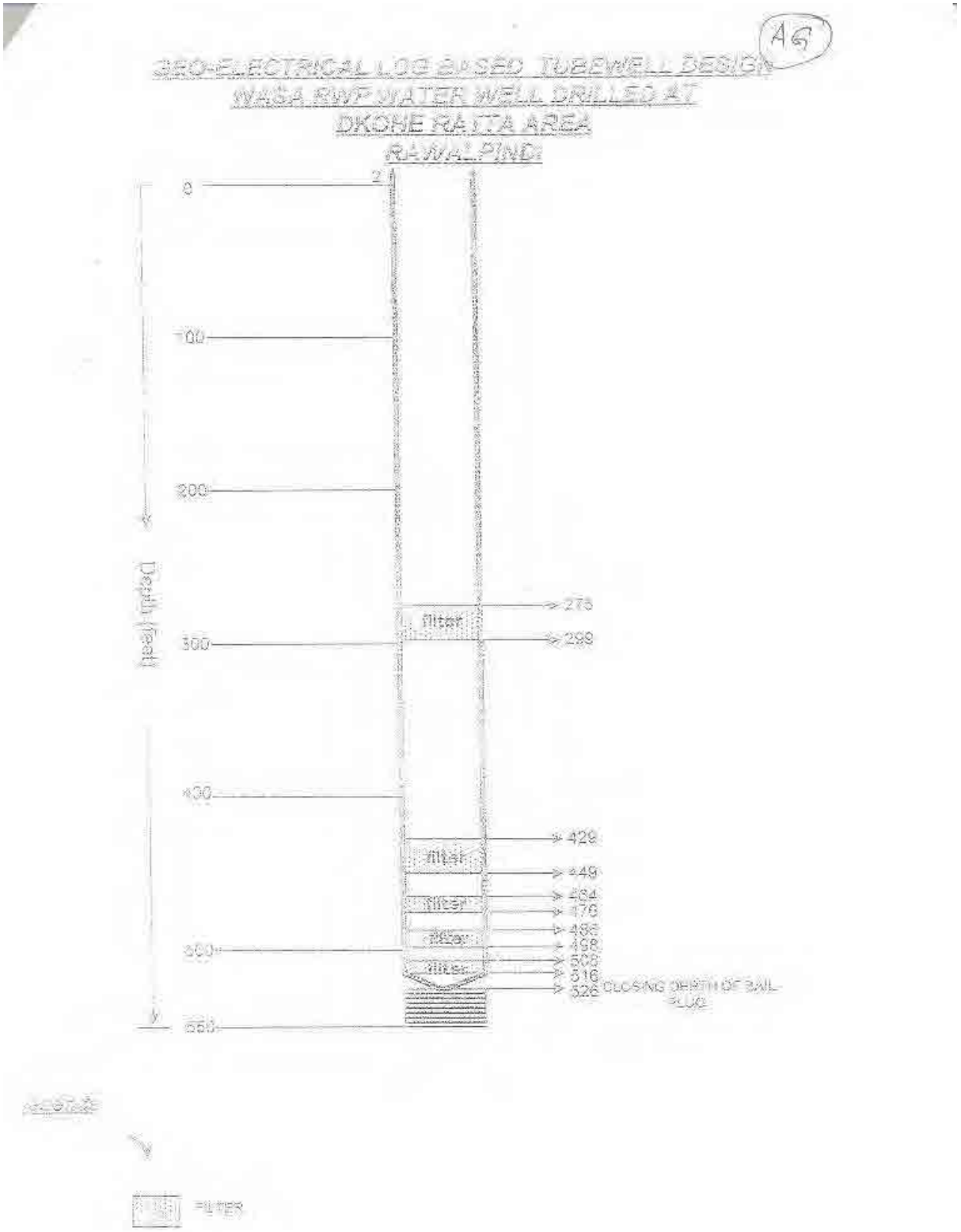
AE

GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN

WASA, Rwp Water Supply Scheme Khuram Colony area Rawalpindi



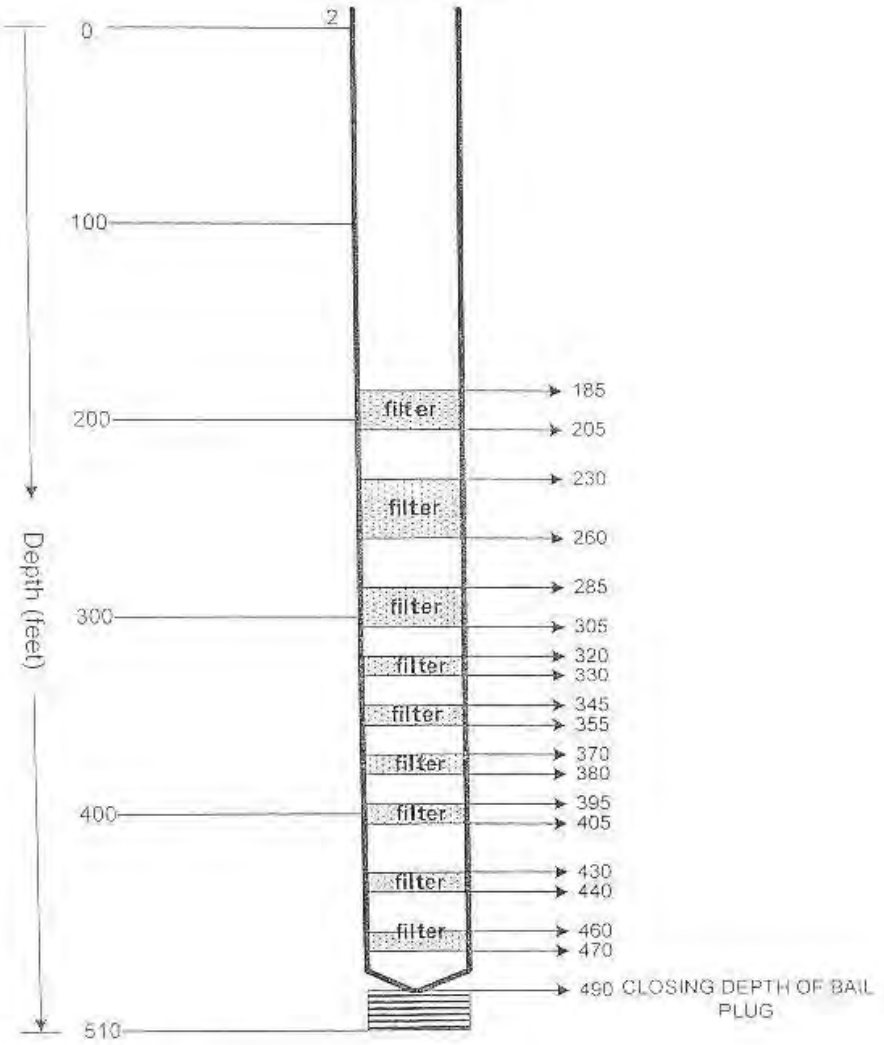

Geo-Electrical Log Based Tubewell Design
WASA water well at site of UC—09 Islam-pura
Pir-Wadhai area
RAWALPINDI
0
100
200
300
400
500
550
Depth (feet)
filter
200 198
210 208
220
240
270 260
290
340 335
350 345
405
415
425
435
470 468
480 475
510
520
540 CLOSING DEPTH OF BAIL PLUG
legends
filter


AG
GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN
WASA RWP WATER WELL DRILLED AT
DKOHE RATTA AREA
RAWALPINDI
0
100
200
300
400
500
550
Depth (feet)
filter
275
299
429
449
464
476
486
498
508
516
526
CLOSING DEPTH OF BAIL PLUG
FILTER

Geo-Electrical Log Based Tubewell Design
WASA water well at site of UC—10 Khayaban-e-Sir syed

AH

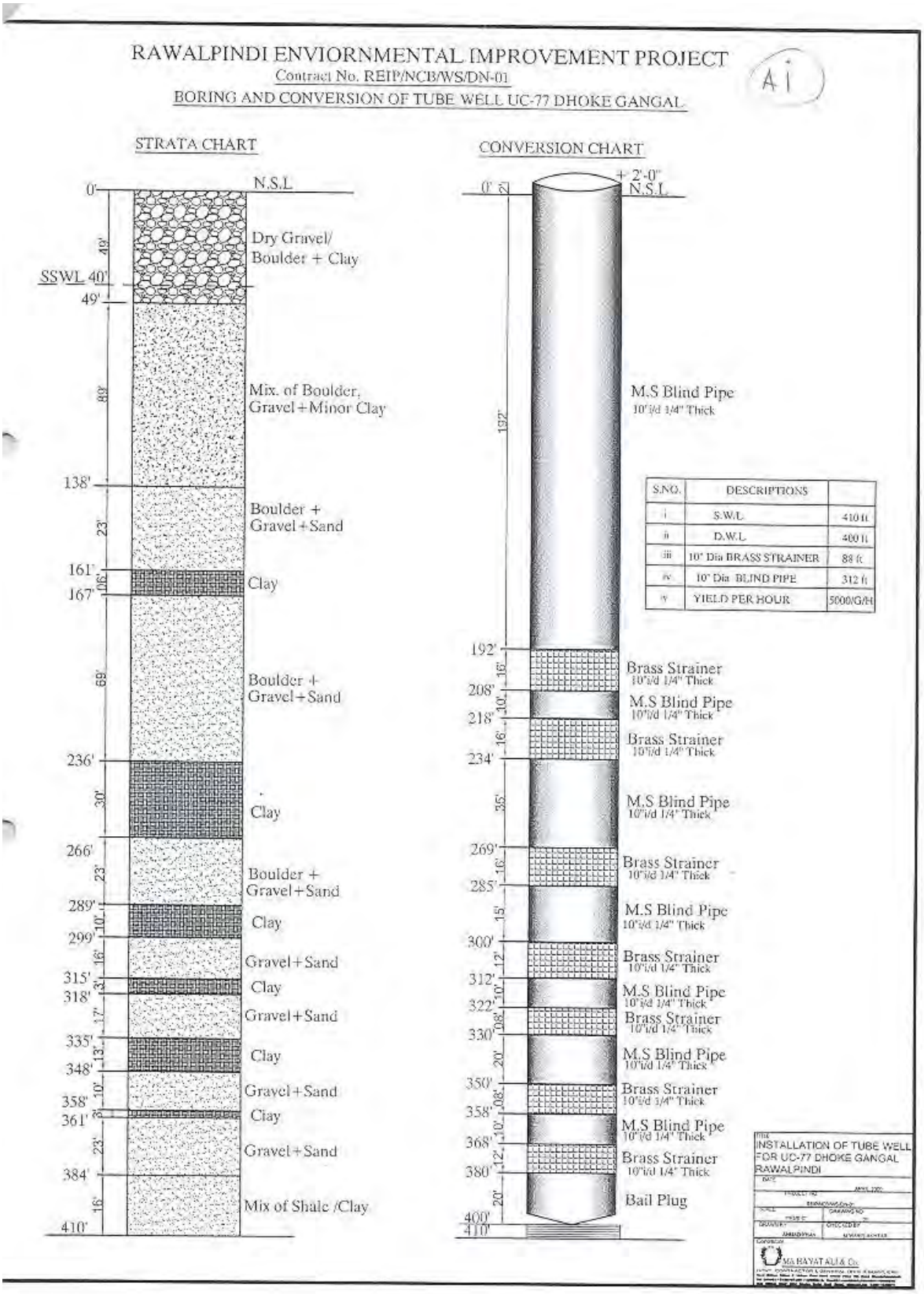
RAWALPINDI



legends

filter

ASSISTANT DIRECTOR
Water Supply
WASA Rawalpindi



S.NO.	DESCRIPTIONS	
i	S.W.L	410 ft
ii	D.W.L	400 ft
iii	10" Dia BRASS STRAINER	88 ft
iv	10" Dia BLIND PIPE	312 ft
v	YIELD PER HOUR	5000/G/H

عثمانی OSMANI
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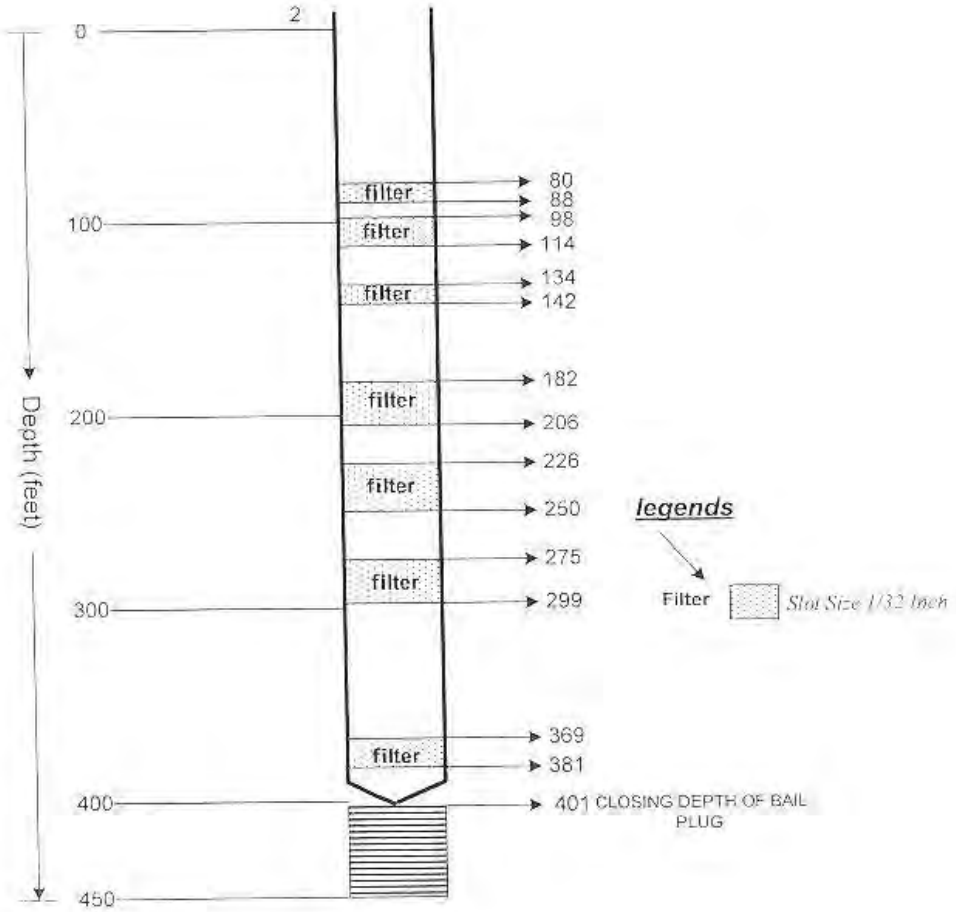
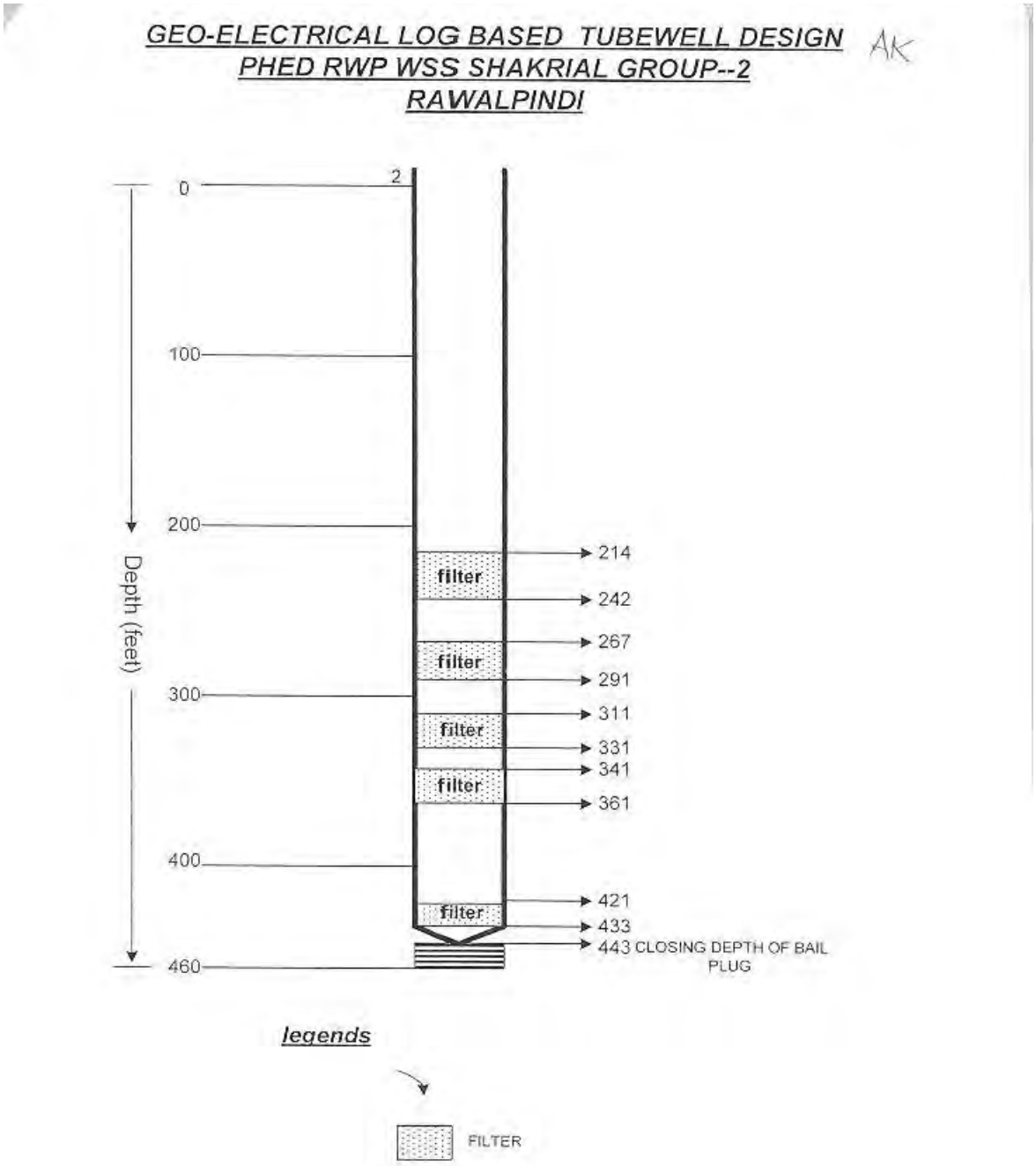
Aj

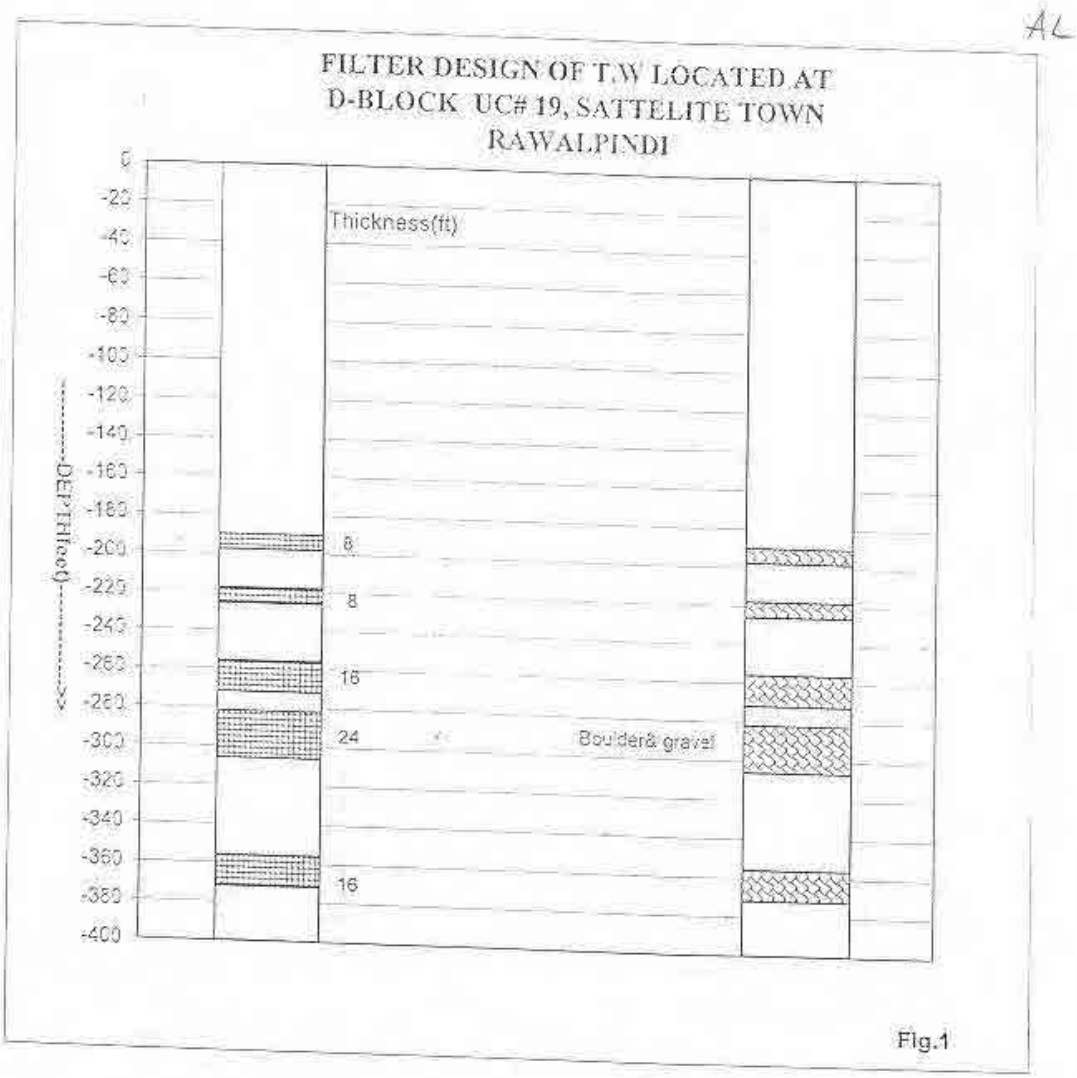
GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN

Water Well Drilled For WSS BILAL TOWN KHANA DAK Area ISLAMABAD



OSMANI
Engineering - Architecture - Planning - Mapping - Technology


GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN
PHED RWP WSS SHAKRIAL GROUP--2
RAWALPINDI
AK
2
0
100
200
300
400
460
Depth (feet)
filter
filter
filter
filter
filter
214
242
267
291
311
331
341
361
421
433
443 CLOSING DEPTH OF BAIL PLUG
legends
FILTER


AL
FILTER DESIGN OF T.W LOCATED AT
D-BLOCK UC# 19, SATTELITE TOWN
RAWALPINDI
Thickness(ft)
DEPTH(ft)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
-320
-340
-360
-380
-400
8
8
16
24
16
Boulder& gravel
Fig.1

AM

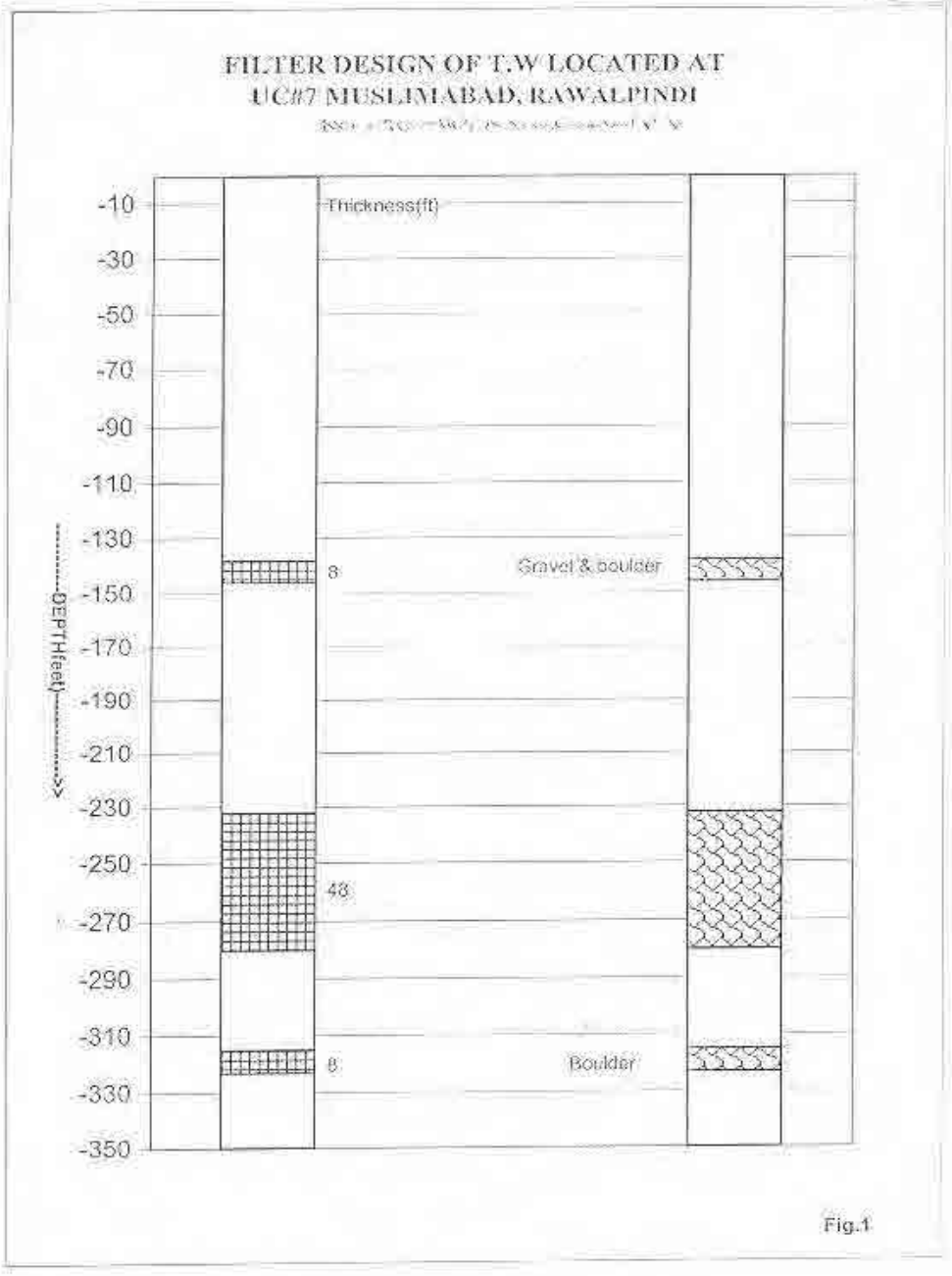

FILTER DESIGN OF T.W LOCATED AT
UC#7 MUSLIMABAD, RAWALPINDI
Thickness(ft)
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
-310
-330
-350
DEPTH(feet)
8
Gravel & boulder
48
8
Boulder

Fig.1

AN-01

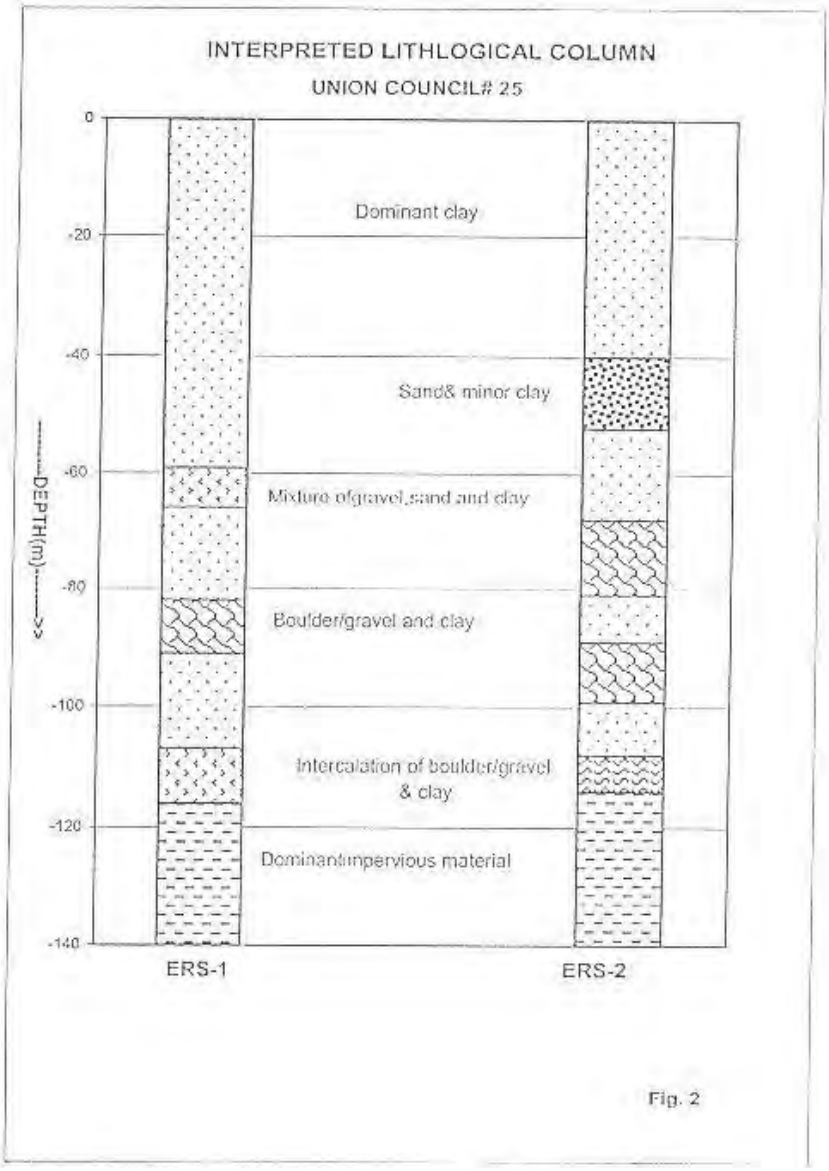

INTERPRETED LITHLOGICAL COLUMN
UNION COUNCIL# 25
0
-20
-40
-60
-80
-100
-120
-140
DEPTH(m)
Dominant clay
Sand& minor clay
Mixture of gravel,sand and clay
Boulder/gravel and clay
Intercalation of boulder/gravel & clay
Dominant impervious material
ERS-1
ERS-2

Fig. 2

AN-02

INTERPRETED LITHLOGICAL COLUMN

UNION COUNCIL# 21

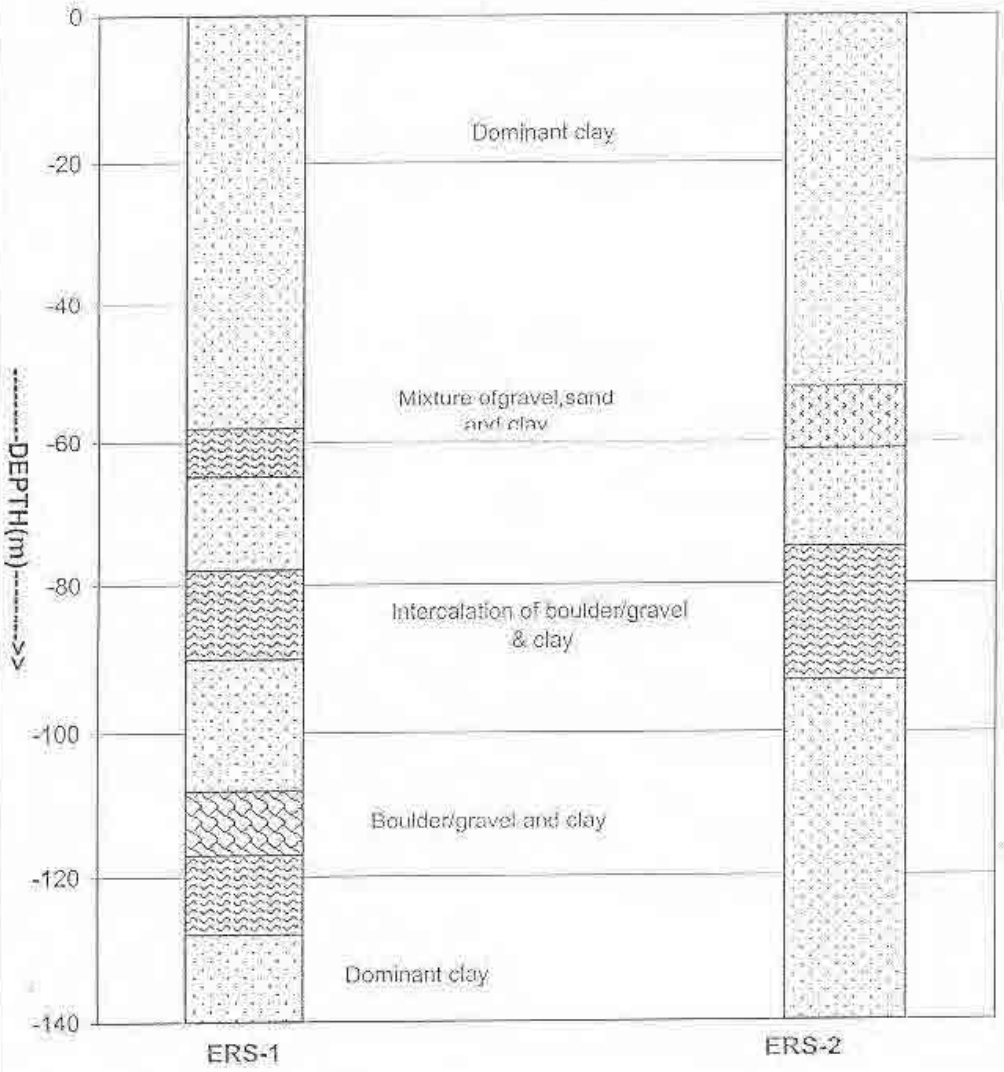


Fig. 3

AN-03

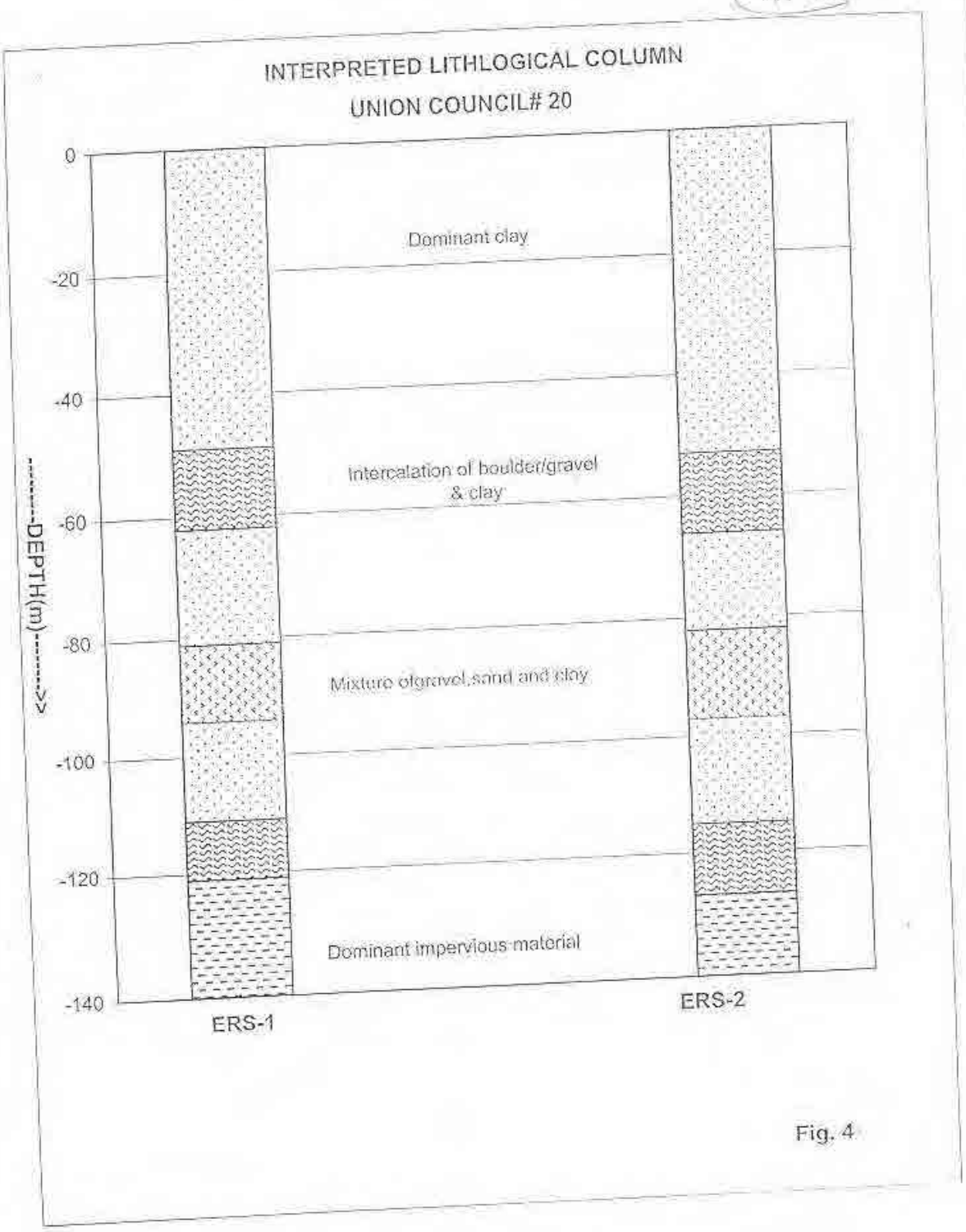

INTERPRETED LITHLOGICAL COLUMN
UNION COUNCIL# 20
0
-20
-40
-60
-80
-100
-120
-140
<<-----DEPTH(m)----->>
Dominant clay
Intercalation of boulder/gravel & clay
Mixture of gravel,sand and clay
Dominant impervious material
ERS-1
ERS-2

Fig. 4

AN-04

INTERPRETED LITHLOGICAL COLUMN
UNION COUNCIL# 15

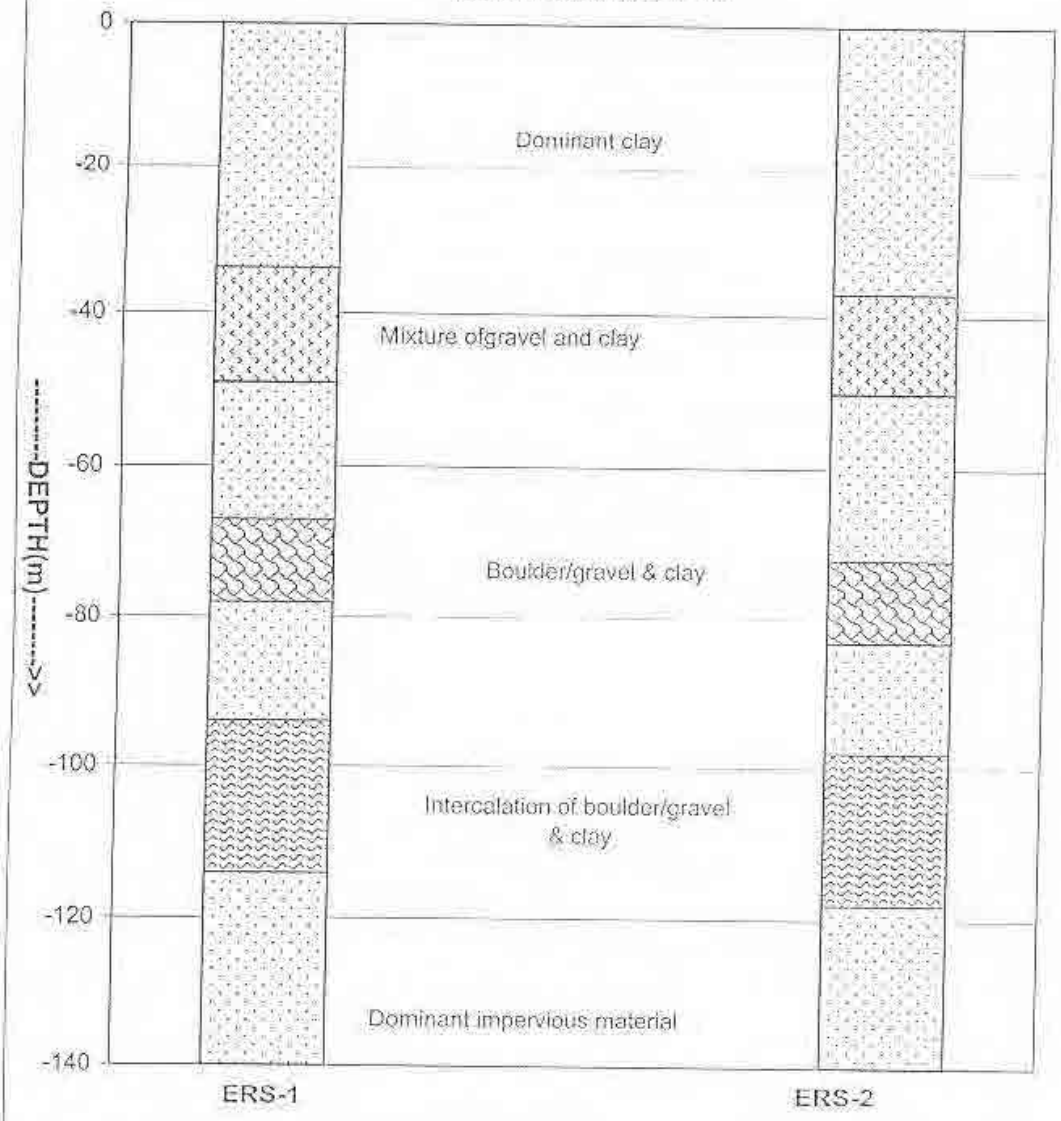


Fig. 5

AN-05

INTERPRETED LITHLOGICAL COLUMN
UNION COUNCIL# 35, EID GAH MOHALLAH

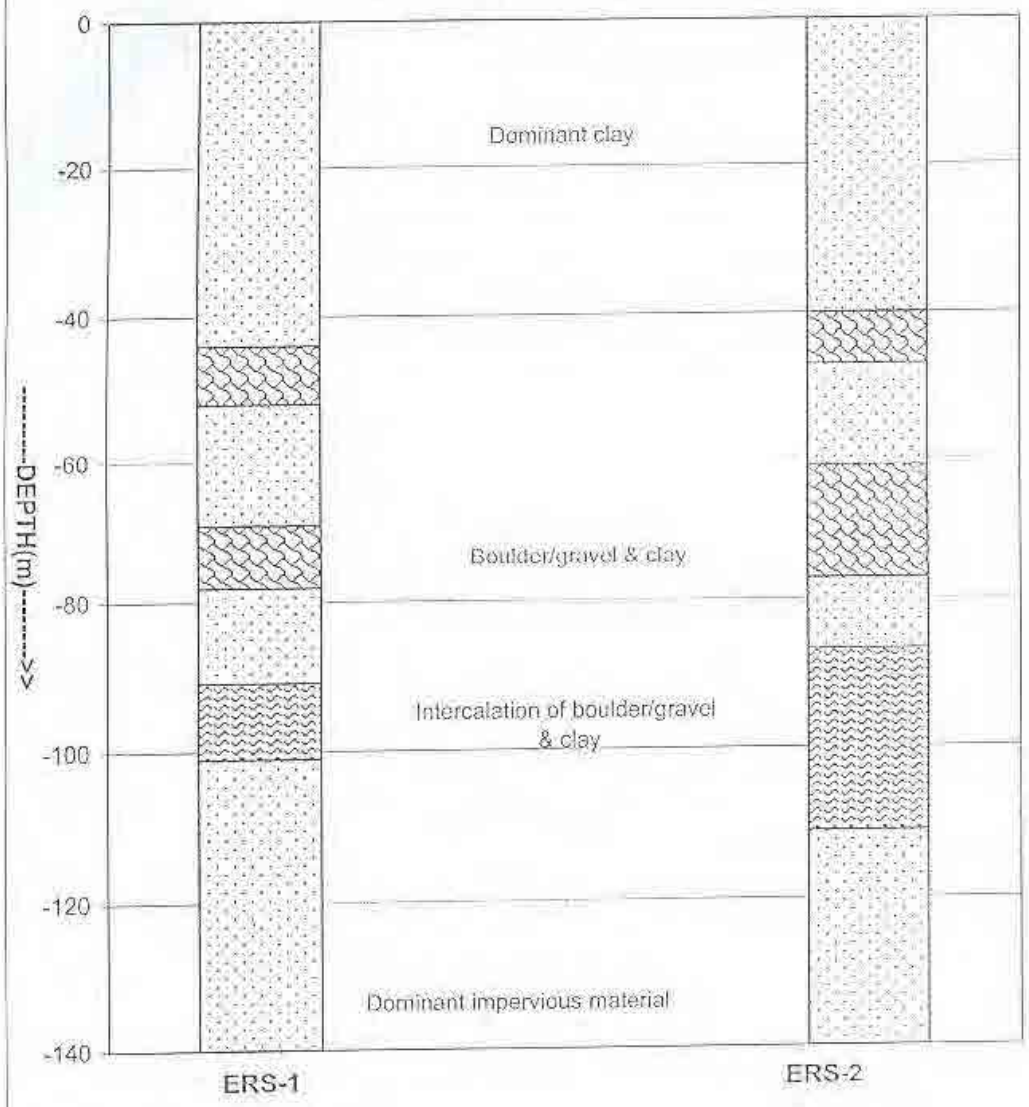


Fig. 6

AN-06

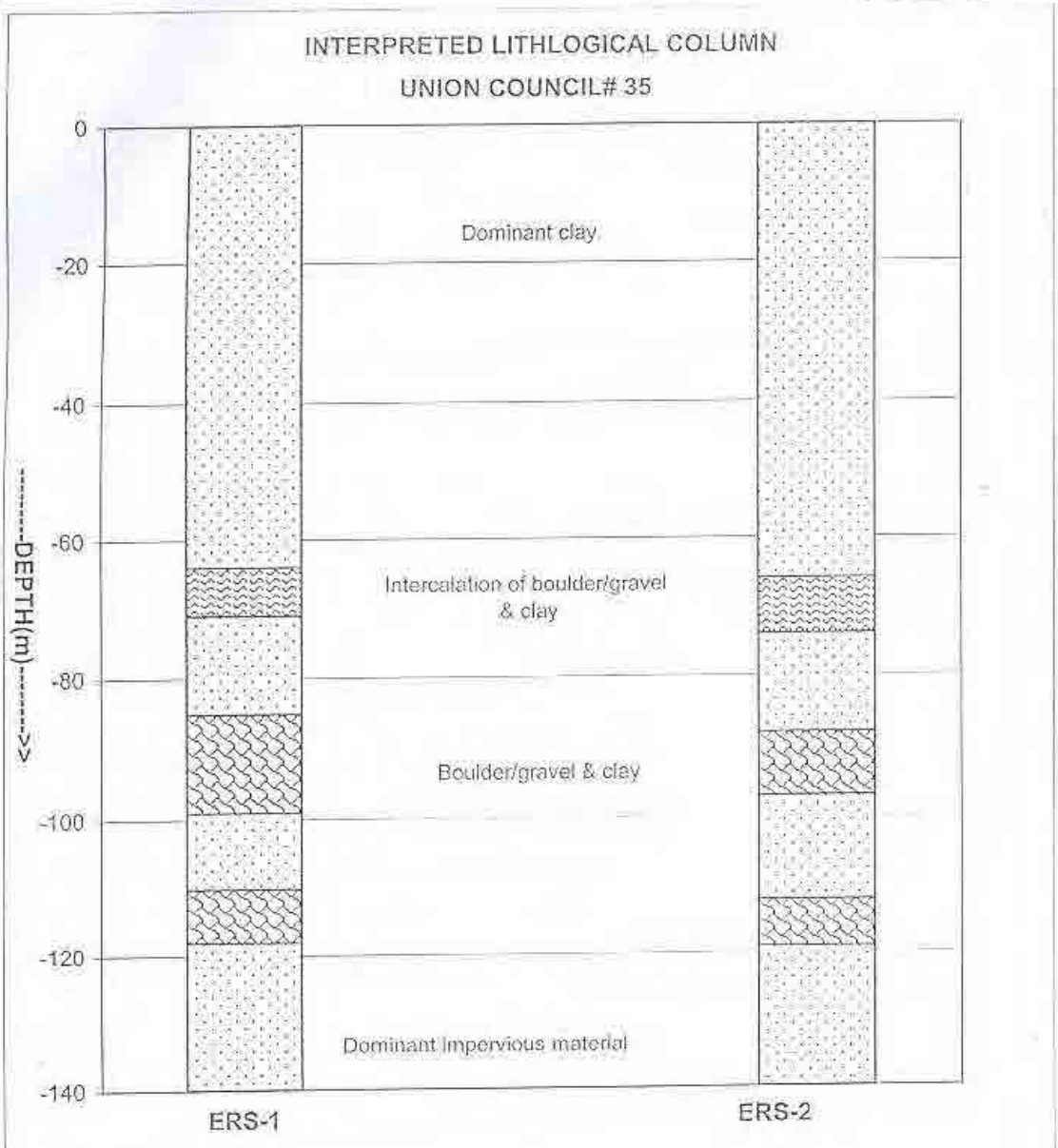


Fig. 7

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AN-07

INTERPRETED LITHLOGICAL COLUMN

UNION COUNCIL# 5

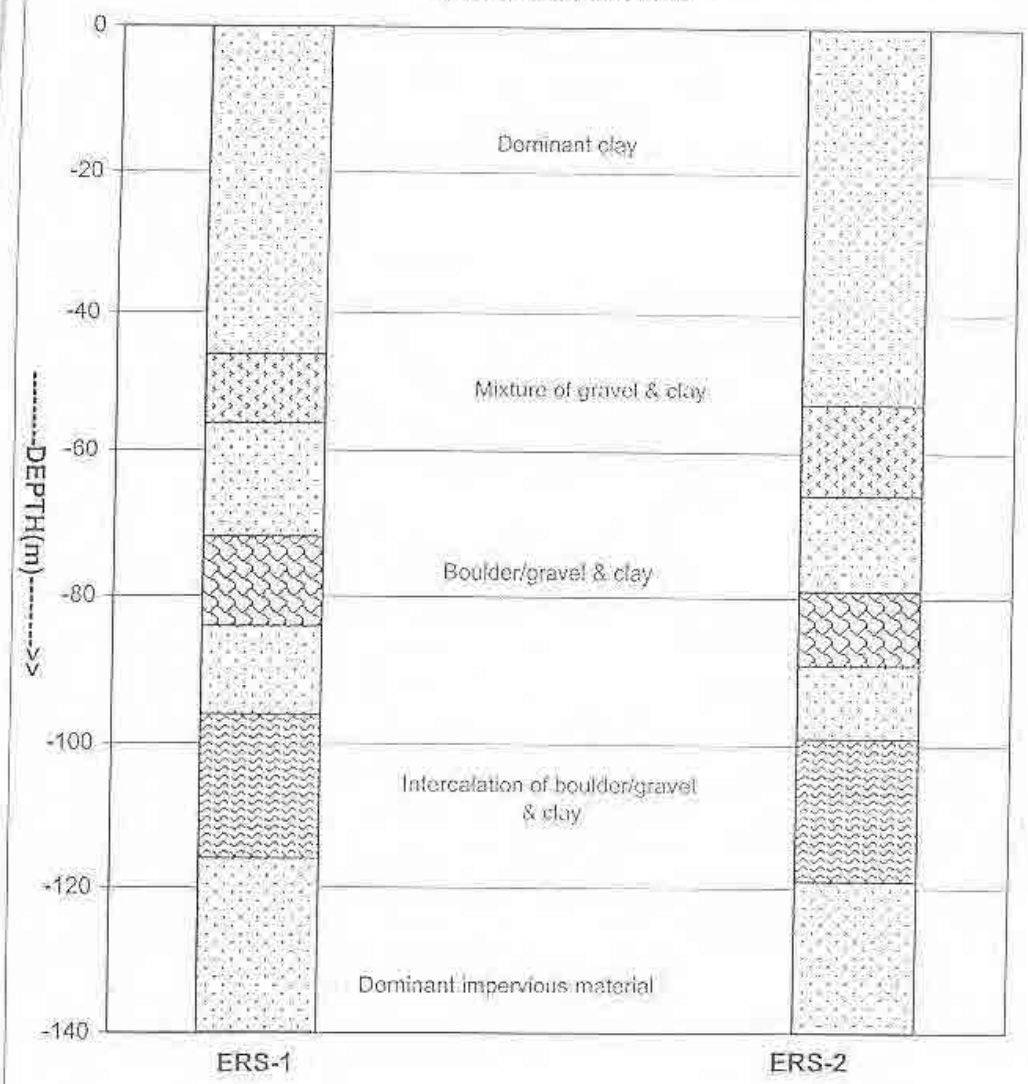


Fig. 8

AN-08

INTERPRETED LITHLOGICAL COLUMN

UNION COUNCIL# 8

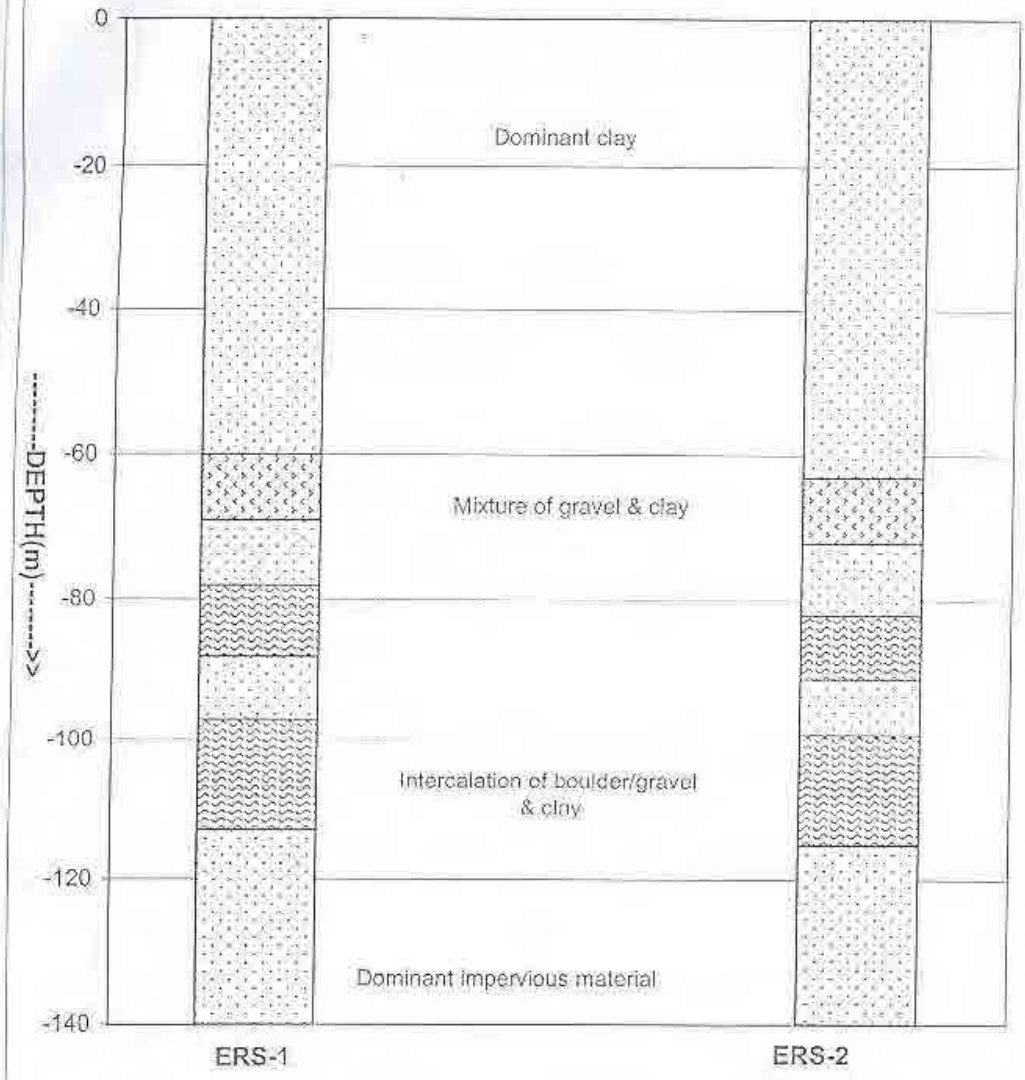


Fig. 9

AN-09

INTERPRETED LITHLOGICAL COLUMN
UNION COUNCIL# 7

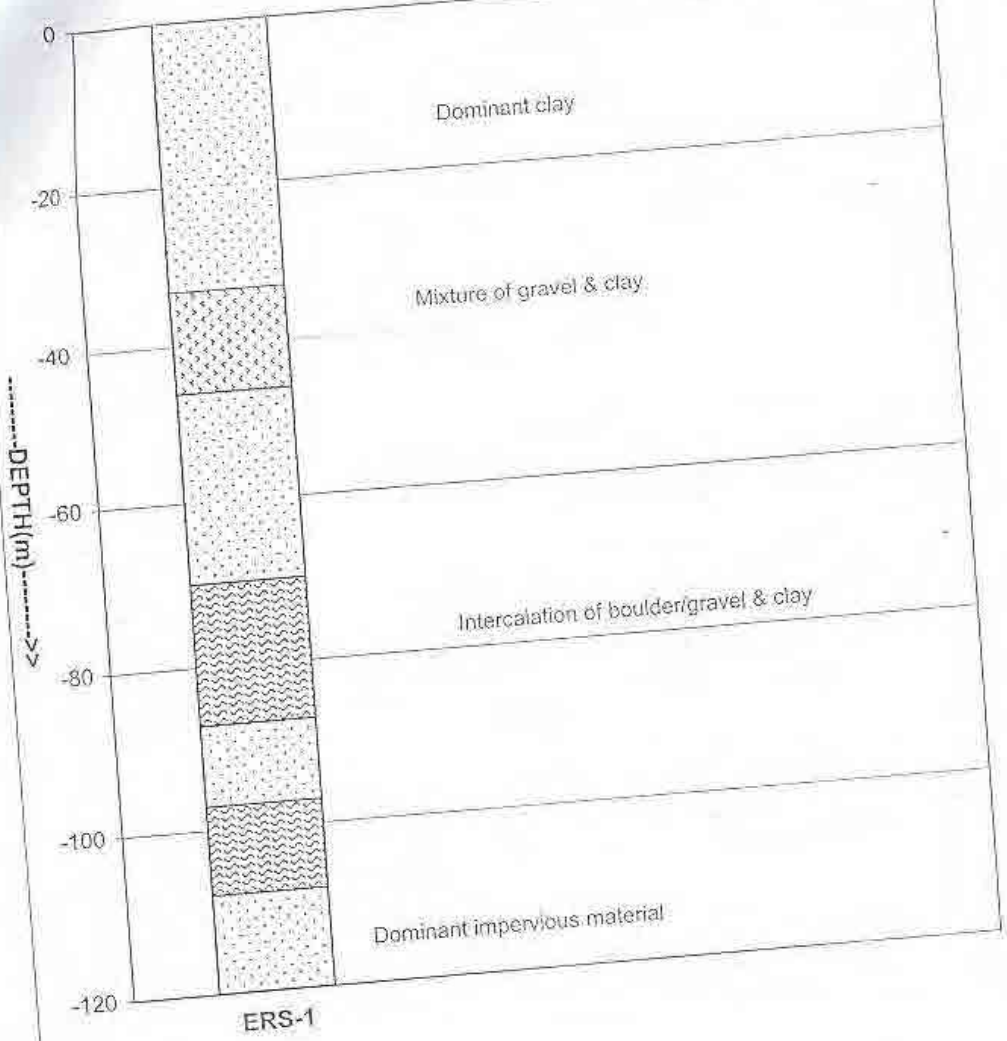
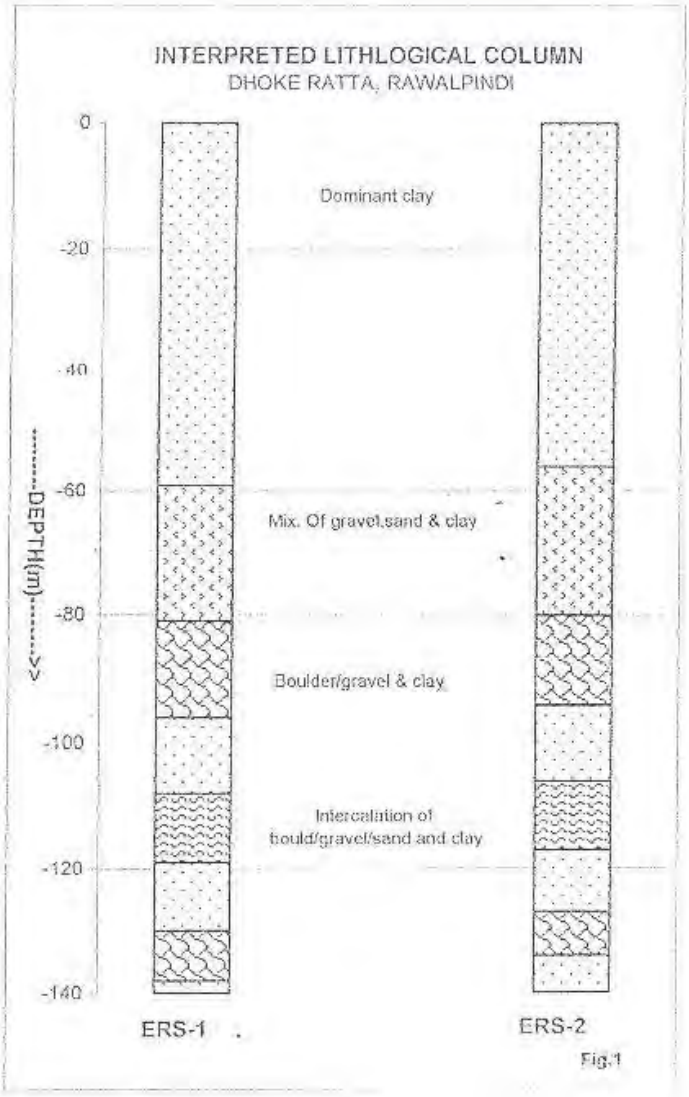


Fig. 10

A0


INTERPRETED LITHLOGICAL COLUMN
DHOKE RATTA, RAWALPINDI
0
-20
-40
-60
-80
-100
-120
-140
DEPTH(m)
Dominant clay
Mix. Of gravel,sand & clay
Boulder/gravel & clay
Intercalation of
bould/gravel/sand and clay
ERS-1
ERS-2
Fig.1

AP-01

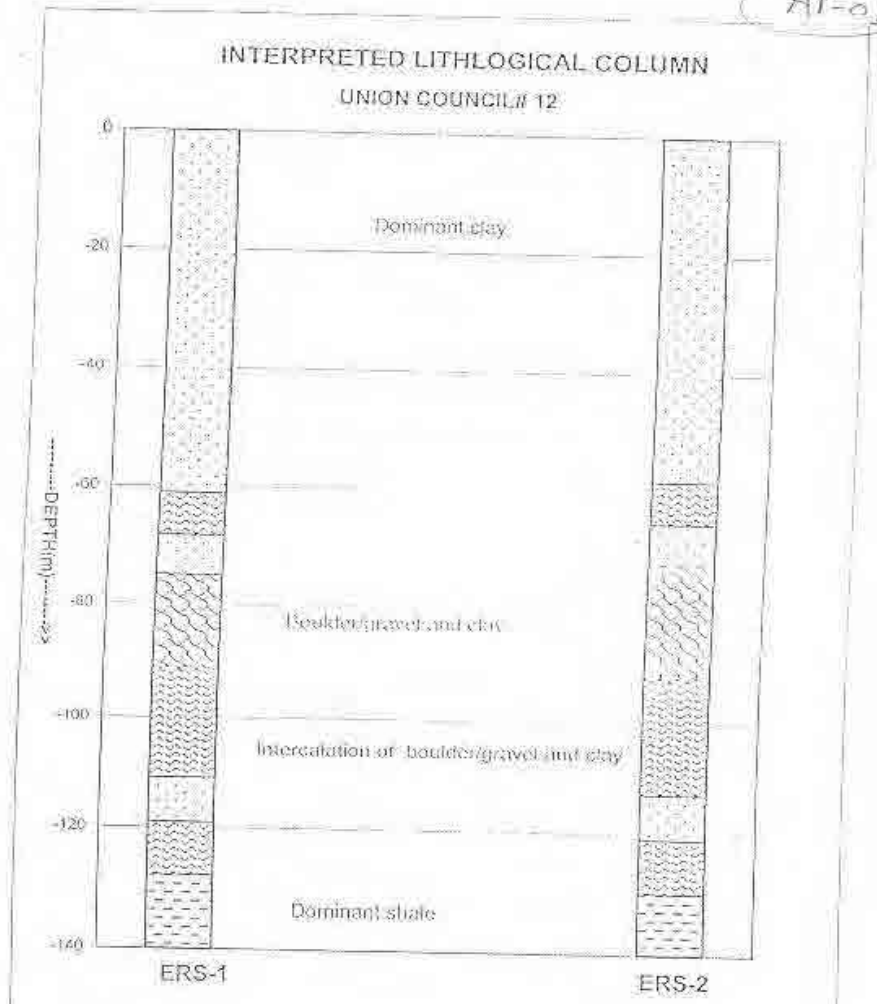
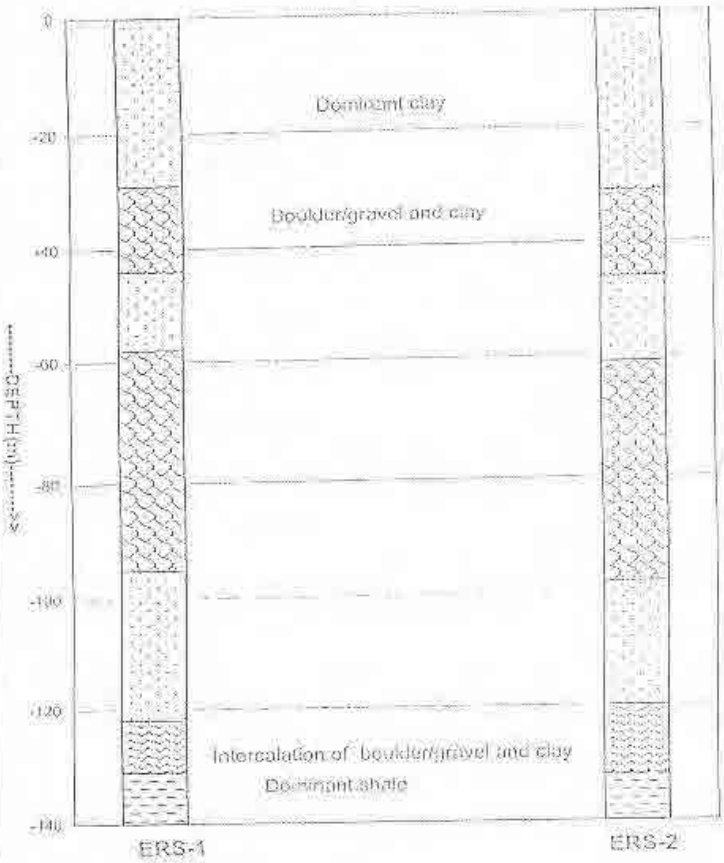

INTERPRETED LITHLOGICAL COLUMN
UNION COUNCIL# 12
0
-20
-40
-60
-80
-100
-120
-140
DEPTH(m)
Dominant clay
Boulder/gravel and clay
Intercalation of boulder/gravel and clay
Dominant shale
ERS-1
ERS-2

Fig. 1

AP-02

INTERPRETED LITHLOGICAL COLUMN

UNION COUNCIL# 9



(B)

FILTER DESIGN OF T.W LOCATED AT
UC#5, RAWALPINDI

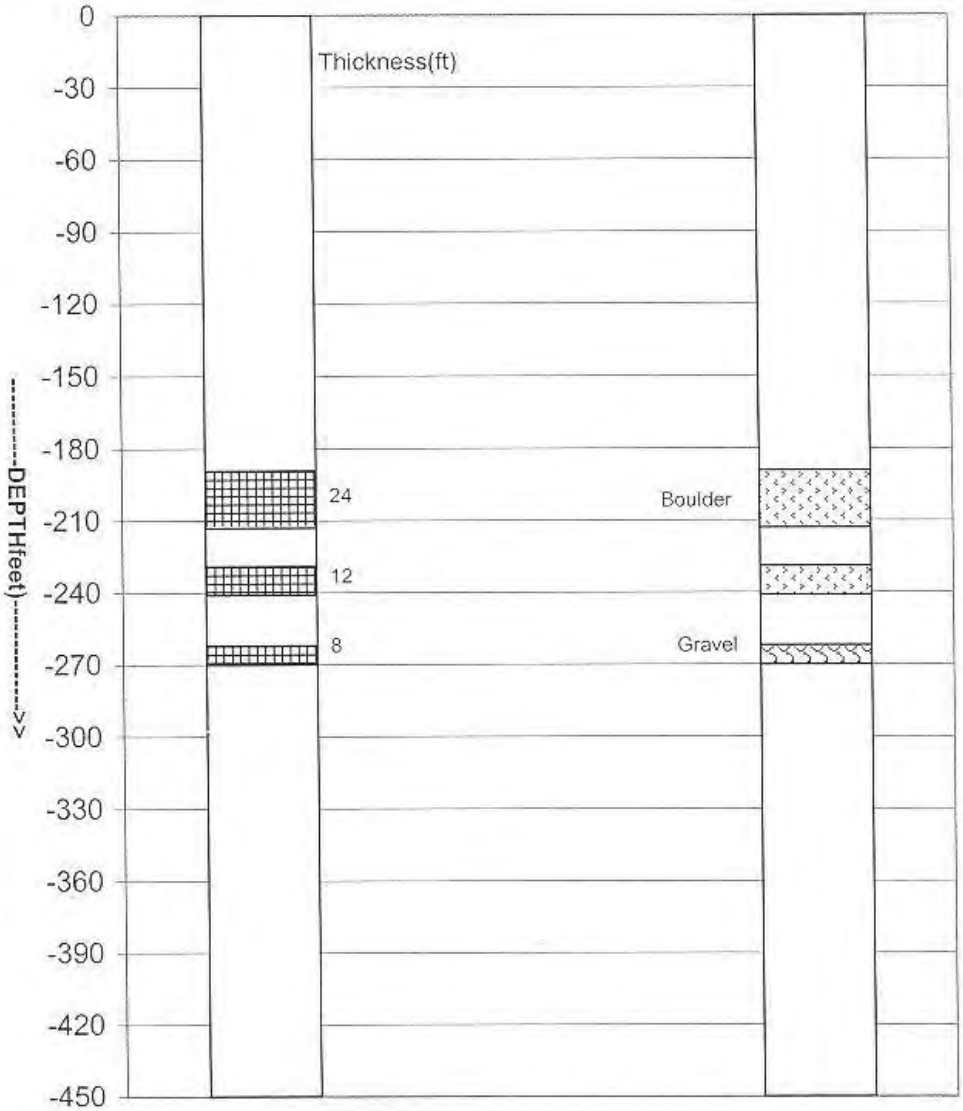


Fig.1

C-1

INTERPRETED LITHLOGICAL COLUMN

UNION COUNCIL# 12

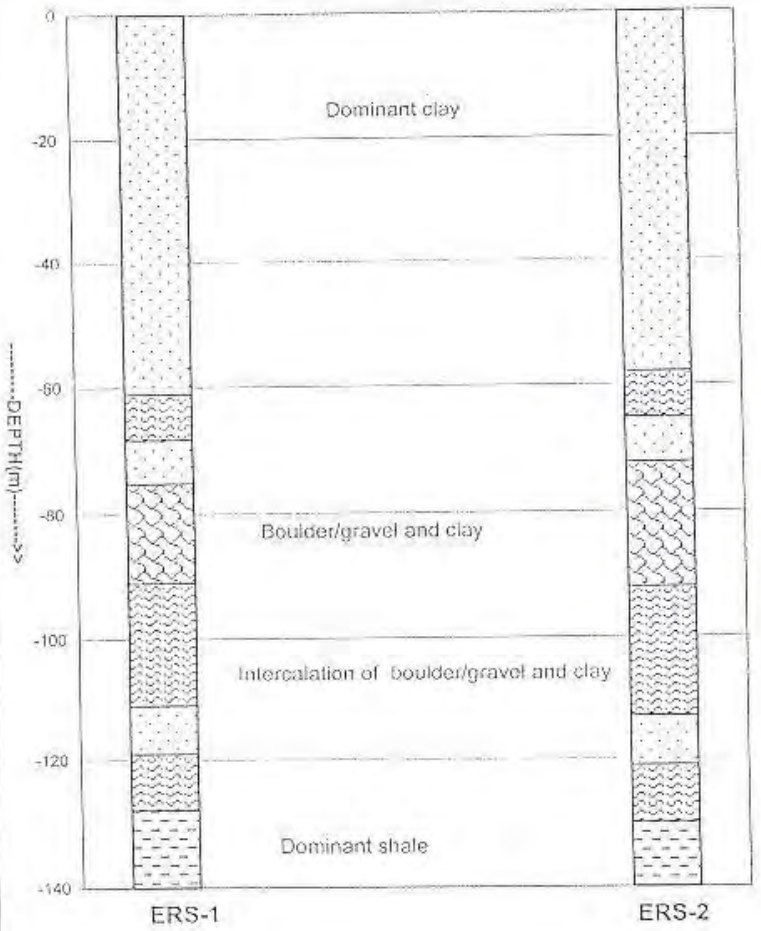


Fig. 1

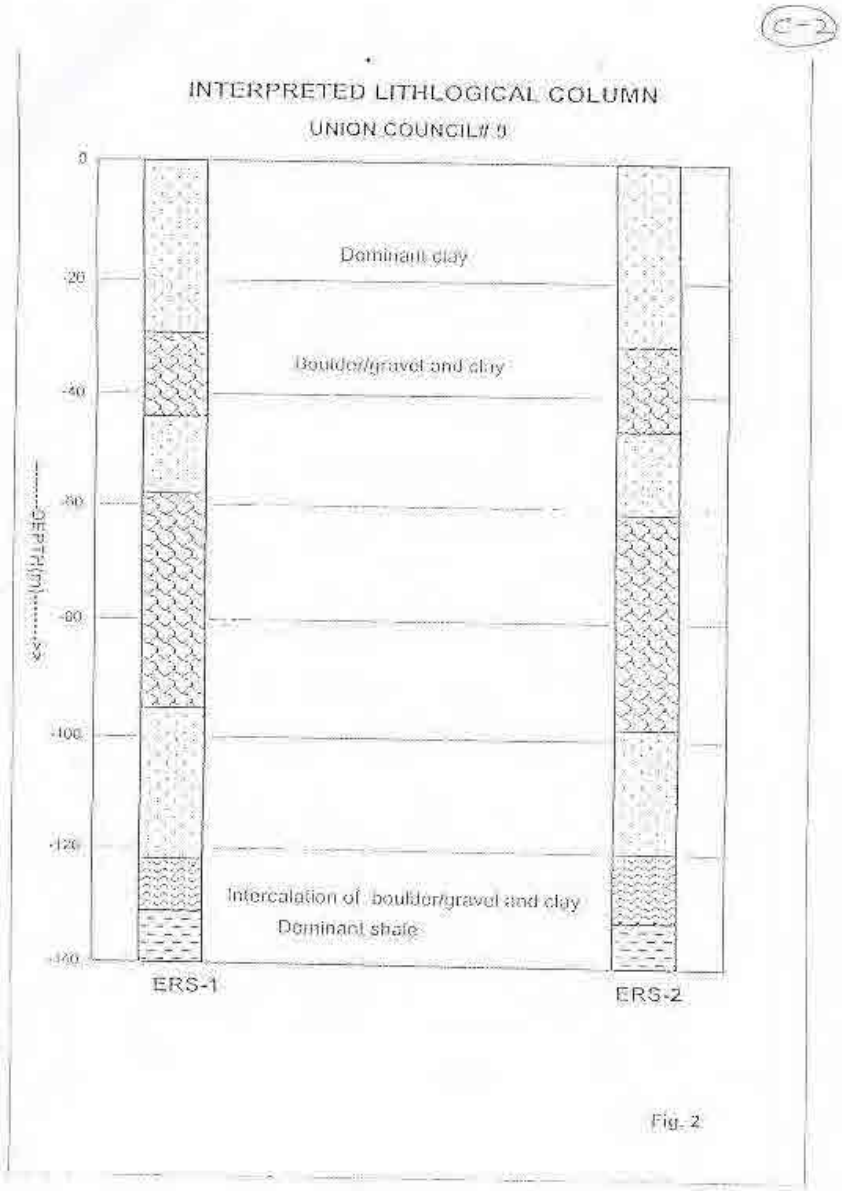
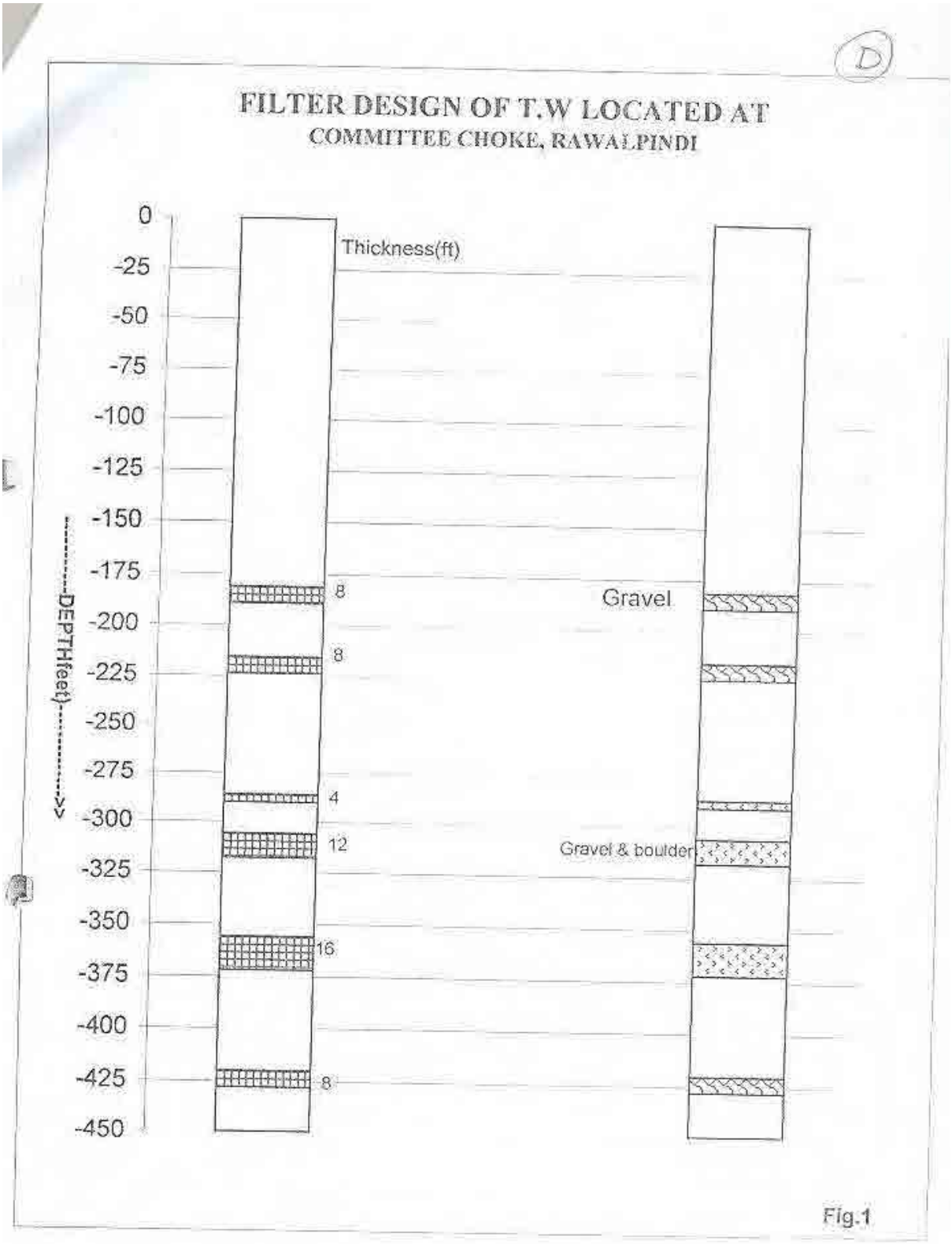

C-2
INTERPRETED LITHLOGICAL COLUMN
UNION COUNCIL# 9
0
-20
-40
-60
-80
-100
-120
-140
DEPTH(m)
Dominant clay
Boulder/gravel and clay
Intercalation of boulder/gravel and clay
Dominant shale
ERS-1
ERS-2

Fig. 2



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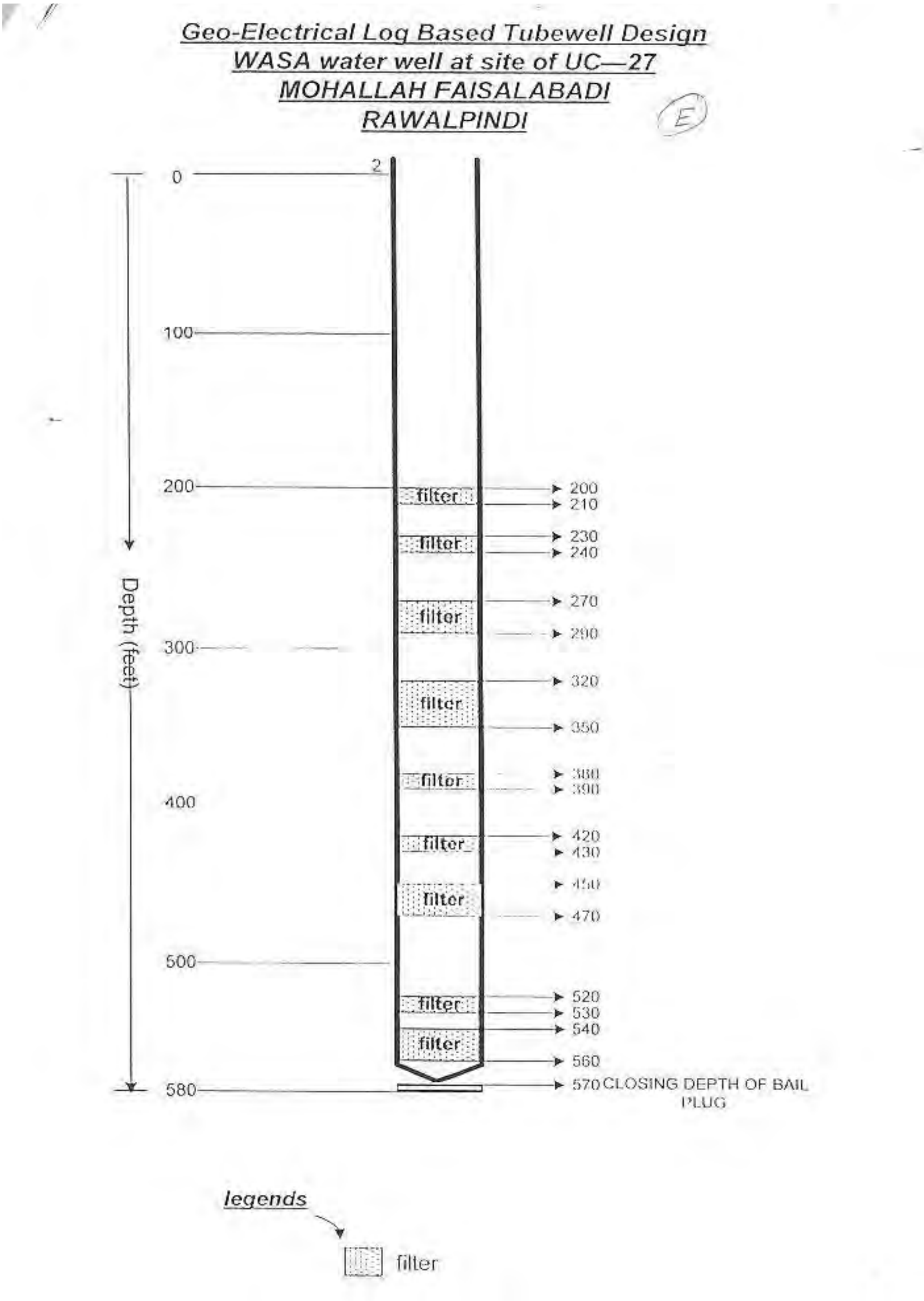
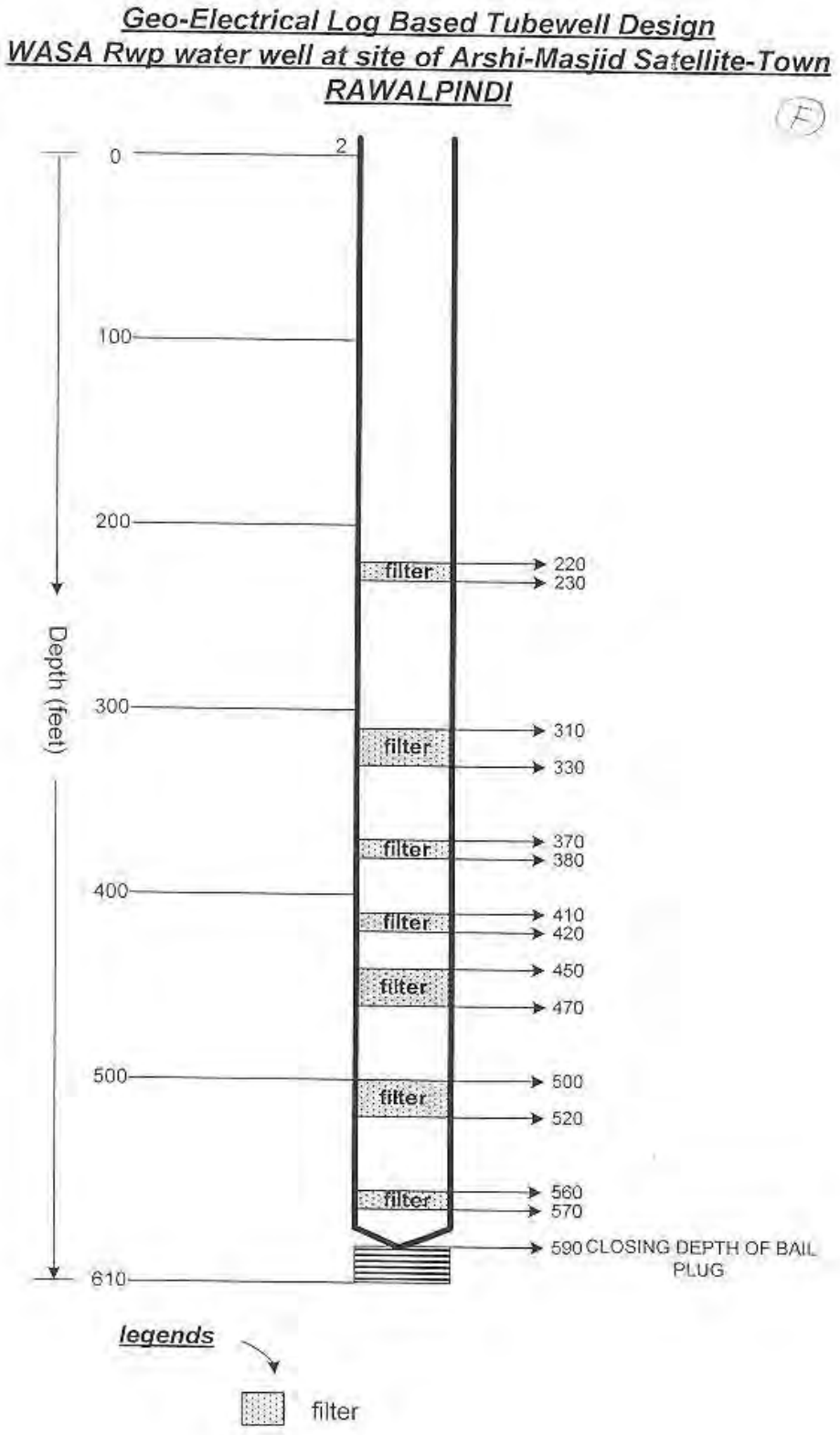
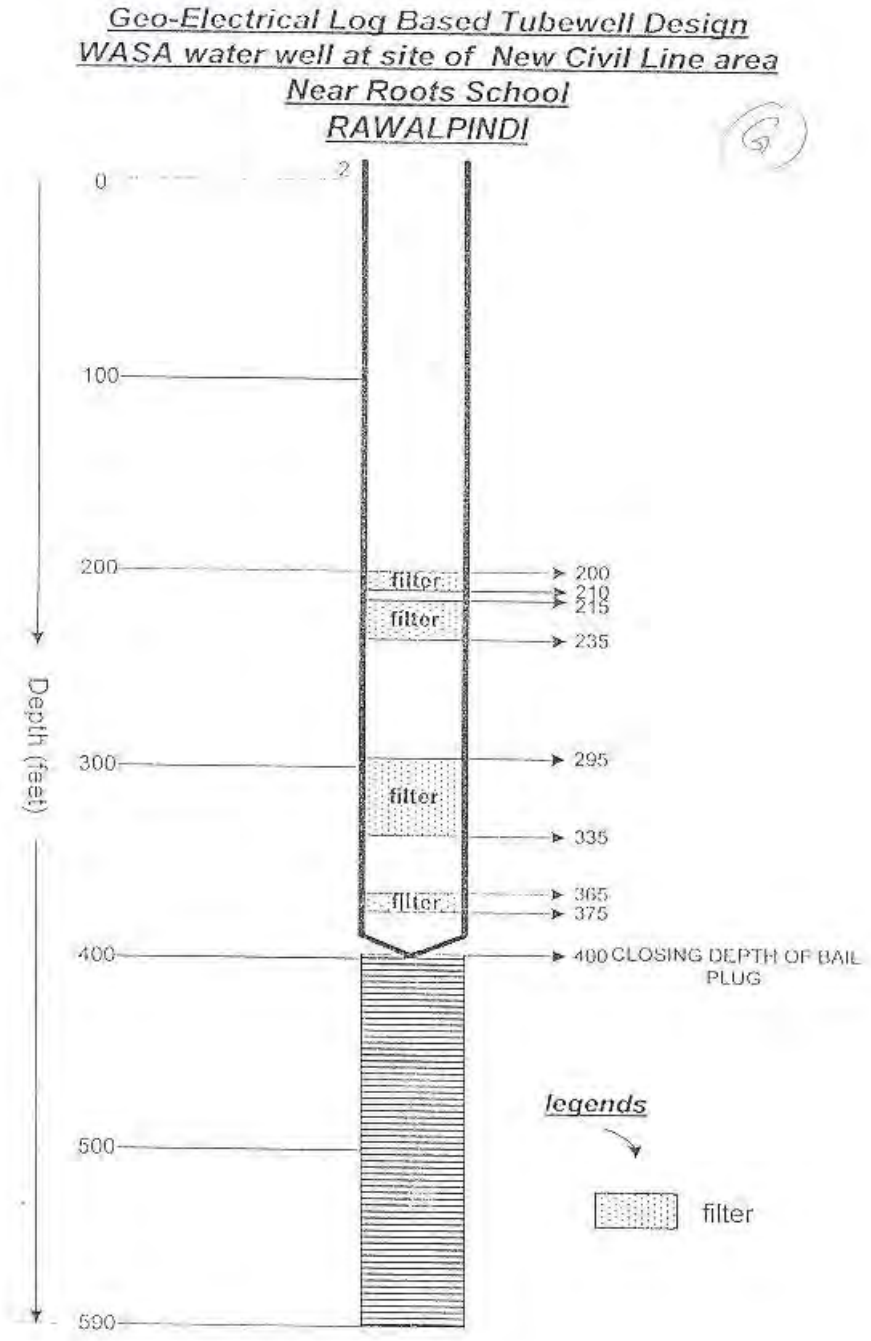
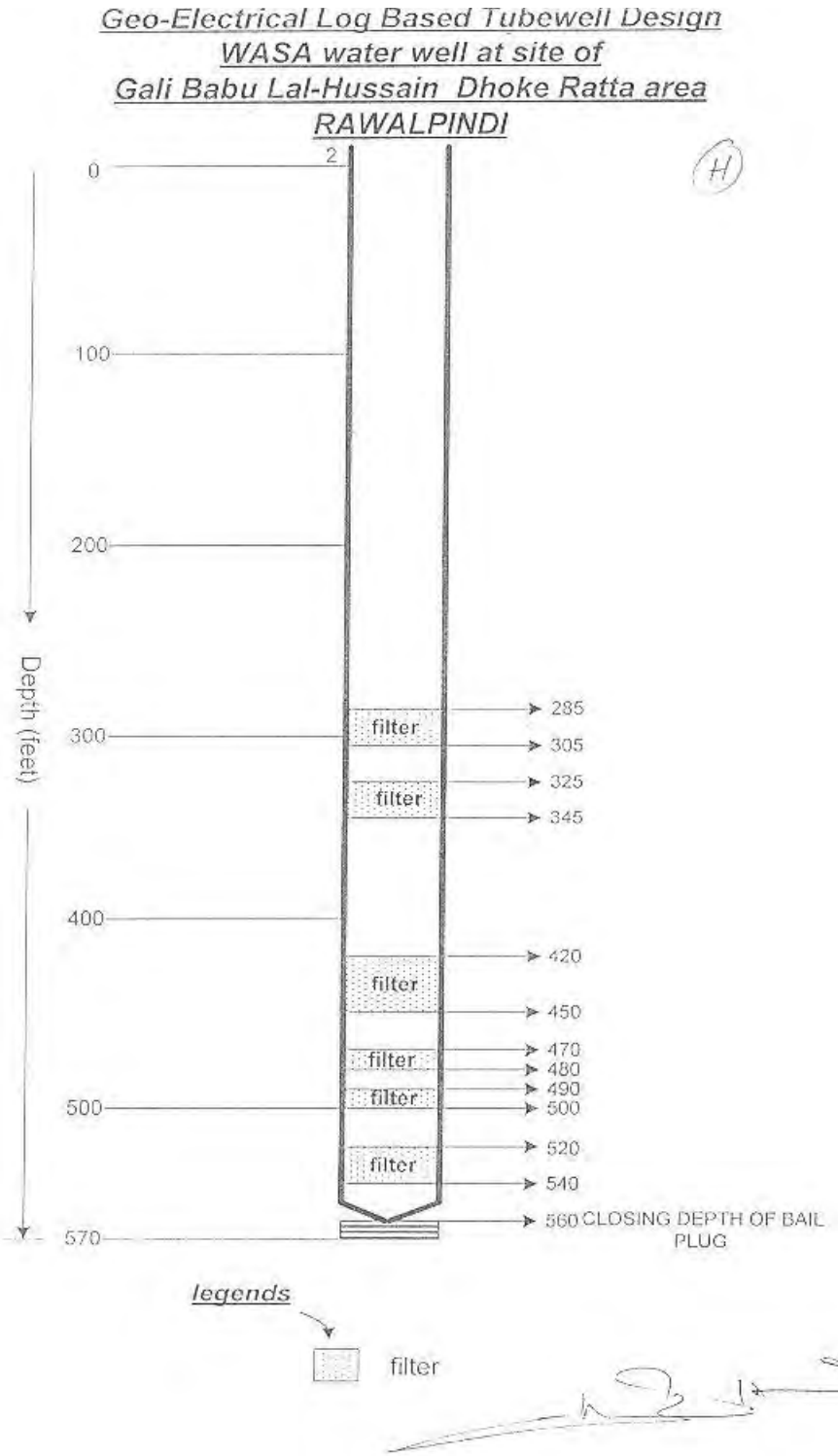
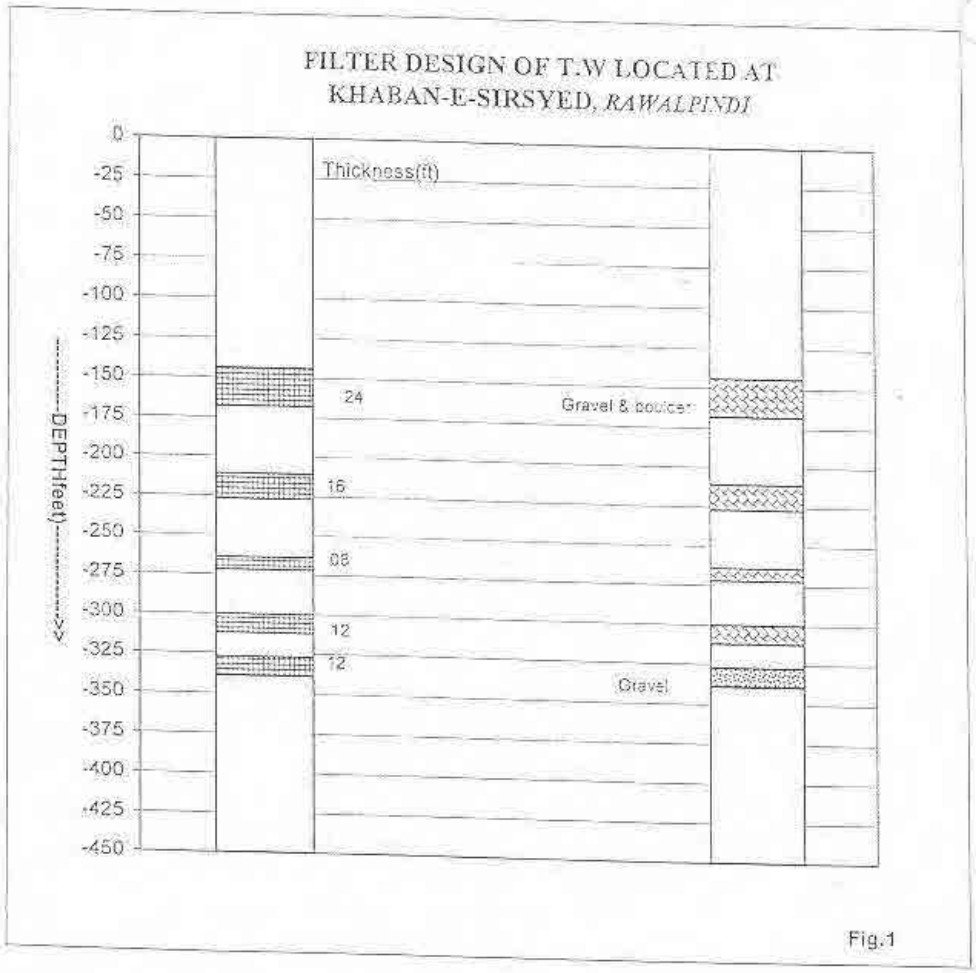
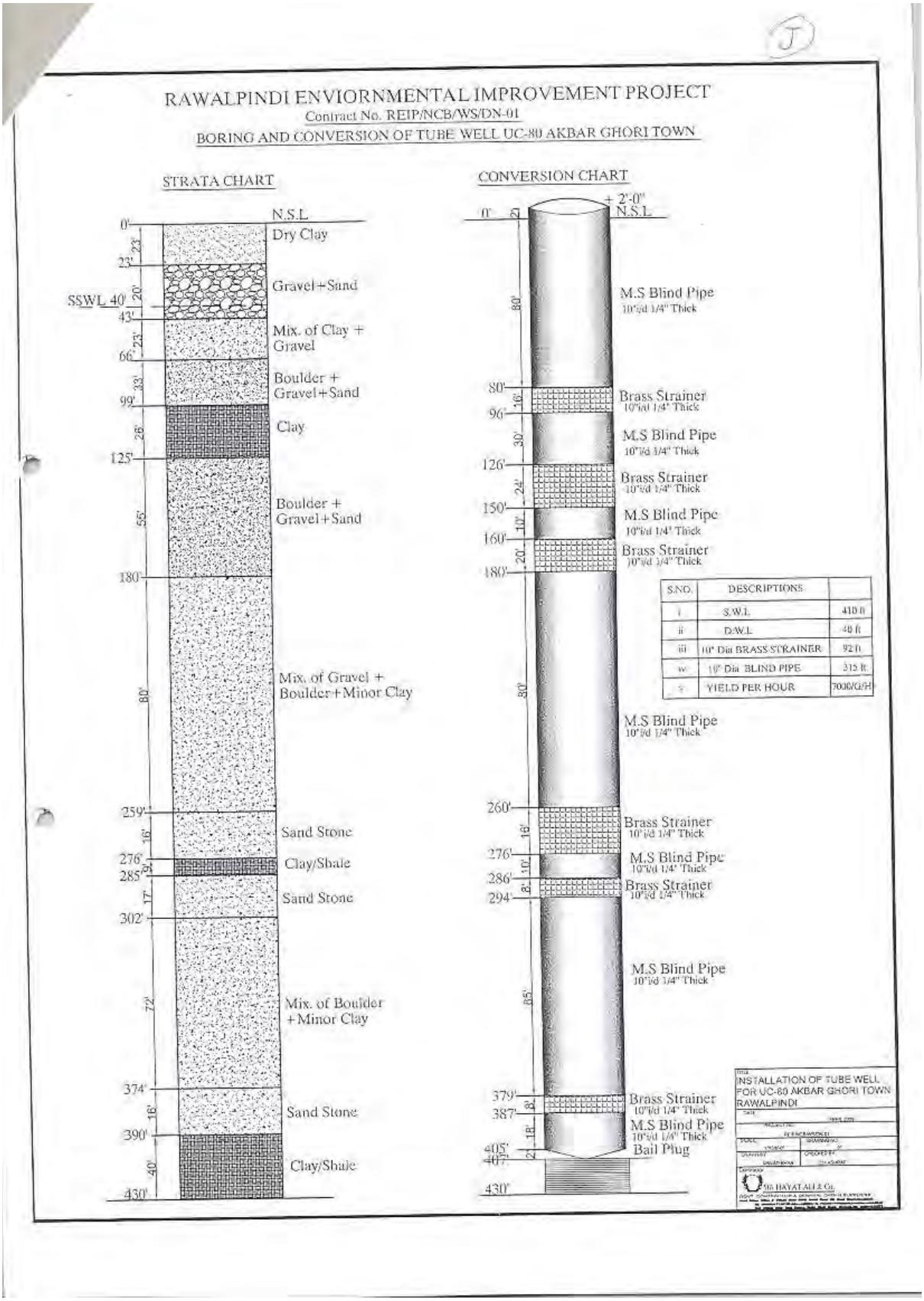

Geo-Electrical Log Based Tubewell Design
WASA water well at site of UC—27
MOHALLAH FAISALABADI
RAWALPINDI
Depth (feet)
0
100
200
300
400
500
580
filter
200
210
230
240
270
290
320
350
380
390
420
430
450
470
520
530
540
560
570 CLOSING DEPTH OF BAIL PLUG
legends
filter

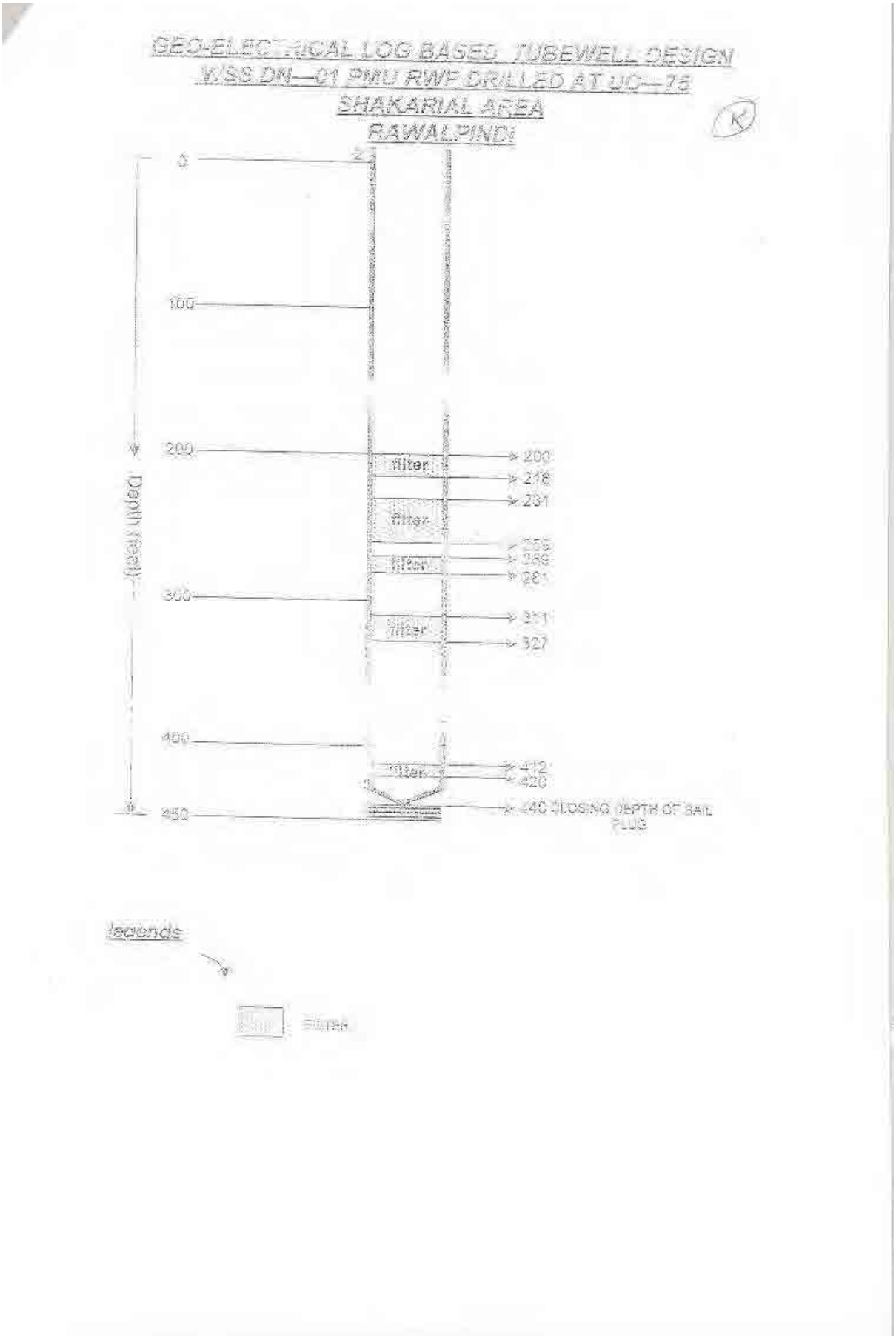

Geo-Electrical Log Based Tubewell Design
WASA Rwp water well at site of Arshi-Masjid Satellite-Town
RAWALPINDI
F
2
0
100
200
300
400
500
610
Depth (feet)
filter
220
230
310
330
370
380
410
420
450
470
500
520
560
570
590 CLOSING DEPTH OF BAIL PLUG
legends
filter


Geo-Electrical Log Based Tubewell Design
WASA water well at site of New Civil Line area
Near Roots School
RAWALPINDI
Depth (feet)
0
100
200
300
400
500
590
filter
filter
filter
filter
filter
200
210
215
235
295
335
365
375
400 CLOSING DEPTH OF BAIL PLUG
legends
filter


Geo-Electrical Log Based Tubewell Design
WASA water well at site of
Gali Babu Lal-Hussain Dhoke Ratta area
RAWALPINDI
2
H
0
100
200
300
400
500
570
Depth (feet)
filter
filter
filter
filter
filter
filter
285
305
325
345
420
450
470
480
490
500
520
540
560 CLOSING DEPTH OF BAIL PLUG
legends
filter

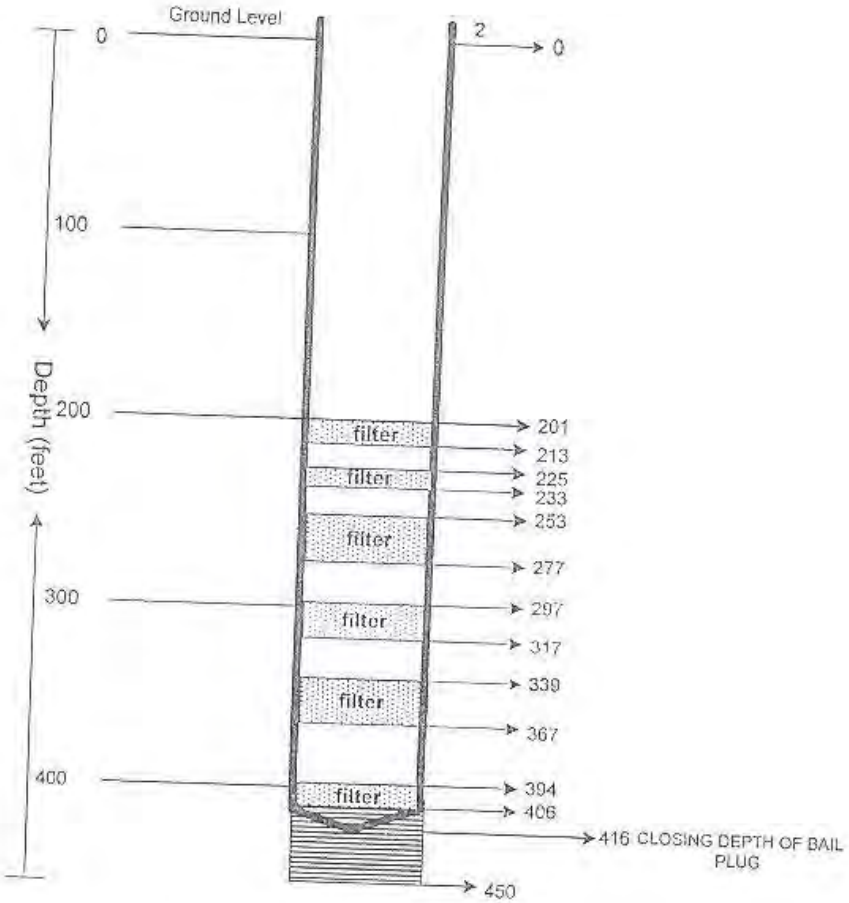

FILTER DESIGN OF T.W LOCATED AT
KHABAN-E-SIRSYED, RAWALPINDI
Thickness(ft)
DEPTH(feet)
0
-25
-50
-75
-100
-125
-150
-175
-200
-225
-250
-275
-300
-325
-350
-375
-400
-425
-450
24
16
08
12
12
Gravel & pouder
Gravel
Fig.1


RAWALPINDI ENVIORNMENTAL IMPROVEMENT PROJECT
Contract No. REIP/NCB/WS/DN-01
BORING AND CONVERSION OF TUBE WELL UC-80 AKBAR GHORI TOWN
STRATA CHART
N.S.L
0'
Dry Clay
23'
Gravel+Sand
SSWL 40'
43'
Mix. of Clay + Gravel
66'
Boulder + Gravel+Sand
99'
Clay
125'
Boulder + Gravel+Sand
180'
Mix. of Gravel + Boulder+Minor Clay
259'
Sand Stone
276'
Clay/Shale
285'
Sand Stone
302'
Mix. of Boulder +Minor Clay
374'
Sand Stone
390'
Clay/Shale
430'
CONVERSION CHART
+ 2'-0"
N.S.L
0'
M.S Blind Pipe
10"i/d 1/4" Thick
80'
Brass Strainer
10"i/d 1/4" Thick
96'
M.S Blind Pipe
10"i/d 1/4" Thick
126'
Brass Strainer
10"i/d 1/4" Thick
150'
M.S Blind Pipe
10"i/d 1/4" Thick
160'
Brass Strainer
10"i/d 1/4" Thick
180'
M.S Blind Pipe
10"i/d 1/4" Thick
260'
Brass Strainer
10"i/d 1/4" Thick
276'
M.S Blind Pipe
10"i/d 1/4" Thick
286'
Brass Strainer
10"i/d 1/4" Thick
294'
M.S Blind Pipe
10"i/d 1/4" Thick
379'
Brass Strainer
10"i/d 1/4" Thick
387'
M.S Blind Pipe
10"i/d 1/4" Thick
405'
Bail Plug
407'
430'
S.NO. | DESCRIPTIONS
i | S.W.L | 410 ft
ii | D.W.L | 40 ft
iii | 10" Dia BRASS STRAINER | 92 ft
iv | 10" Dia BLIND PIPE | 315 ft
v | YIELD PER HOUR | 7000 G/H
INSTALLATION OF TUBE WELL FOR UC-80 AKBAR GHORI TOWN RAWALPINDI
M/s HAYAT ALI & Co.


GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN
WSS DN—01 PMU RWP DRILLED AT UC—13
SHAKARIAL AREA
RAWALPINDI
0
100
200
300
400
450
Depth (feet)
filter
200
216
231
255
269
281
311
327
412
420
440 CLOSING DEPTH OF BAIL PLUG
legends
filter

GEO-ELECTRIC LOG BASED TUBE WELL DESIGN

WASA water supply well at C-Block Satellite-town Rawalpindi



legends

Boulder+Gravel+Sand (FILTER)

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FILTER DESIGN OF T.W LOCATED AT

UC#34 BANI CHOWK, RAWALPINDI

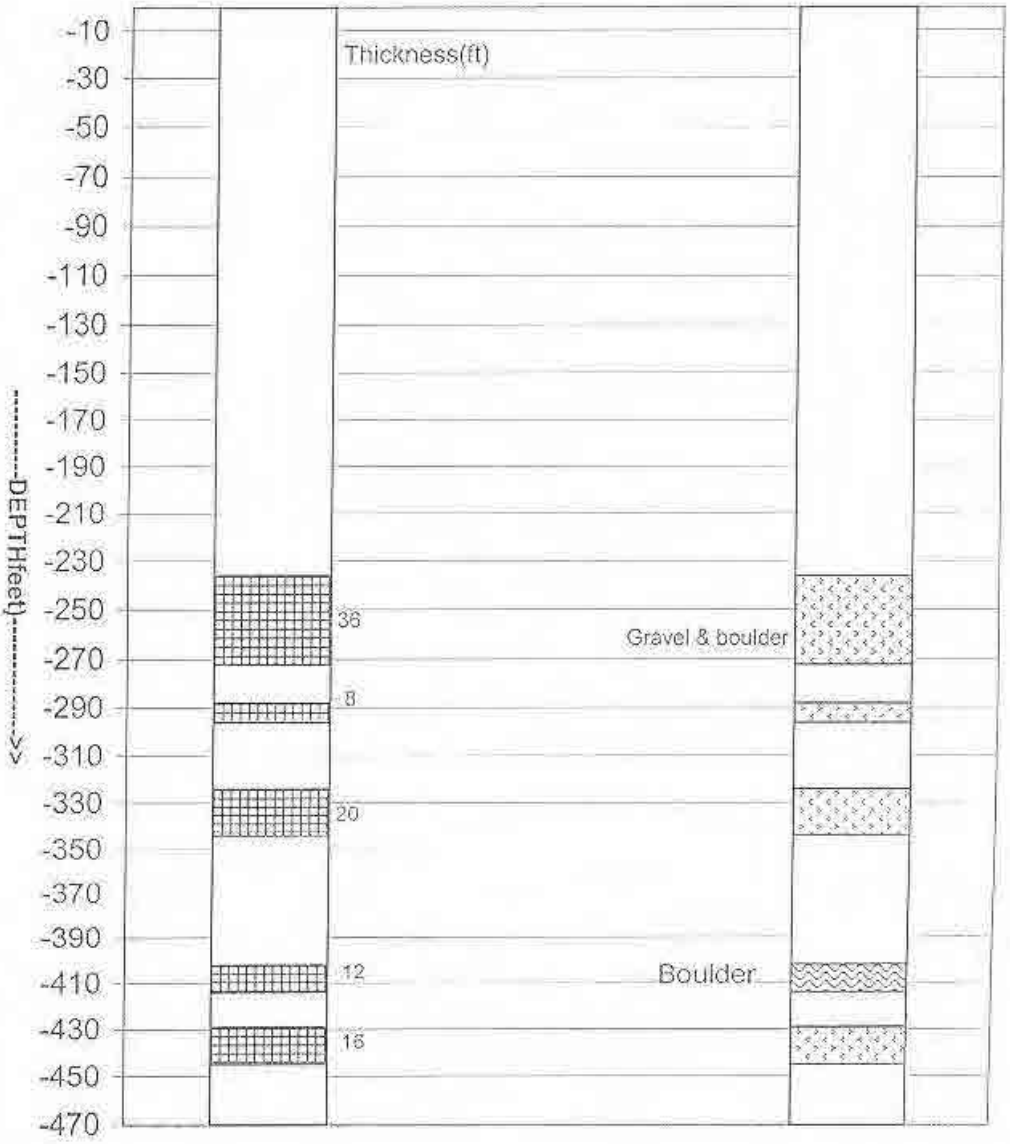

Fig.1

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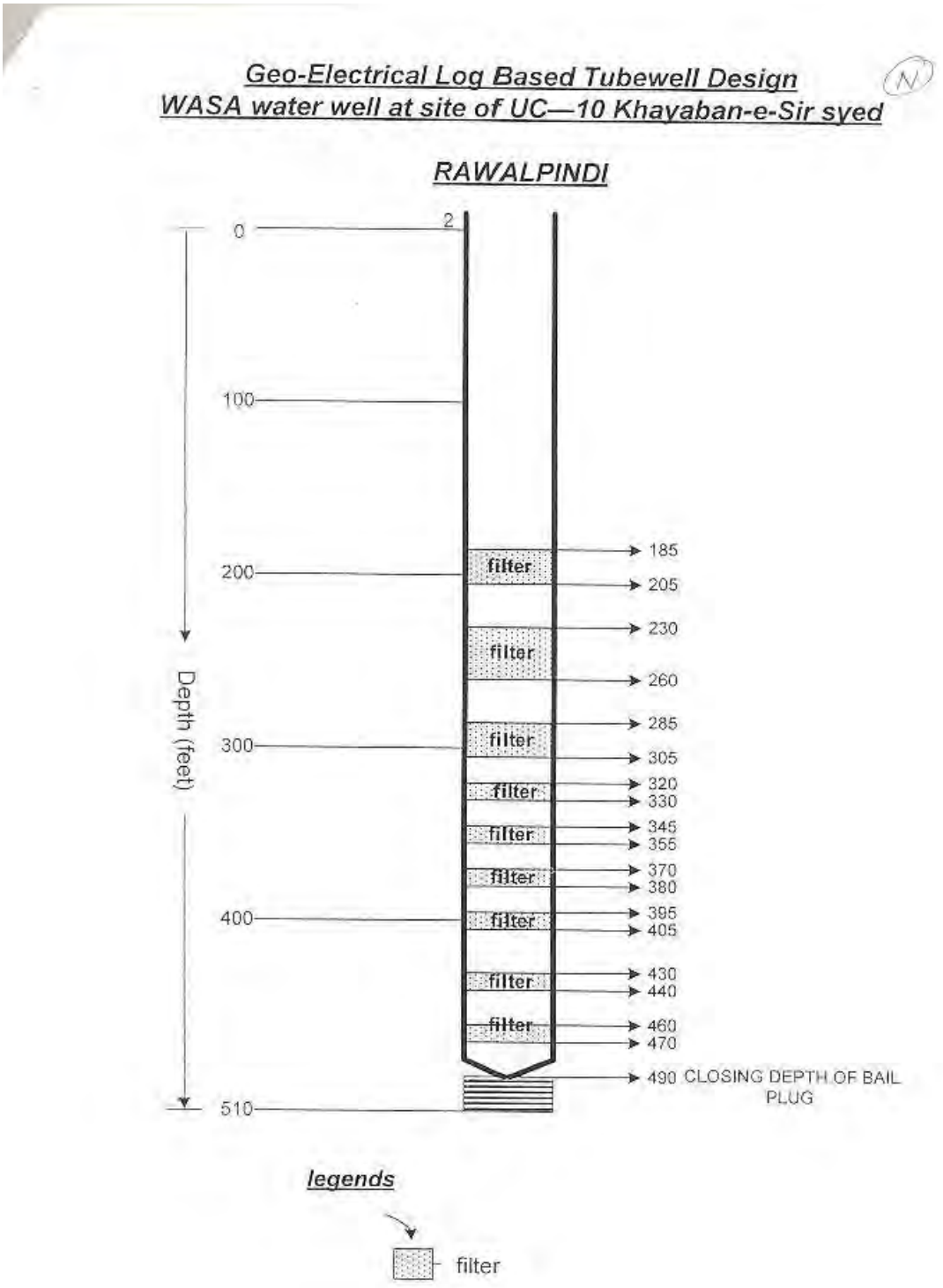
Geo-Electrical Log Based Tubewell Design
WASA water well at site of UC—10 Khayaban-e-Sir syed
RAWALPINDI
Depth (feet)
0
100
200
300
400
510
2
filter
185
205
230
260
285
305
320
330
345
355
370
380
395
405
430
440
460
470
490 CLOSING DEPTH OF BAIL PLUG
legends
filter

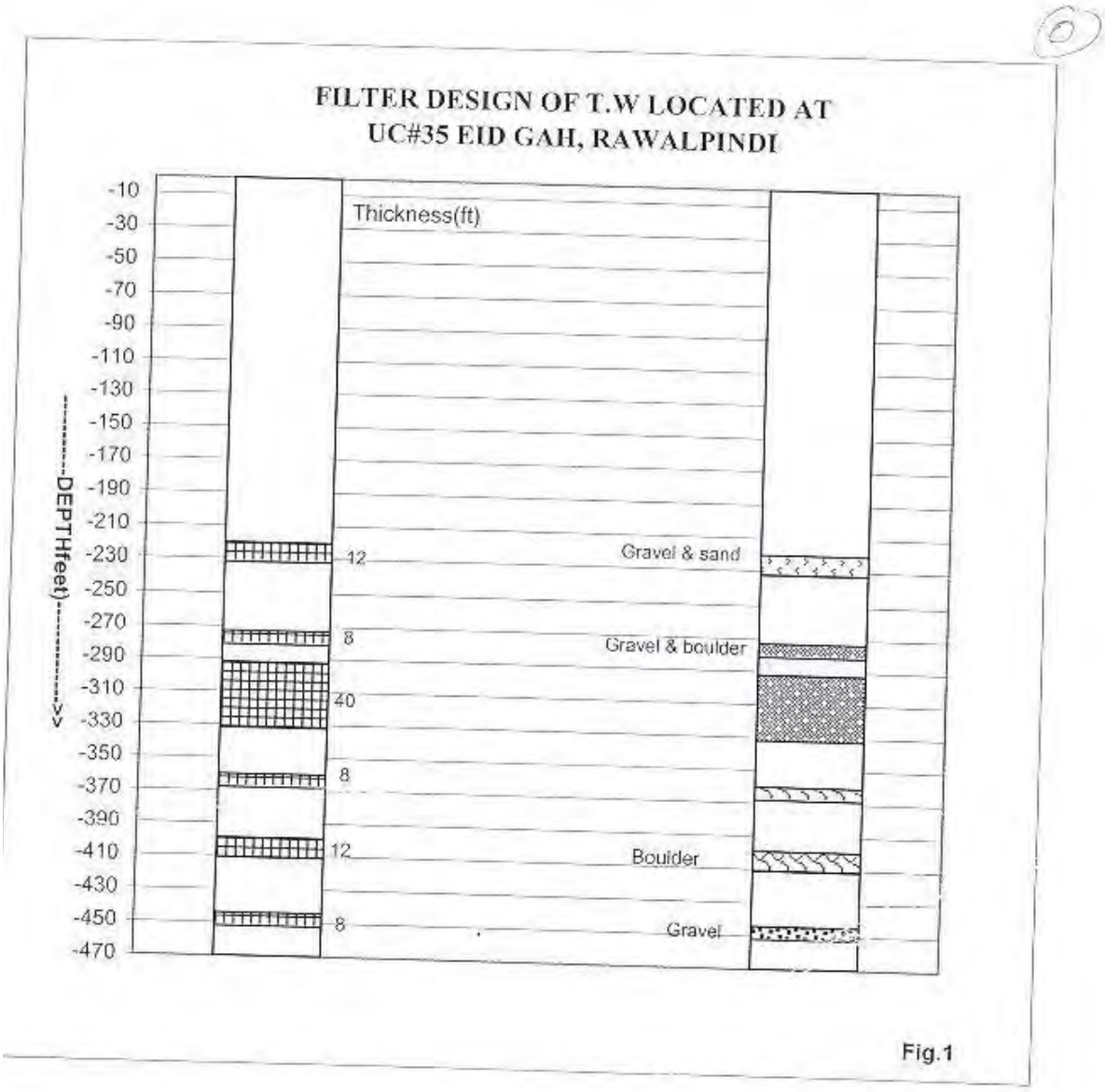

Fig.1

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P-01

FILTER DESIGN OF T.W LOCATED AT

UC#9 PIRWADI, RAWALPINDI

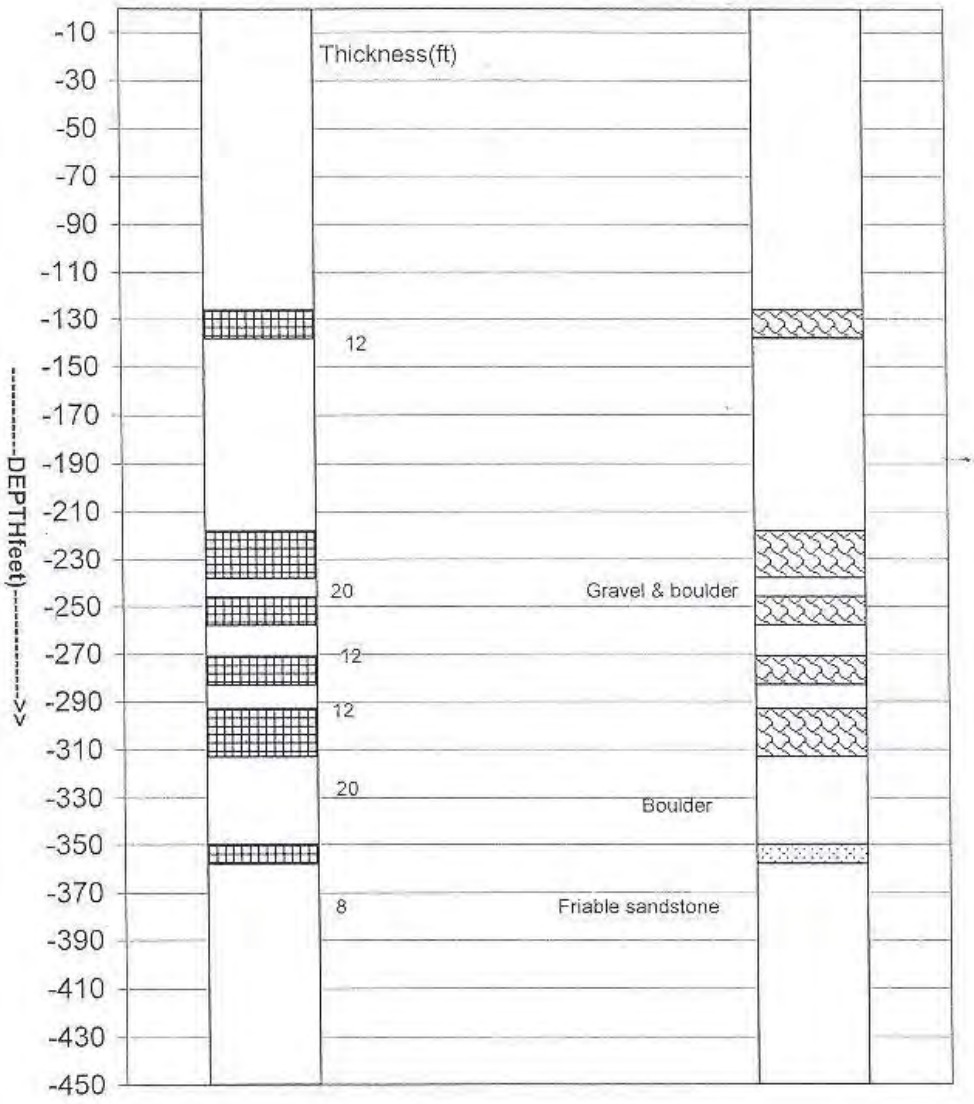
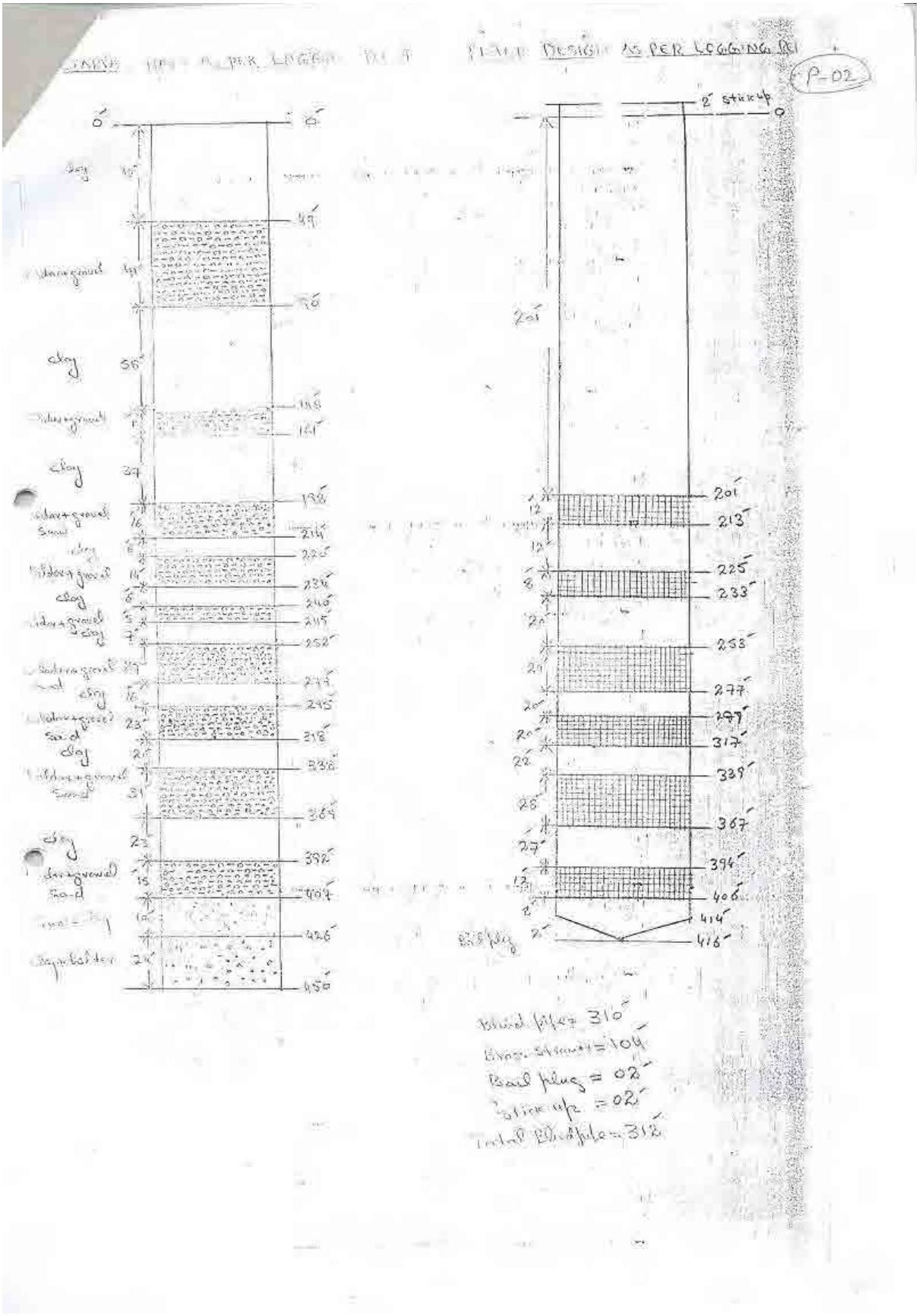


Fig.1



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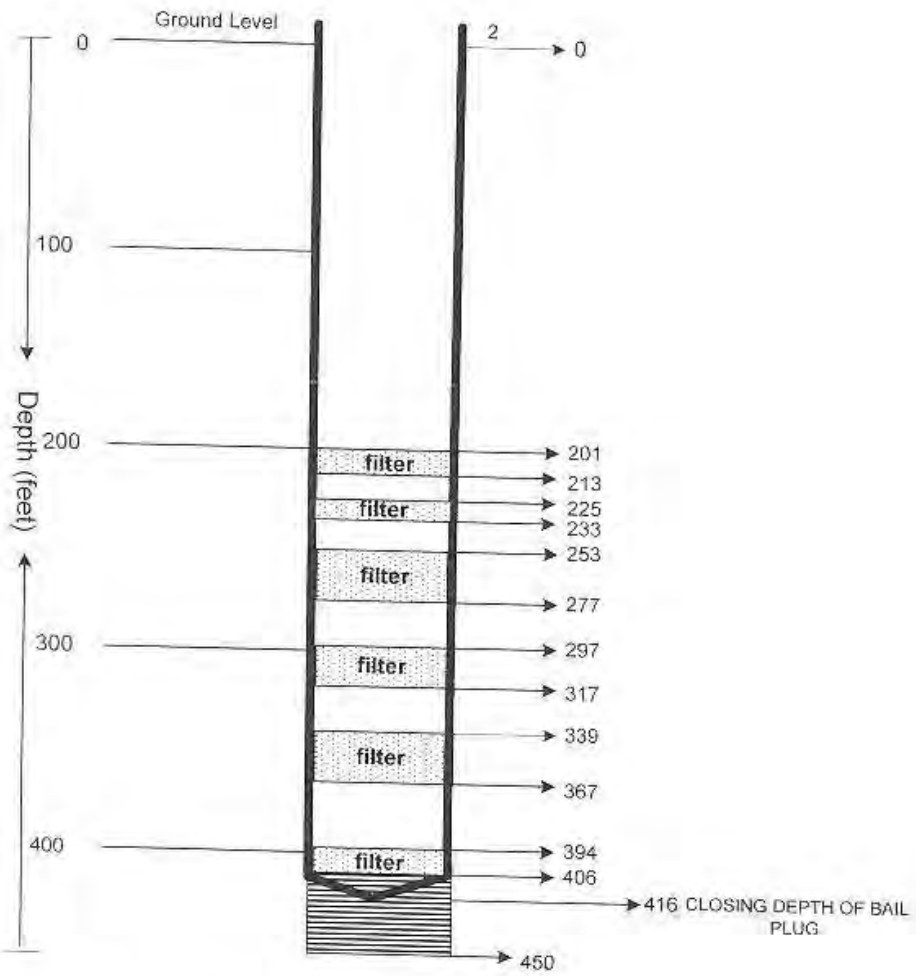
GEO-ELECTRIC LOG BASED TUBE WELL DESIGN

WASA water supply well at C-Block Satellite-town Rawalpindi



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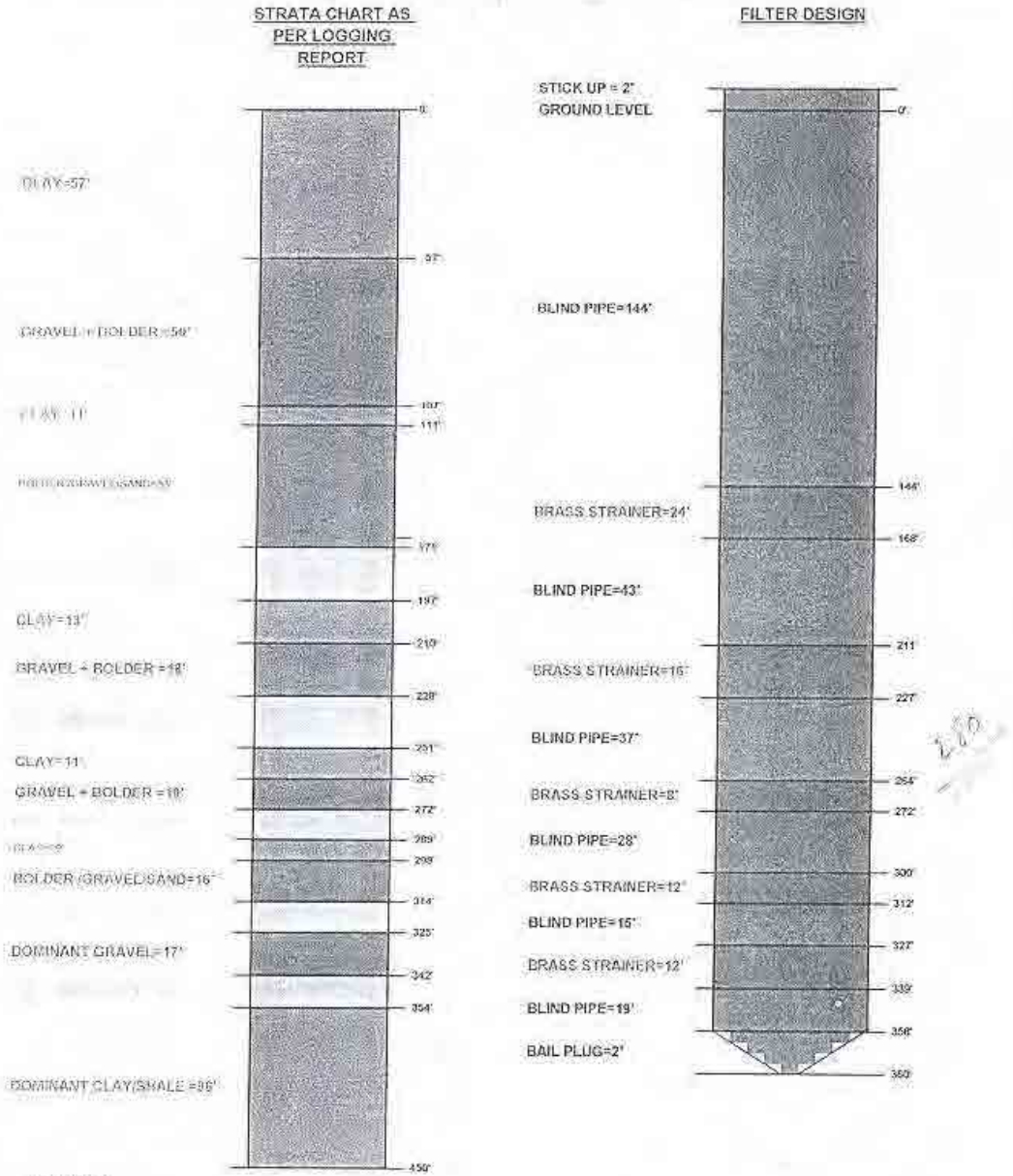
STRATA CHART AND FILTER DESIGN AS PER LOGGING REPORT FOR NEW TUBEWELL LOCATED IN KHIYABAN-E-SIRSYED, RAWALPINDI UC-12

R-01



SUB ENGINEER ASSISTANT DIRECTOR DEPUTY DIRECTOR

R-02

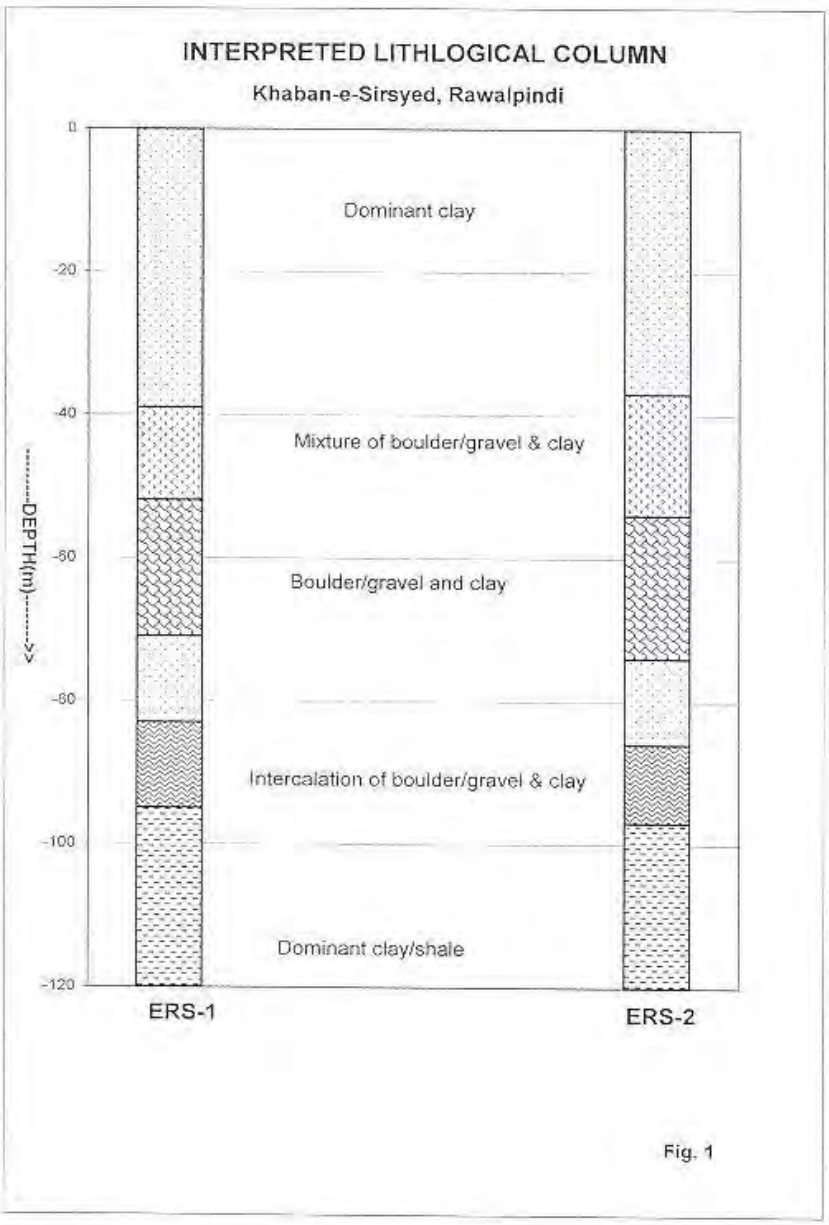
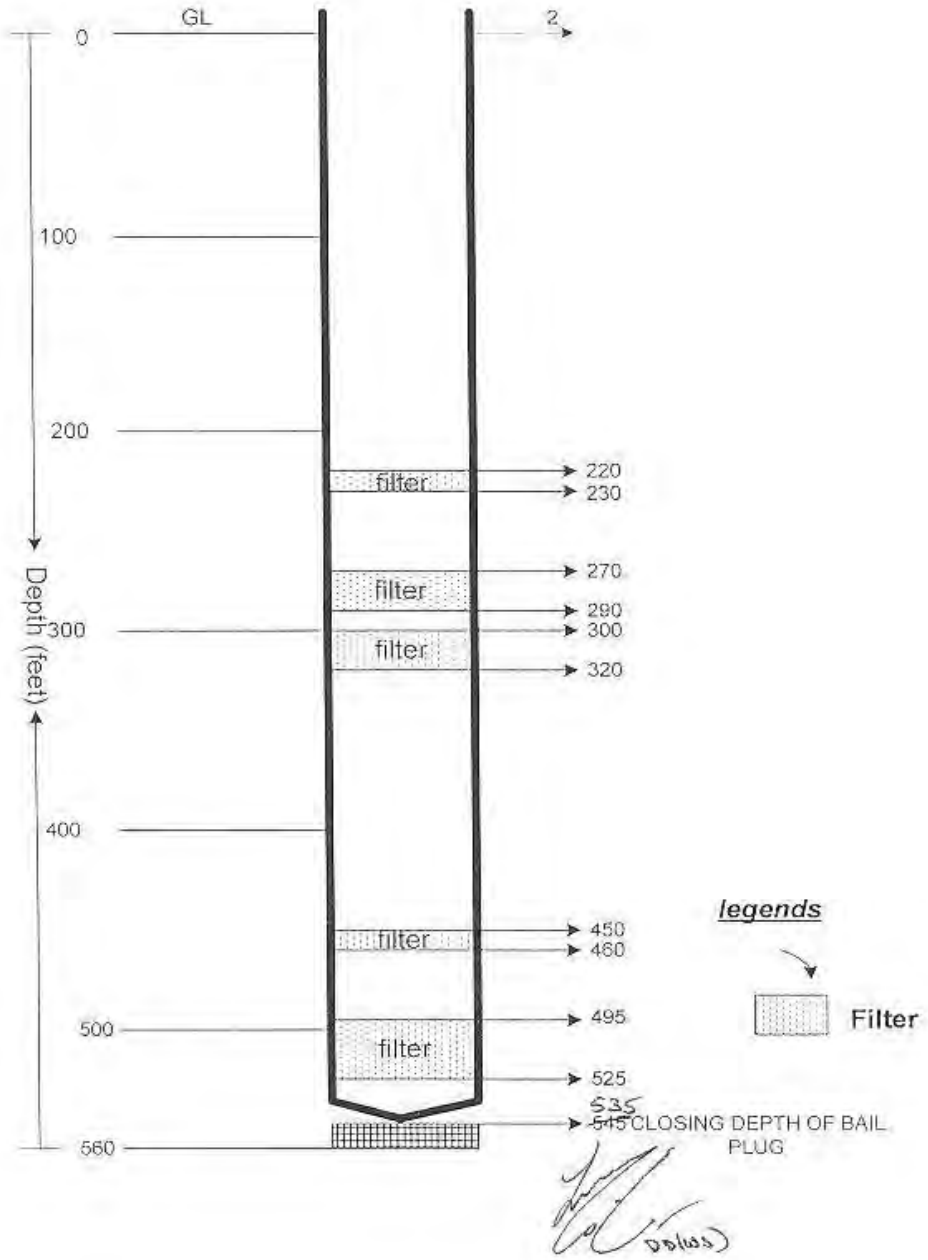

INTERPRETED LITHLOGICAL COLUMN
Khaban-e-Sirsyed, Rawalpindi
0
-20
-40
-60
-80
-100
-120
DEPTH(m)
Dominant clay
Mixture of boulder/gravel & clay
Boulder/gravel and clay
Intercalation of boulder/gravel & clay
Dominant clay/shale
ERS-1
ERS-2

Fig. 1

GEO-ELECTRICAL LOG BASED TUBEWELL DESIGN

WASA, Rwp Water Supply Scheme UC—04 Dhoke Matkal
Drilled in the UC—37 near Chungi No--4 area
Rawalpindi



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FILTER DESIGN OF T.W (CENTRE) LOCATED AT
SOWAN VILLAGE, RAWALPINDI

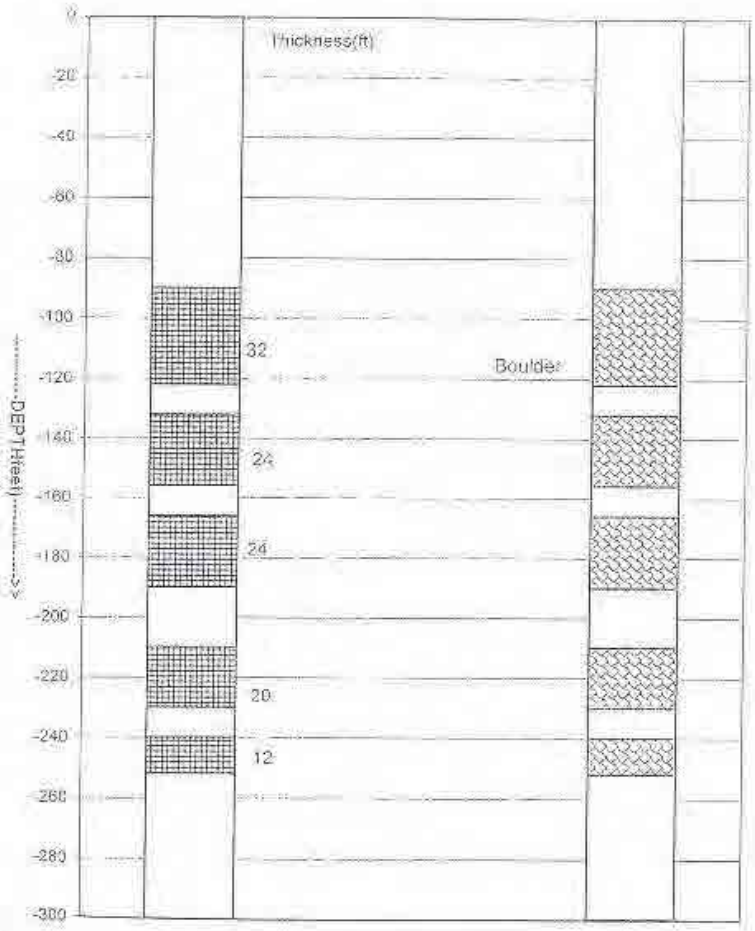
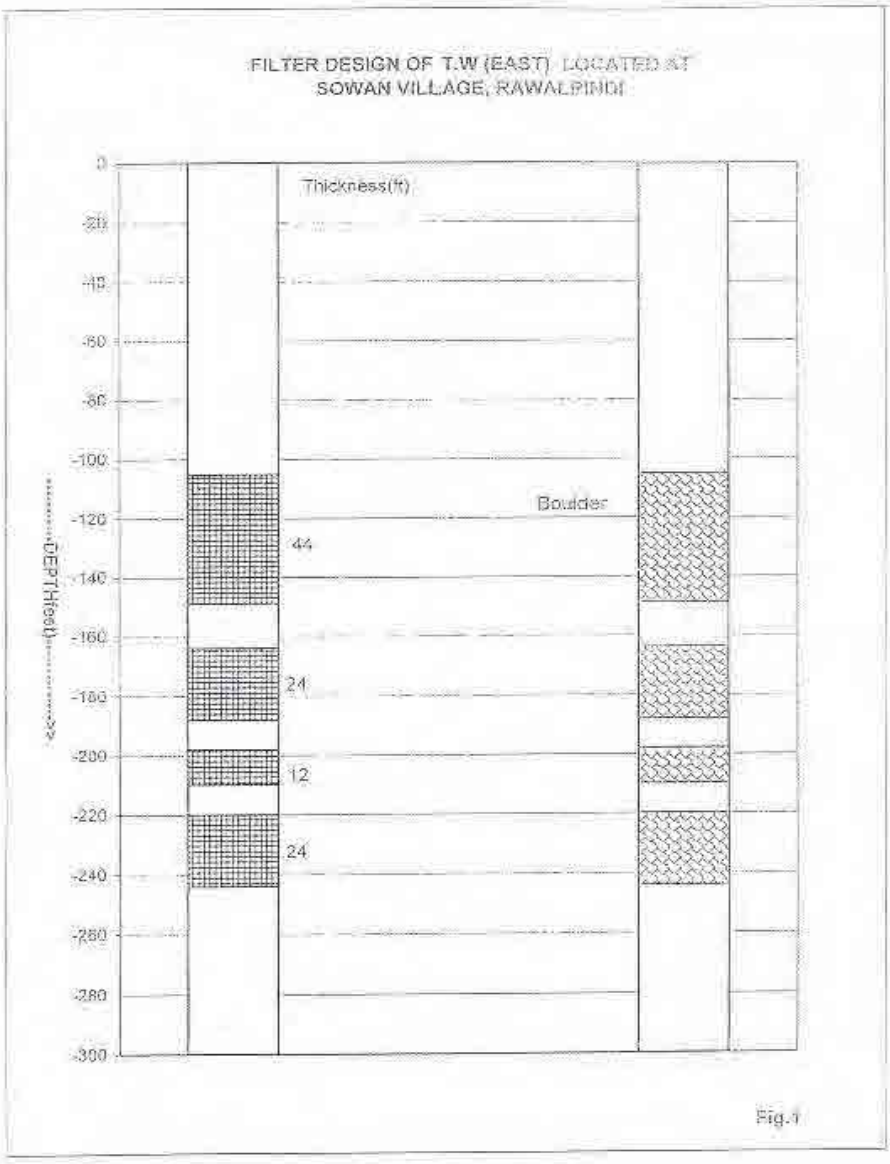
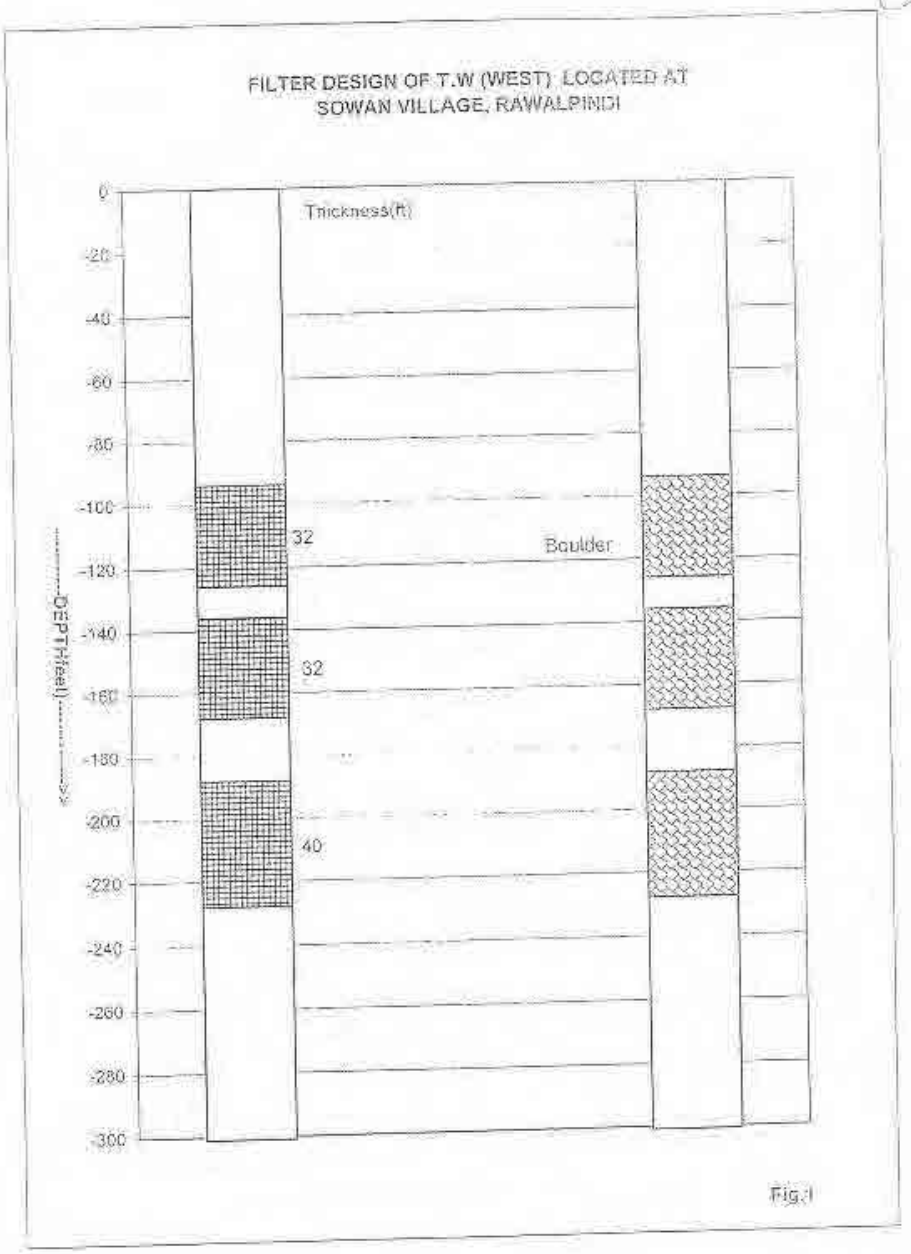


Fig.i


FILTER DESIGN OF T.W (EAST) LOCATED AT
SOWAN VILLAGE, RAWALPINDI
Thickness(ft)
Boulder
44
24
12
24
DEPTH(feet)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
Fig.1



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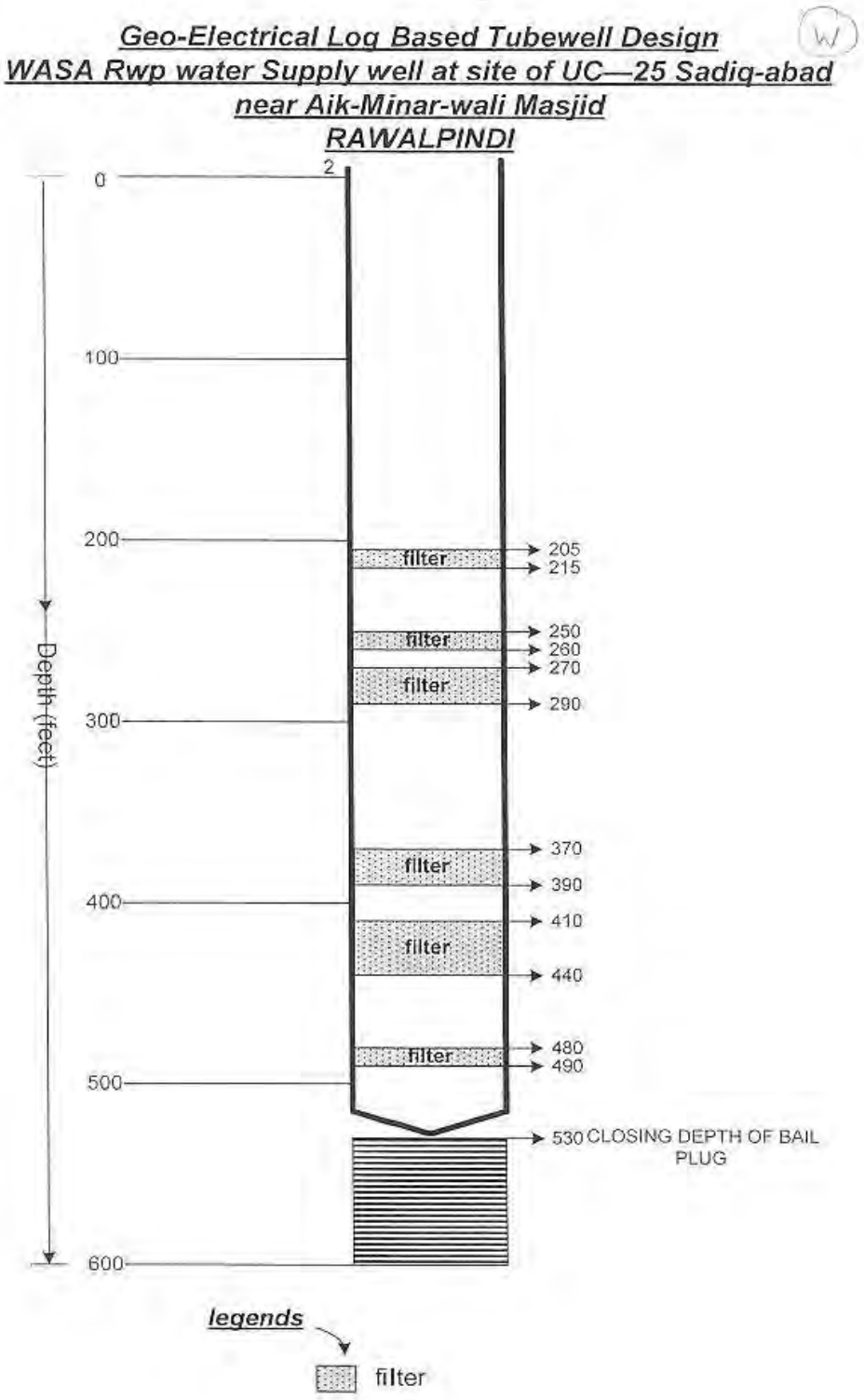
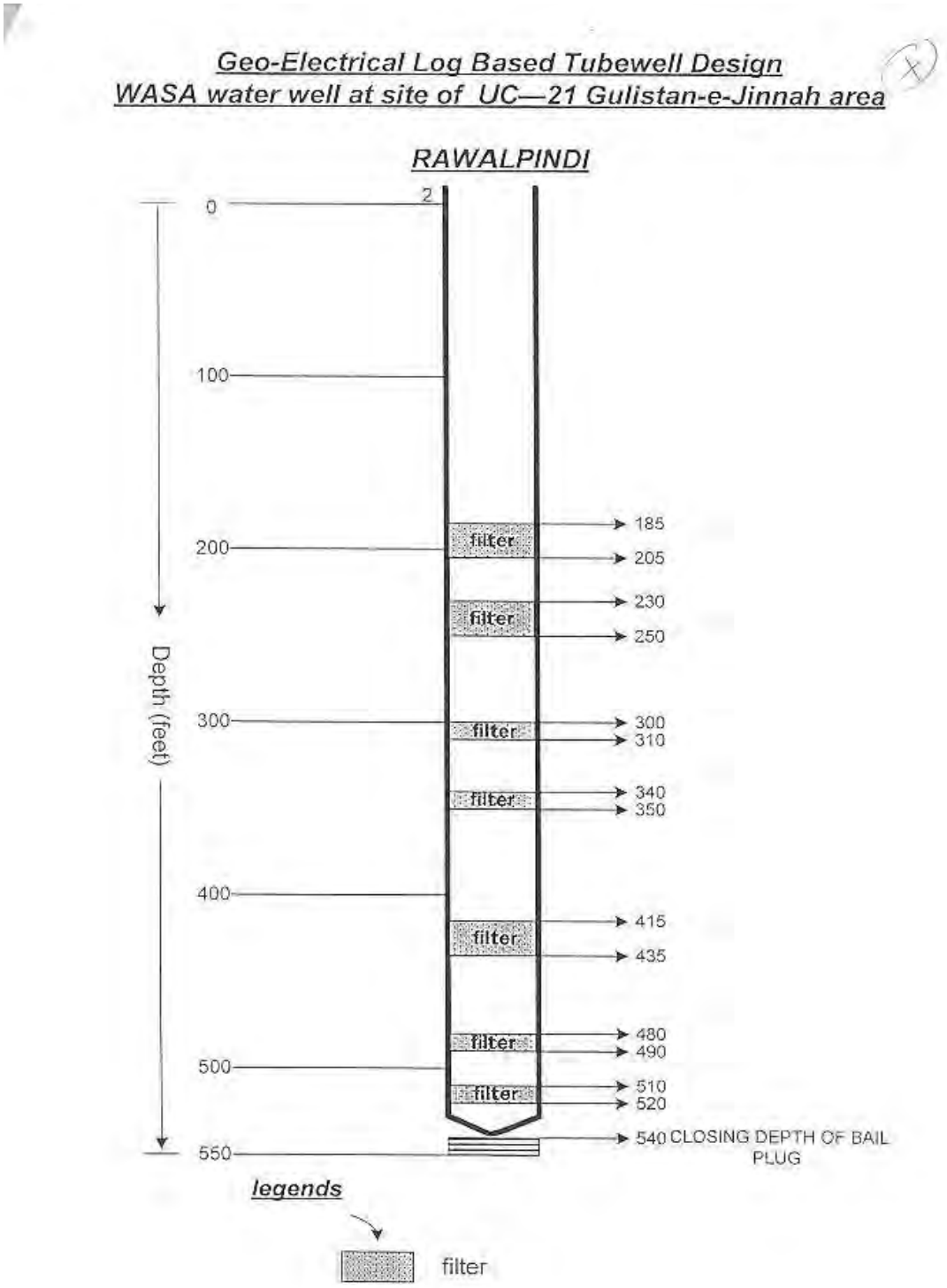

Geo-Electrical Log Based Tubewell Design
WASA Rwp water Supply well at site of UC—25 Sadiq-abad
near Aik-Minar-wali Masjid
RAWALPINDI
2
0
100
200
300
400
500
600
Depth (feet)
filter
filter
filter
filter
filter
filter
205
215
250
260
270
290
370
390
410
440
480
490
530 CLOSING DEPTH OF BAIL PLUG
legends
filter



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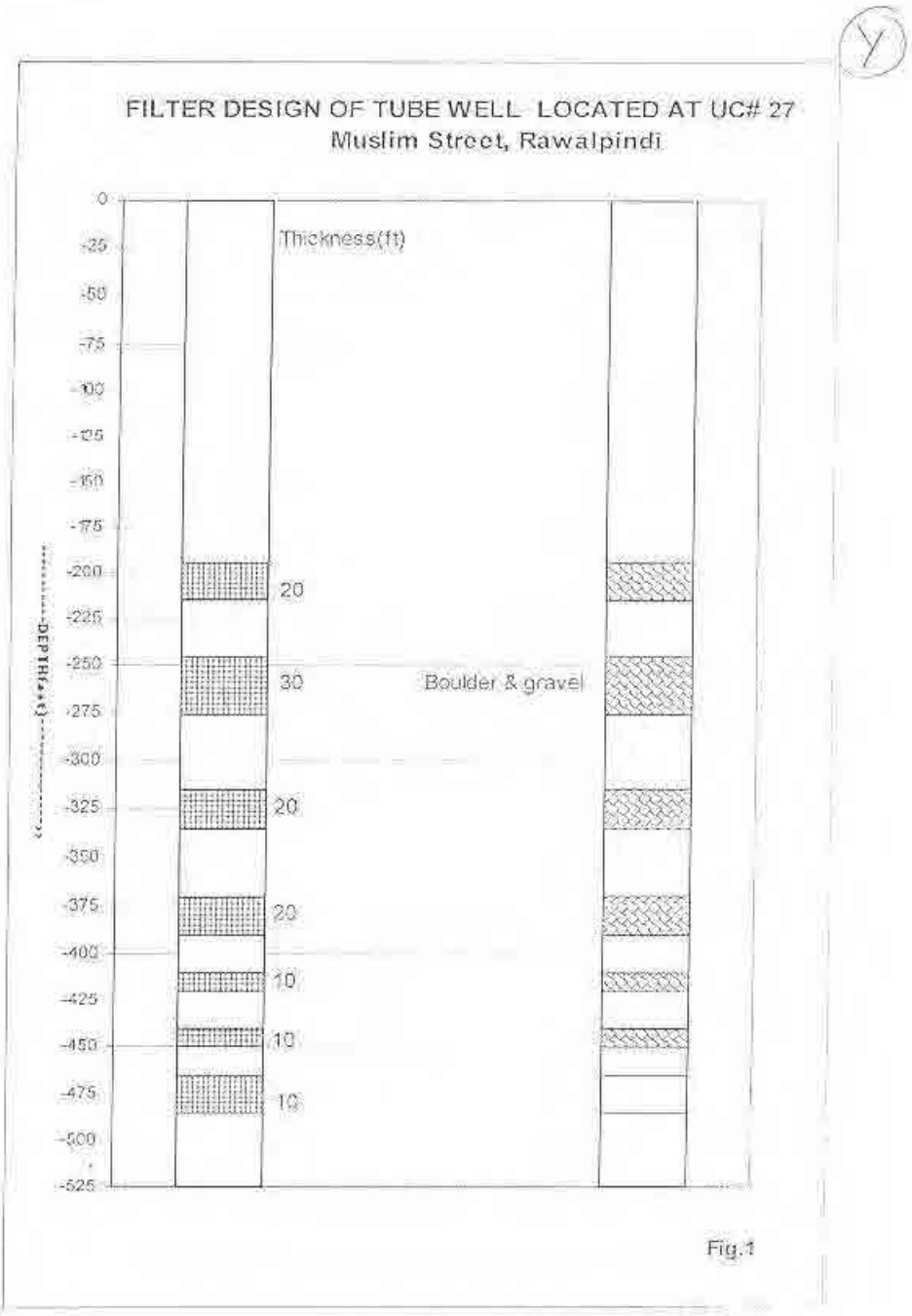

5

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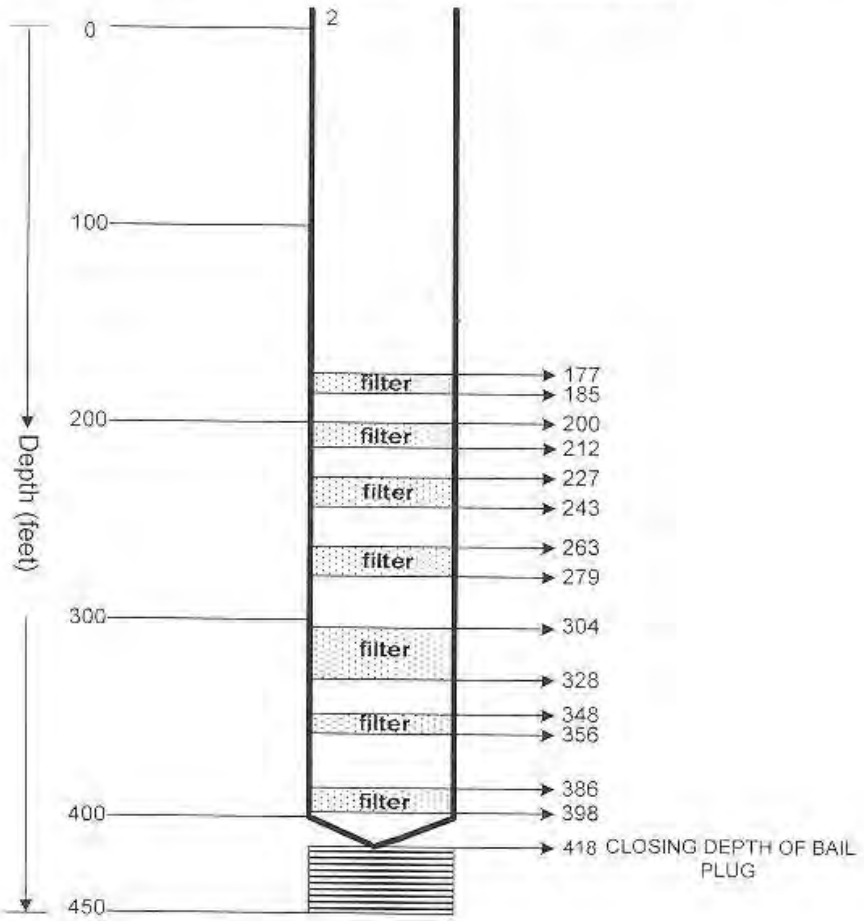
Geo-Electrical Log Based Tubewell Design of water well at site of WASA at Khayaban-e-Sir Syed Sector 4—B near Well No--165 Rwp



legends

filter

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Annexure J: Environmental and Social Assessment Guidelines and Protocols for WSS&D Schemes

Environmental and Social Assessment Guidelines and Protocols for WSS&D Schemes

By : Dr. Jamil Hassan Kazmi
Advisor Environment
Osmani & Co. Pvt Ltd.

TASK-2: Develop Environmental and Social Assessment Guidelines and Protocols for WSS&D schemes

REQUIRED ACTIVITIES:

- To Prepare guidelines for the screening of water supply, sewerage and storm water for environmental assessment.
- To Prepare guidelines and assessment tools for social and environmental assessment of water supply, sewerage and storm water project.
- To Conduct intensive training programme for the staff of the WASA to use the guidelines for project planning, implementing and M&E.
- To Prepare Generic Environmental Management Plan for all major water supply, sewerage and storm water schemes separately. It would also include GEMP for water and waste water treatment plants.

Pakistan Environmental Protection Act (PEPA), 1997

- As Per Section 12 of PEPA, 1997. Revised in 2000

Initial Environmental Examination and Environmental Impact Assessment-(1) No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an initial environmental examination or, where the project is likely to cause an adverse environmental effect, an environmental impact assessment and has obtained from the Federal Agency approval in respect thereof;

Purpose of the Environmental Assessment

- To identify and assess any potentially adverse environmental effects of a new development.
- To suggest measures to avoid or reduce adverse impacts.
- To ensure that environmental consequences were taken into account during planning, construction and operational stages.
- To develop environmental management and mitigation plan.

SCREENING OF EIA:

The process of an EIA commences at the early stages of the conception and design of the project. The first step of screening is to judge the projection according to the schedules of PEPA, which may decide the fate of the project in IEE or EIA.

Whereas at the final stage of screening the rigorous survey of literature will be conducted to review the relevant legislation.

Screening of water supply and sewerage Scheme, for environmental assessment

SCHEDULE II (Project required EIA)

F. Water supply and treatment

- Water supply schemes and treatment plants with total cost of Rs. 25 million and above may fall under EIA

Best Management Practices for Storm (BMPS) water drains

- No laws and rules are available in Pakistan.
- After literature review its is recommended that internationally BMPSs are followed for storm water drain.
- Storm water will used for different purposes, *i.e.*, irrigation, gardening, water reservoirs etc.

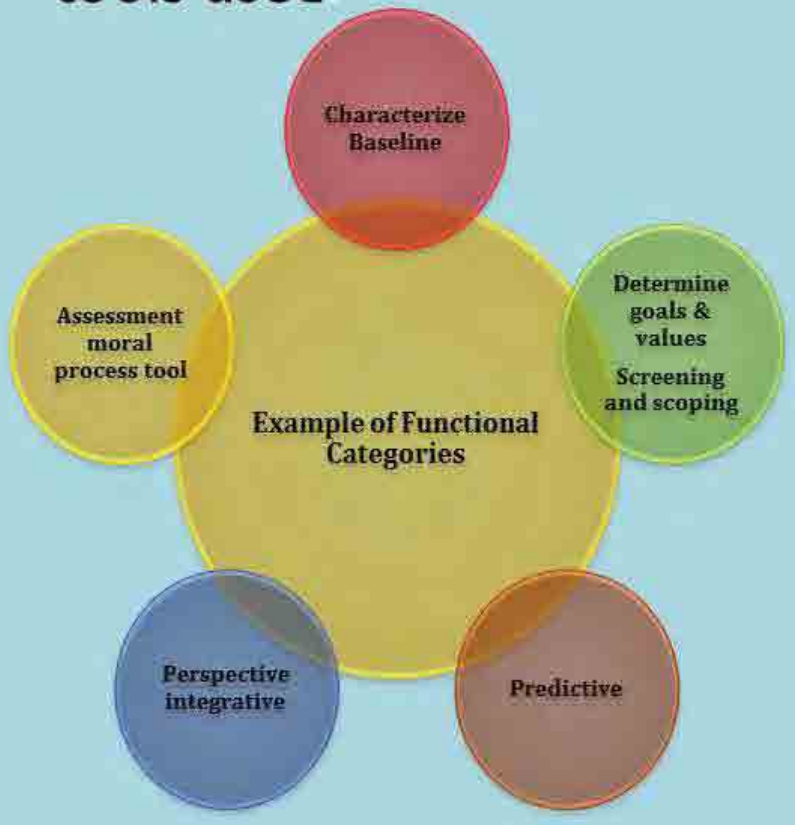
ASSESSMENT TOOLS FOR SOCIAL AND ENVIRONMENTAL ASSESSMENT OF WATER SUPPLY, SEWERAGE AND STORM WATER PROJECT

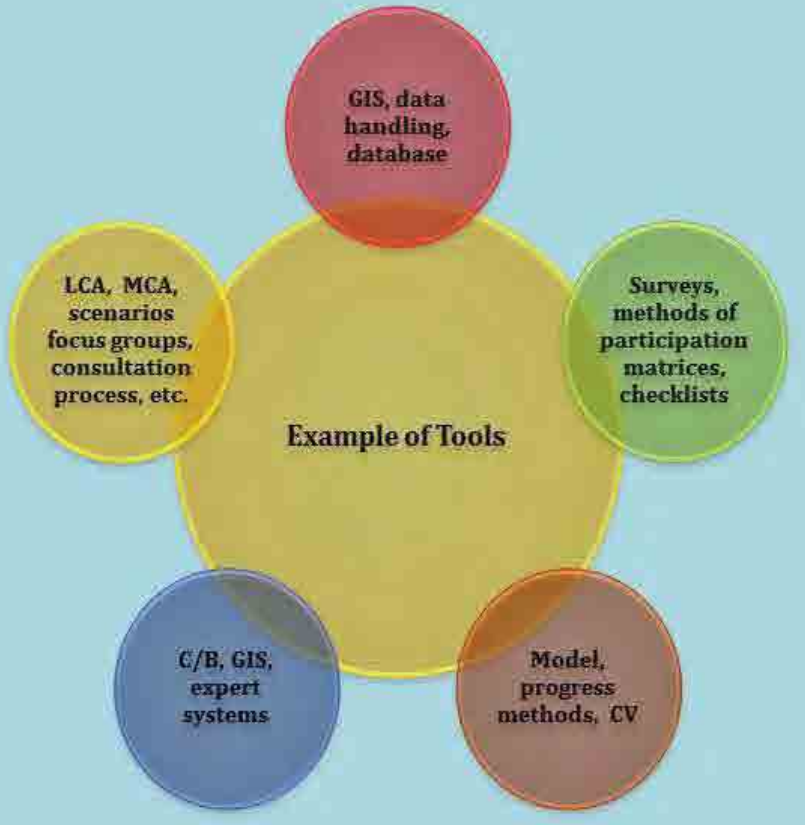
Impact Factors

- For the assessment of social and environmental evaluation of water supply, sewerage and storm water project following themes are identified:
  a. Baseline studies
  b. Management ideologies
  c. Planning doctrine
  d. EA doctrine
  e. Legal regulation mode: "Rule of law" or welfare state model
  f. Professional Culture
  g. View on future
  h. Environmental Discourse : problem perception, problem definition etc.

Assessment Tools

- These tools depends upon impact factors and context of tools used





Context of tools used

- Context of tools includes the following;
  a. Environmental issues
  b. Decision process
  c. Stakeholders and parties to conflict
  d. Sector
  e. Level (national, regional/local)
  f. Legal regulation
  g. Education and "tool competence"
  h. Professional/corporate/administrative culture

Conduct intensive training programme for the staff of the WASA to use the guidelines for project planning, implementing and monitoring & evolution

- Modern tools/techniques for planning, drafting, design and construction supervision of projects is carried out for advance services by using latest/world renowned software for example.
  - MIKE URBAN,
  - Water CAD,
  - Storm CAD,
  - EPANET, etc.
  - Arc-Hydro
- Detailed training will be provided for monitoring & Evaluation of EMMP, OH&S, ERP, QMS.

MANAGEMENT AND TRAINING

Institutional support is critical for the successful wastewater utility operation. It begins with appropriate staffing. Recommended team members are:

1. A manager with technical and administrative experience
2. An environmental engineer
3. Supervisors and workers in operations
4. Sewer maintenance and plant maintenance crafts
5. Laboratory directors and technicians; and
6. Support staff in accounting, budgeting, and clerical areas

- The project includes on-site disposal systems, holding tanks or small-diameter sewers with settling tanks, staff will be needed to develop and enforce standards for the facilities, and to inspect and approve installations, and there will have to be provision for on-site system maintenance.

- A customer relations unit is essential to receive and investigate customer complaints, provide information to customers, and conduct education programs related to the system's services (e.g., hygiene and sanitation, on-site system upkeep). If the utility is responsible for revenue collection, a billing and collections group will be required.

- Training should begin before system start-up, with the assistance of a design consultant. Training should include:

1. operations and maintenance training on the actual equipment
2. basic familiarization with the system
3. its relationship to the environment, and
4. fundamentals of occupational health and safety.

- Industrial waste control staff will need training on operation and maintenance of pretreatment equipment

- A start-up plan should be prepared for any new wastewater facility of significant size to ensure that the requirements described above are met. The start-up plan should provide for:
  - Assembling staff
  - Maintenance equipment and spare parts in advance of need
  - Training all personnel, and
  - Establishing revenue sources and budget.

Generic Environmental Management Plan

Water supply and sewerage System

- **Potential impacts on the environment**

1. Positive Impacts
2. Negative Impacts
3. Planning Considerations
4. Pre-Development Environmental Impacts
5. Post-Development Environmental Impacts
6. Recommendations and Findings

Environmental Impacts and mitigation measures for Sewerage water supply Schemes

- Sewerage Scheme Planning
- Water Quality
- Surface Water Quality
- Groundwater
- Flooding
- Geology & Seismicity
- Soils
- Flora and Fauna
- Health and Safety
- Socio-cultural Impacts
- Cumulative Impacts

Emission requirements

- Air quality issues to consider as part of the mitigation response include fixed and mobile sources of odor, dust, and methane.
- The sources may include treatment of sewage and bio-solids, accidental release of chemicals, storage of effluent and bio-solids, incineration of bio-solids or solid waste and digester gas.
- Air quality tests; if a significant issue found, should include: according to NEQS of Pakistan
  - Baseline data on the ambient quality of the air
  - The projected quantity, frequency and times of emissions.

Monitoring and Reporting

1. Total volume and composition;
2. Hazardous substances entering treatment works;
3. Enforcement of industrial pretreatment conditions;
4. Control of the treatment process;
5. Management of the treatment plant performance;
6. Environmental quality at disposal locations; and
7. Sludge products and reclaimed wastewater quality.

Effect of Various Contaminants on Water Quality and Human Health

Substance	When present within permissible limits of NEQS	When in Excess (Beyond threshold of NEQS)
• Calcium	• Human friendly/ healthy bones	• Heart burning/skin warts
• Magnesium	• Health	• Laxative effects, stomach problems
• Chloride	• No significant effects	• Imparts saltish taste in water
• Sulphate	• Noticeable taste	• Laxative effects
• Nitrate-Nitrite	• No effect	• Blue baby syndrome(infant methaemeglobinaemia) indicator of pollution
• Fluoride	• Helps protection against dental cavities (Human friendly)	• Bone deformation, children get mottled teeth

Substance	When present within permissible limits	When in Excess
• Arsenic	• No significant effect	• Poison, skin cancer, circulatory system problems
• Lead	• No significant effect	• Toxic effect on nervous system(delays mental growth in children)
• Chromium	• No significant effect	• Allergic dermatitis, may cause lung cancer
• Iron	• No noticeable effect	• May cause stains laundry and plumbing fixtures
• Cadmium	• No significant effect	• Kidney damage, carcinogenic
• Cyanide	• No significant effect	• Nerve damage, thyroid problems
• Coli forms	• No significant effect	• Indicators of harmful bacteria.

BMPS for Storm water schemes

Introduction

There are both proven and evolving alternatives to conventional drainage techniques and site designs that can substantially reduce surface runoff quantities and resultant pollutant loadings. These alternative development techniques, commonly called Best Management Practices or BMPs, are aimed at soaking up every drop of rainwater close to where it falls.

Common goals for BMPs

Common goals of Best Management Practices for RWASA are :

1. To reduce the amount of impervious surface areas to reduce storm water runoff;
2. To utilize the landscape and soils to naturally move, store and filter storm water runoff before it leaves the development site; and
3. To prevent, control or treat storm water discharges.

Types of Sewer System

Two types of sewer systems are used to convey storm water runoff: separate storm sewers and combined sewers.

1. ***Separate storm sewer systems*** convey only storm water runoff. Water conveyed in separate storm sewers is frequently discharged directly to receiving streams without receiving any intentional form of treatment.

2. In a *combined sewer system*

Storm water runoff is combined with sanitary sewer flows for conveyance. Flows from combined sewers are treated by sewerage treatment plants prior to discharge to receiving streams. During large rainfall events however, the volume of water conveyed in combined sewers can exceed the storage and treatment capacity of the wastewater treatment system. As a result, discharges of untreated storm water and sanitary wastewater directly to receiving streams can frequently occur in these systems. These types of discharges are known as combined sewer overflows (CSOs).

- ***Site design features*** such as providing rain barrels, dry wells to capture rooftop and driveway runoff, maintaining open space, preserving stream buffers and riparian corridors, using porous pavement systems for parking lots and driveways, and using grassed filter strips and vegetated swales in place of traditional curb-and-gutter type drainage systems can greatly reduce the amount of storm water generated from a site and the associated impacts.

- ***Construction practices*** such as minimizing disturbance of soils and avoiding compaction of lawns and greenways with construction equipment can help to maintain the infiltrative capacity of soils.

Principles for BMPs

- Typically storm water runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), *coliform* etc. Rapid runoff, even of uncontaminated storm water, also degrades the quality of the receiving water by eroding stream beds and banks. In order to reduce the need for storm water treatment, the following principles should be applied:

Principles:

1. Storm water should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge;
2. Surface runoff from process areas or potential sources of contamination should be prevented;
3. Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff;
4. Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds);
5. Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority should be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present;

6. When water quality criteria permits, storm water should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility;
7. Oil water separators and grease traps should be installed and maintained as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas; and
8. Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Specific Considerations for BMPs

1. Vehicle maintenance
2. Lawn and garden care
3. Vehicle Washing
4. Tree planting
5. Backyard stream
6. Contained planters
7. Rain Barrels
8. Rain garden
9. Drainage swales
10. Naturalized detention basin
11. Dry wells
12. Natural landscaping

1. Vehicle maintenance

- By maintaining your car properly you can prevent oil leaks, heavy metals and toxic materials from traveling from your car onto the street. Rain washes oil and other hazardous chemicals from the street into the nearest storm drain, ultimately draining into the *Nallah*.

2. Lawn and Garden Care

- When fertilizing lawns and using other common chemicals, such as pesticides and herbicides, remember you're not just spraying the lawn. When it rains, the rain washes the fertilizers, pesticides and herbicides along the curb and into storm drains, which ultimately carry runoff into the nearest *Nallah*.
- In addition to degrading the water quality of our streams and rivers, pesticides can kill living organisms in the stream and fertilizers can cause algal blooms, which hold up our waterways of oxygen that fish need to survive. If you have to use fertilizers, pesticides, and herbicides, carefully read all labels and apply these products sparingly.

3. Vehicle Washing

- Car washing is a common routine for residents and street Car washers to earn money. However, most of the time, cars are washed in driveways and parking lots which allow wash water (dirty water) to finds its way to the nearest storm drain.

- The wash water often contains pollutants, such as oils and grease, phosphates (from the soap), and heavy metals all of which are unhealthy for people.

4. Tree Planting

- Trees are not only a beautiful addition to the landscape, but they also provide invaluable benefits to cities. Mature trees decrease local temperatures. Trees naturally clean the air of pollutants and create a neighborhood noise buffer.

- Trees also improve storm water management, reducing the amount of polluted storm water that normally would go directly into storm drains. Tree roots also allow rainwater to filter back into the soil, recharging the often thirsty water table.

5. Backyard Stream

- Establish a streamside (riparian) buffer, a vegetated area along the edge of the stream that protects it from pollution and erosion. This buffer zone absorbs pollutants and nutrients that would otherwise end up running directly into the stream.

- Plant material slows runoff and filters out pollutants and sediments. Well-planted streamside buffers are also a great low-cost way to control erosion. While plants slow runoff, filter pollutants, and help control erosion, trees cast shade on the stream, cooling the water, reducing algae growth and improving fish habitat.

6. Contained Planters

- Planters reduce impervious cover (impenetrable surfaces, such as concrete sidewalks, parking lots, etc.) by retaining storm water runoff rather than allowing it to directly drain into nearby sewers.

- Planters offer "green space" in tightly confined urban areas by providing a soil/plant mixture suitable for storm water capture and treatment. They can be used on sidewalks, parking areas, back yards, rooftops and other impervious areas.

7. Rain Barrels

- A rain barrel collects and stores storm water runoff from rooftops. By detaining (temporarily holding) the storm water runoff during a rain event, you can help add capacity to the city's sewer system and reduce sewer overflows.

- The collected rain water can be reused for irrigation to water lawns, gardens, window boxes or street trees. Rain barrels are effective for storm water management when the stored water is emptied in between storms, making room in the barrel for the next storm.

8. Rain Garden

- A rain garden uses native plants and landscaping to soak up rain water (storm water) that flows from downspouts or simply flows over land during a rain event.

- The center of the rain garden holds several inches of water, allowing the storm water to slowly seep into the ground instead of flow directly from your roof, yard or driveway into the nearest storm drain.

9. Drainage Swales

- A swale is a broad, vegetated channel used for the movement and temporary storage of runoff. Swales also can move a portion of the runoff into the ground and filter out runoff pollutants.
- Swales can be effective alternatives to enclosed storm sewers and lined channels, where their only function is to rapidly move runoff from a developed site. On some sites, natural drainage courses may still be present and it is recommended that they be retained as part of the site drainage plan.
- In contrast to conventional curb-and-gutter/storm sewer systems, swales can reduce both the rate and volume of stormwater runoff on a site. Since this is achieved via absorption of runoff into the soil, swales in sandy soils will be much more effective than swales in clay soils.

10. Naturalized Detention Basin

- Naturalized detention is intended to serve multiple functions, in addition to flood prevention, including pollutant removal and creation of wildlife habitat (where appropriate).
- Natural detention basin designs emulate natural lake or wetland systems by utilizing native plants along the water's edge and on side slopes.
- The design generally incorporates flat slopes at the edge of the water or wetland, shallow zones of emergent vegetation at the edge of wet basins, and a combination of vegetated and open water areas in wetland basins.

11. Dry Wells

- Dry wells are small, excavated pits, filled with stone or gravel that temporarily stores storm water runoff until it infiltrates (soaks) into the surrounding soil.

- The storm water can come straight-off of the roof of your house via a downspout that either indirectly or directly connects to the dry well. It can travel indirectly to the dry well through a grassy swale or it can travel directly into the well through a pipe.

- Dry wells help protect streams in combined and separate sewer areas. Dry wells also recharge groundwater through infiltration, which leads to more flow in streams during dry weather (when it is not raining) and less stream bank erosion during wet weather (when it is raining).

12. Natural Landscaping

- Natural landscaping refers to the use of native vegetation – particularly prairie, wetland and woodland species – on a development.
- Native vegetation is a low-cost alternative to traditional landscaping that utilizes turf grass and ornamental plantings.
- A site that is naturally landscaped will produce substantially less storm water runoff than a conventional landscape.
- Native vegetation enhances both absorption of rainfall and evaporation of soil moisture due to extensive root systems that extend down 3 to 10 feet or more. In contrast, the root zone of turf grass typically extends only about 3 to 4 inches.
- The benefits of natural landscaping are enhanced if runoff from impervious surfaces is routed across native vegetation buffer strips. Natural landscaping reduces pollutants associated with urban runoff

- It can be estimated that removal rates for suspended solids and heavy metals (such as cadmium and lead) could be as high as 80 percent and removal rates for nutrients (such as phosphorus and nitrogen) could be as high as 70 percent for a residential development utilizing natural drainage and native landscaped filter strips.

- Deep-rooted native plants effectively stabilize soils and prevent erosion. It reduced maintenance needs of natural landscaping not only save money, but also reduce air, water and noise pollution.

Reference

- Center for Watershed Protection (2001). "*On-Lot Treatment*" fact sheet in Storm water Manager's Resource Center.
- South River Federation & Center for Watershed Protection (August 2002). *How to Install a Rain Garden.* Instructional Flyer. Chesapeake Bay Trust grant.
- Wachter, S M. 2005. *The Determinants of Neighborhood Transformations in Philadelphia Identification and Analysis: The New Kensington Pilot Study, Published by:* The Wharton School, University of Pennsylvania.
- Center for Watershed Protection (2002). Fact Sheet #5: *Vehicle Washing*. Skills for Protecting Your Stream: Retrofitting Your Own Back Yard.
- Storm water permanent best management practice manual (2007). Department of transportation highway division, State of Hawaii

Bibliography:

Anderson, G.S., 1977, Artificial recharge experiments on the Ship Creek alluvial fan, Anchorage, Alaska: U.S. Geo-logical Survey Water-Resources Investigations Report 77-38, 39 p.

Aronson, D.A., and Seaburn, G.E., 1974, Appraisal of operating efficiency of recharge basins on Long Island, New York, in 1969: U.S. Geological Survey Water-Supply Paper 2001-D, 22 p.

Aronson, D.A., Reilly, T.E., and Harbaugh, A.W., 1979, Use of storm-water basins for artificial recharge with reclaimed water, Nassau County, Long Island, New York--A hydraulic feasibility study: Long Island Water Resources Bulletin 11, 57 p.

Bloyd, R.M., 1971, Underground storage of imported water in the San Gorgonio Pass area, southern California: U.S. Geological Survey Water-Supply Paper 1999-D, 37 p.

Bradner, L.A., 1996, Estimation of recharge through selected drainage wells and potential effects from well closure, Orange County, Florida: U.S. Geological Survey Open-File Report 96-316, 30 p.

Brashears, M.L., 1941, Ground-water temperature on Long Island, New York, as affected by recharge of warm water: Econ. Geology, v. 36, no. 8, p. 811-828.

_____,1946, Artificial recharge of ground water on Long Island, New York: Econ. Geology, v. 41, no. 5, p. 503- 516.

Brown, R.F., Signor, D.C., and Wood, W.W., 1978, Artificial ground-water recharge as a water-management tech-nique on the Southern High Plains of Texas and New Mexico: Texas Department of Water Resources Report 220, 32 p.

Brown, R.F., and Keys, W.S., 1985, Effects of artificial recharge on an alluvial aquifer, Ogallala Formation, Texas: U.S. Geological Survey Water-Supply Paper 2251, 56 p.

Brown, S. G., 1963, Problems of utilizing ground water in the west-side business district of Portland, Oregon: U.S. Geological Survey Water-Supply Paper 1619-O, 42 p.

Burns, A.W., 1980, Hydrologic analysis of the proposed Badger-Beaver Creeks Artificial Recharge Project, Morgan County, Colorado: U.S. Geological Survey Water-Resources Investigations Report 80-46, 90 p.

Burns, A.W., 1984, Simulated effects of an artificial-recharge experiment near Proctor, Logan County, Colorado: U.S. Geological Survey Water-Resources Investigations Report 84-4010, 17 p.

Bush, P.W., 1979, Connector well experiment to recharge the Floridan Aquifer, East Orange County, Florida: U. S. Geological Survey Water-Resources Investigations Report 78-73, 40 p.

Carter, J.M., 1996, Hydrologic data for 1994-96 for the Huron Project of the High Plains Ground-Water Demonstra-tion Program: U. S. Geological Survey Open-File Report 96-555, 131 p.

Cederstrom, D.J., 1947, Artificial recharge of a brackish water well: Virginia Chamber Commerce, v. 14, no. 12, p. 31, 71-73.

Crider, A.F., 1906, Drainage of wet lands in Arkansas by wells: U.S. Geological Survey Water-Supply Paper 160, p. 54-58.

Cronin, J.G., 1964, A summary of the occurrence and development of ground water in the Southern High Plains of Texas with a section on artificial recharge studies by B.N. Meyers: U.S. Geological Survey Water-Supply Paper 1693, 88 p.

Emmons, P.J., 1977, Artificial-recharge tests in upper Black Squirrel Creek Basin, Jimmy Camp Valley, and Fountain Valley, El Paso County, Colorado: U.S. Geological Survey Water-Resources Investigations Report 77-11, 49 p.

_____, 1987, Preliminary assessment of potential well yields and the potential for artificial recharge of the Elm and Middle James Aquifers in the Aberdeen Area, South Dakota: U.S. Geological Survey Water Resources Investigation Report 87-4017, 33p.

Foxworthy, B.L., 1970, Hydrologic conditions and artificial recharge through a well in the Salem Heights area of Salem, Oregon: U.S. Geological Survey Water-Supply Paper 1594-F, 56 p.

Fuller, M.L., 1911, Drainage by wells: U.S. Geological Survey Water-Supply Paper 258, p. 6-22.

Garrett, A.A., and Londquist, C.J., 1972, Feasibility of artificially recharging basalt aquifers in eastern Washington: U.S. Geological Survey Open-File Report, 42 p.

Garza, Serge, 1977, Artificial recharge for subsidence abatement at the NASA-Johnson Space Center, Phase I: U. S. Geological Survey Open-File Report 77-219, 82 p.

Garza, S., Weeks, E.P., and White, D.E., 1980, Appraisal of potential for injection-well recharge of the Hueco Bolson with treated sewage effluent--Preliminary study of the northeast El Paso area, Texas: U. S. Geological Survey Open-File Report 80-1106, 38 p.

Gillespie, J.B., and Slagle, S.E., 1972, Natural and artificial ground-water recharge, Wet Walnut Creek, central Kan-sas: Kansas Water Resources Board Bulletin no. 17, 94 p.

Gillespie, J.B., Hargadine, G.D., and Stough, M.J., 1977, Artificial-recharge experiments near Lakin, western Kan-sas: Kansas Water Resources Board Bulletin no. 20, 91 p.

Graham, D.D., 1989, Methodology, results, and significance of an unsaturated-zone tracer test at an artificial-recharge facility, Tucson, Arizona: U.S. Geological Survey Water-Resources Investigations Report 89-4097, 28p.

Hall, C.W., Meinzer, O.E., and Fuller, M.L., 1911, Geology and underground waters of Minnesota: U.S. Geological Survey Water-Supply Paper 256, 406 p.

Hamlin, S.N., 1987, Evaluation of the potential for artificial ground-water recharge in eastern San Joaquin County, California--Phase 3: U. S. Geological Survey Water-Resources Investigations Report 87-4164, 17 p.

Hart, D.H., 1958, Artificial recharge to ground water in Oregon and Washington: U.S. Geological Survey open-file report, 55 p.

Heisel, J.E., and Gonzales, J.R., 1979, Water budget and hydraulic aspects of artificial recharge, south coast of Puerto Rico: U.S. Geological Survey Water-Resources Investigations Report 78-58, 102 p.

Hickey, J.J., 1979, Hydrogeologic data for the South Cross Bayou Subsurface-Injection Test Site, Pinellas County, Florida: U.S. Geological Survey Open-File Report 78-575, 87 p.

Hickey, J.J., and Barr, G.L., 1979, Hydrogeologic data for the Bear Creek Subsurface-Injection Test Site, St. Peters-burg, Florida: U.S. Geological Survey Open-File Report 78-853, 53 p.

Horton, R.E., 1905, The drainage of ponds into drilled wells: U.S. Geological Survey Water-Supply Paper 145, p. 30- 39.

Hutchinson, C.B., and Wilson, W.E., 1974, Evaluation of a proposed connector well, northeastern Desoto County, Florida: U. S. Geological Survey Water-Resources Investigations Report 74-5, 41 p.

Karlinger, M.R., and Hansen, A.J., 1983, Engineering economic analyses of artificial recharge in the Columbia Basin Project, Washington: Water Resources Bulletin, v. 19, no. 6, p. 967-975

Kimrey, J.O., and Fayard, L.D., 1984, Geohydrologic reconnaissance of drainage wells in Florida: U.S. Geological Survey Water-Resources Investigations Report 84-4021, 67 p.

Knochenmus, D.D., 1975, Hydrologic concepts of artificially recharging the Floridan Aquifer in eastern Orange County, Florida--A feasibility study: Florida Bureau of Geology Report of Investigations no. 72, 36 p.

Koch, N.C., 1984, Effects of artificial recharge on the Big Sioux Aquifer in Minnehaha County, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 84-4312, 8 p.

Lacombe, P.J., 1996, Artificial recharge of ground water by well injection for storage and recovery, Cape May County, New Jersey, 1958-92: U.S. Geological Survey Open-File Report 96-313, 29 p.

Leggette, R.M., and Brashears, M.L., 1938, Ground water for air conditioning on Long Island, N.Y.: Am. Geophys. Union Trans., v. 19, pt. 1, p. 412-418.

Lichtler, W.F., Stannard, D.I.,and Kouma, E., 1980, Investigation of artificial recharge of aquifers in Nebraska: U.S. Geological Survey Water-Resources Investigations Report 80-93, 112 p.

Maurer, D.K., and Fischer, J.M., 1988, Recharge to the Eagle Valley Groundwater Basin by augmented streamflow in Vicee Canyon, western Nevada: U. S. Geological Survey Water-Resources Investigations Report 88-4158, 66 p.

Maurer, D.K., and Peltz, L.A., 1994, Potential for, and possible effects of, artificial recharge in Carson Valley, Dou-glas County, Nevada: U. S. Geological Survey Water-Resources Investigations Report: 94-4126, 87 p.

May, J.E., 1985, Feasibility of Artificial Recharge in the Coastal Plain near Atlantic City, New Jersey, with Emphasis on the 800-Foot Sand of the Kirkwood Formation: : U. S. Geological Survey Water-Resources Investigations Report 85-4063, 24 p.

Meyer, F.W., 1974, Availability of groundwater for the U.S. Navy well field near Florida City, Dade County, Florida: U. S. Geological Survey Open-File Report 74-014, 50 p.

Meyer, W., and Patrick, L, 1980, Effects of artificial-recharge experiments at Ship Creek alluvial fan on water levels at Spring Acres Subdivision, Anchorage, Alaska: U.S. Geological Survey Open-File Report 80-1284, 42 p.

Moulder, E.A., annd Frazor, D.R., 1958, Artificial recharge experiments at McDonald well Field, Amarillo, Texas: Texas Board of Water Engineers Bull. 5701, 34 p.

Muir, K.S., and Coplen, T.B., 1981, Tracing ground-water movement by using the stable isotopes of oxygen and hydrogen, upper Penitencia Creek alluvial fan, Santa Clara Valley, California: U.S. Geological Survey Water- Supply Paper 2075, 18 p.

Norvitch, R.F., Thomas, C.A., and Madison, R.J., 1969, Artificial recharge to the Snake Plain Aquifer in Idaho; An evaluation of potential and effect: Idaho Dep. Reclam. Water Information Bull. no.12, 59 p.

Price, C. E., 1961, Artificial recharge through a well tapping basalt aquifers, Walla Walla area, Washington: U.S. Geological Survey Water-Supply Paper 1594-A, 33 p.

Prill, R.C., and Aaronson, D.B., 1973, Ponding-test procedure for assessing the infiltration capacity of storm-water basins, Nassau County, New York: U.S. Geological Survey Water-Supply Paper 2049, 29 p.

Prill, R.C., Oaksford, E.T., and Potorti, J.E., 1979, A facility designed to monitor the unsaturated zone during infiltra-tion of tertiary-treated sewage, Long Island, New York: U.S. Geological Survey Water-Resources Investigations 79-48, 14 p.

Prill, R. C., 1977, Movement of moisture in the unsaturated zone in a loess-mantled area, southwestern Kansas: U.S. Geological Survey Professional Paper 1021, 21 p.

Reichard, E.G., and Meadows, J.K., 1992, Evaluation of a ground-water flow and transport model of the Upper Coachella Valley, California: U. S. Geological Survey Water-Resources Investigations Report 91-4142, 101 p.

Reeder, H.O., Wood, W.W., Ehrlich, G.G., and Sun, R.J., 1976, Artificial recharge through a well in fissured carbon-ate rock, West St. Paul, Minnesota: U.S. Geological Survey Water-Supply Paper 2004, 80 p.

Rorabaugh, M.I, 1949, Progress report on the ground-water resources of the Louisville area, Kentucky, 1945-49: City of Louisville and Jefferson County, Kentucky (dupl. report), 64 p.

Schaefer, D.H., and Warner, J.W., 1975, Artificial recharge in the upper Santa Ana River area, San Bernardino County, California: U. S. Geological Survey Water-Resources Investigations Report 75-15, 27 p.

Schiner, G.R.and German, E.R., 1983, Effects of recharge from drainage wells on quality of water in the Floridan Aquifer in the Orlando Area, central Florida: U. S. Geological Survey Water-Resources Investigations Report 82- 4094, 124 p.

Schneider, B.J., Ku, H.F.H., and Oaksford, E.T., 1987, Hydrologic effects of artificial-recharge experiments with reclaimed water at East Meadow, Long Island, New York: U. S. Geological Survey Water-Resources Investiga-tions Report 85-4323, 79 p.

Seaburn, G.E., 1970, Preliminary results of hydrologic studies at two recharge basins on Long Island, New York: U.S. Geological Survey Professional Paper 627-C, p C1-C17.

Signor, D.C., Growitz, D.J., and Kam, William, 1970, Annotated bibliography on artificial recharge of ground water: U.S. Geological Survey Water-Supply Paper 1990, 141 p.

Sinclair, W.C., 1977, Experimental study of artificial recharge alternatives in northwest Hillsborough County, Florida: U. S. Geological Survey Water-Resources Investigations Report 77-13, 52 p.

Sniegocki, R.T. 1953, Plans for the first year's work on the artificial recharge project, Grand Prairie region, Arkansas: U. S. Geological Survey Open-File Report, Little Rock, Arkansas, 16 p.

Sniegocki, R.T.,Bayley, F.H., Engler, Kyle, and Stephens, J.W., 1965, Testing procedures and results of studies of artificial recharge in the Grand Prairie region, Arkansas: U.S. Geological Survey Water-Supply Paper 1615-G, 56 p.

Stearns, H.T., Crandall, L., and Stewart, W.G., 1938, Geology and ground-water resources of the Snake River Plain in southeastern Idaho: U.S. Geological Survey Water-Supply Paper 774, 268 p.

Stearns, H.T., Bryan, L.L., and Crandall, L., 1939, Geology and water resources of the Mud Lake region, Idaho, including the Island Park area: U.S. Geological Survey Water-Supply Paper 818, 125 p.

Stringfield, V.T., 1933, Ground-water investigations in Florida: Florida Geological Survey Bull. 11, 33 p.

_____,1936, Artesian water in the Floridan Peninsula: U.S. Geological Survey Water-Supply Paper 773-C, p. 115-195.

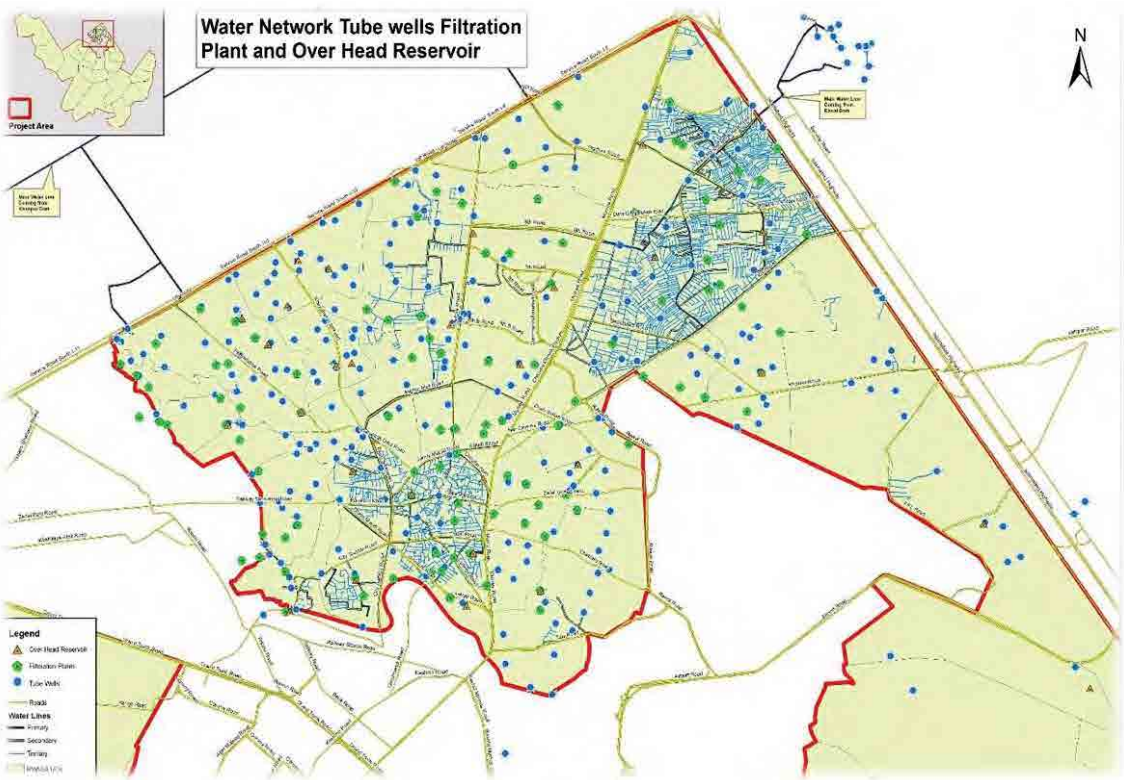
Sumner, D.M., Schuh, W.M., and Cline, R.L., 1991, Field experiments and simulations of infiltration-rate response to changes in hydrologic conditions for an artificial-recharge test basin near Oakes, southeastern North Dakota: U.S. Geological Survey Water-Resources Investigations Report 91-4127, 46 p.

Sumner, D. M., 1996, Hydraulic characteristics and nutrient transport and transformation beneath a rapid infiltration basin, Reedy Creek Improvement District, Orange County, Florida: U. S. Geological Survey Water-Resources Investigations Report 95-4281, 51 p.

WASA

RAWALPINDI

Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi



Study "C" Report (Draft) – June 2015

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Engineering - Architecture - Planning - Mapping - Technology

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STUDY-C

STUDY UNACCOUNTED FOR WATER AND PREPARE STRATEGY FOR ITS REDUCTION TO INTERNATIONAL STANDARDS AND PREPARE PLAN FOR 24/7 WATER SUPPLY

Part I

Detail plan for unaccounted for water (UFW) reduction to less than 20% and leakage detection system / strategy.

1. Detail plan for unaccounted for water (UFW) reduction to less than 20% and leakage detection system / strategy.

The scope of work for this part of the study is as under:

i) Define and identify the District Metering Areas (DMA), identification of goods requirement and consumer survey.

a. Prepare the maps showing water supply lines with size.
b. Show the locations of existing sluice valves.
c. Pinpoint the defective sluice valves.
d. Develop the DMAs. Each DMA should have a size between 15000 to 25000 connections.

ii) Design of individual DMAs with the help of network mapping, isolation of the areas, installation of flow and pressure equipment's, 100% consumer metering, network up-gradation to boost the pressure.

a. Design the individual DMAs with the help of network mapping.
b. For isolation of each DMA mention the inlet and outlet points.
c. Mention the OHRs to boost up the water pressure.
d. Replace the defective meters.
e. Install new meters where these do not exist.

iii) Assessment of UFW, leak detection, leak repair, replacement of pipes and connections.

a. Detect the leakage (visible & invisible) for repair.
b. Replace the old water supply lines with new ones.
c. Old consumer pipe lines be replaced with new ones.

iv) Devise and implement an active Leakage Control Policy / Strategy

2. District Metering Areas (DMA)

RWASA is supplying water to the residents on 8 to 10 hours on daily basis. Some factors that have contributed to this practice of discontinuous supply include:

- Rapid growth in population and water demand (and in some areas, shortage of water);
- Inadequate water charges and billing/collection mechanisms, leading to insufficient revenues to repair, maintain, and replace infrastructure;
- Intermittent and poor quality electricity supply;
- Inadequate human resource development, including training in modern utility operations; and
- Inadequate demand-responsiveness and customer-orientation among service providers.

Most of the times these networks are not the outcome of a single process of design. They are the consequence of years of history giving anarchic response to continually rising new demands. As a result, their layouts lack a clear structure from a topological point of view. Consequently, as other complex systems, water supply networks demand deeper hydraulic knowledge to operate and to carry out tasks of maintenance, guaranteeing the quantity and the regularity of the supply to the final costumer. The division of a network into District Metered Areas (DMA) follows a divide and conquer strategy that splits the large highly interconnected distribution network into smaller sub networks.

DMA's have been used in parts of the world for over 100 years. The DMA approach is recognized as the best practice for distribution system leakage investigation and water loss control. With a DMA, a small portion of the water distribution system can be isolated with supply coming from a single or multiple feeds. Flows are recorded in a manner that allows the minimum night flow to be calculated to determine changes in input volumes that may indicate leakage networks.

From a classical perspective, the division of a water supply network into DMAs is used with the target of leak control like Covas and Ramos [1999], since it helps maintaining a permanent pressure control system. This is the main reason for IWA [2007] to recommend a DMA size between 500 to 3000 service connections (Hunaidi and Brothers [2007]). Nevertheless, this target has become more ambitious recently, and AVSA [2009] incorporated new actions such as: carry out audits to know the hydraulic efficiency, characterize the demand curve, detect frauds or diverse errors of measurement, and reduce maintenance costs.

Presently the RWASA has divided the water supply system in five zones these are:

- Zone East 1 (UC 33, 34, 39 to 46 Total 10 UC's)

- Zone West 1 (UC 1to 9, 35, 37, 38 Total 12 UC's)
- Zone West 1 A (UC 10, 11, 12 Total 3 UC's)
- Zone 2 (Shams-abad (UC 21to 23, 30 to 32), Farouq-e -Azam Road (UC 24to 29) Total UC's 12.
- Zone West 2 (UC 13 to 20, 36 Total UC's 9)

RWASA has requested for formation of DMAs having a size between 15000 to 25000 connections. Further as per Study B TOR DMAs has been defined as district metering area and in Study D Task-2 it is defined as district management area. The design for DMAs would be done during Study D TASK-2: Functional Design of WASA Water Districts & its Capacity Building Program in future to work WASAR as an internationally compatible utility.

2.1. Municipal boundaries

Any boundary between utilities, where water is imported or exported outside the jurisdiction should be metered.

2.2. Distribution facilities

These include pumping stations, pressure reducing facilities, and storage facilities. System flow profiles, reservoir balancing, and real water loss calculations can be achieved with distribution system metering.

2.3. Pressure Management Areas (PMA)

Similar to DMA's, boundaries between pressure areas or districts should be metered. This allows the utility to monitor input flows and demands, and identify areas within the entire system that may require more attention with respect to real water losses.

2.4. Universal Metering

In its simplest definition, universal metering involves moving from a flat rate, or non-metered based, system of billing to a volume based metered user pay system. With a flat rate system, users who consume a high amount of water are billed the same amount as those who use only a little. With a metered system, consumers are billed for the metered volume of water they use.

While there is a comprehensive list of reasons why utilities choose to meter, there are four underlying and fundamental drivers for universal metering:

- ✓ Equity;
- ✓ Water efficiency and environmental stewardship;
- ✓ Economic management benefits; and

- ✓ System management.

To achieve a long-term reduction in efficient and effective water use, universal metering should also be complemented with an appropriate pricing structure and a public education program to show consumers how to use water efficiently.

2.5. Supply Meters

In general, supply meters are used in the following four applications.

A raw water meter measures the amount of water withdrawn from the water source, normally at the point of withdrawal. For surface water sources, it is normally installed at the high lift raw water pumping station; for groundwater systems at the well house. In systems with lengthy raw water transmission piping, a second raw water meter may be installed directly before the treatment facility to determine system loss in the raw water transmission piping.

A production water meter records the total amount of water produced and input into the distribution system. Production metering is best inserted just before water exits the treatment facility into the distribution system. Production metering is an essential operating parameter for treatment facility operation, and for distribution system operation and water accounting.

Source water meters act as both a raw water meter for water withdrawal and a production meter for treatment and system operation. Little or no water is used between the water withdrawal point and the production point. Source water meter installation is recommended at the exit of the treatment facility.

Distribution water meters are used to measure water movement within the distribution system.

2.6. Types of Supply Meters

2.6.1. Differential Pressure Flow Meters

Differential pressure meters include venture style, V-cone and orifice plate designs. The principle of the differential pressure flow meter is to create a flow restriction where water velocity is increased at the restriction. Pressure readings are taken both upstream and at the restriction. The differential pressure reading between both points is directly proportional to the square of the flow.

2.6.2. Magnetic Flow Meters

Magnetic flow meters (mag meters) use the Faraday principle. A magnetic field is generated around the pipe where flowing water induces an electric current that is directly proportional to the velocity of the water.

2.6.3. Turbine and Propeller Flow Meters

These meters have rotor blades placed directly in the path of flowing water. When water strikes the blades, they rotate at a rate that is proportional to the flow velocity. Turbine meters have a rotor mounted on two central bearings. Propeller meters have a tapered propeller face that normally does not cover the entire pipe cross-section.

2.6.4. Ultrasonic Flow Meter

The ultrasonic flow meter is a non-intrusive device that uses a pair of transducers placed appropriately on the pipe such that an ultrasonic pulse is sent in the direction of flow, followed by a return pulse in the opposite direction. The principle is that the pulse along the flow will be faster than the return pulse. The time difference between the pulses is a function of the velocity of the water.

2.6.5. Vortex Flow Meter

The vortex flow meter utilizes a non-streamlined body placed directly in the middle of the pipe axis. This body splits the flow into two streams and creates eddies directly downstream of the meter. Eddies created by the low-pressure area behind the shedding element alternately rotate with the spacing between them being directly proportional to the velocity of the water.

2.6.6. Insertion Flow Meter

Several types of insertion flow meters use the same principles as the full bore flow meters.

They include the pitot rod (differential pressure), turbine, magnetic (single and multipoint), paddle, and vortex insertion meters. Insertion meters measure the velocity of flow at a single point within the pipe and are installed through tap connections with an isolating valve.

2.7. Supply Meter Types Advantages and Disadvantages

The advantages and disadvantages for each type of meter based on accuracy, flow range capability, pressure loss, installation requirements, and maintenance are as under:

Meter Type	Advantages	Disadvantages
Venturi	• Long life, primary element >30 years • Transducer >10 years • Low maintenance	• Difficult to service primary element • Installation costs may be high • Requires more space to install • Lower turndown ratio

Orifice plate	• Low cost flow meter • Easy to install and service • Long life, primary element >30 years • Transducer >10 years	• High pressure loss • Flow range may be too low • More sensitive to pipe arrangement
Magnetic	• Little or no pressure loss or flow obstruction • Large range of sizes • High flow turndown range (bi-directional) • Not affected by minor flow disturbances	• Requires electrical conductivity in water (not usually a problem in drinking water) • Higher accuracy models become expensive
Propeller/ Turbine	• Large range of sizes • Excellent accuracy – short term • Broad range of flow • Easy installation	• High maintenance cost and frequent calibration required • Can be expensive in large pipes • Wear affected by water quality • Very sensitive to flow disturbances
Ultrasonic	• Non-intrusive with no friction loss • No flow interruption during maintenance • Very high range of flow (100:1) • Low installation cost • Cost effective for larger pipes	• Very sensitive to physical fluid characteristics • Very sensitive to flow profile changes • Very sensitive to flow disturbances • Affected by pipe wall condition and internal scaling • Expensive in smaller pipe application
Vortex	• Low head loss • Very high turndown ratio • Simple installation and maintenance • Very good accuracy	• Sensitive to flow profile disturbances • Limited range of pipe sizes • Slightly more expensive than other types of meters of same size
Insertion	• Inexpensive in larger pipe applications • No flow interruption during maintenance • No measurable head loss • Installation is simple and inexpensive	• Very sensitive to flow profile and location of measurement • Requires frequent calibration • More sensitive to pipe arrangement

3. Mapping of the Water Supply Net work

Survey of the RWASA assets is on-going and identified assets are being marked on GIS maps. **Annexure –A,** Figure 1, 2, 3 and 4 shows the mapping of tube wells, Water reservoirs (underground/ overhead), water filtration plants and main water supply network respectively which have been surveyed. As the survey continues, this map will be updated in the subsequent reports.

4. UN accounted for Water

The unaccounted for water (UFW) is also termed as nonrevenue water (NRW) and is the difference between the amount of water put into the distribution system and the amount of water billed to consumers.

Unaccounted-for water can be expressed in millions of gallons per day (mgd) but is usually discussed as a percentage of water production:

Unaccounted-for water (%) = (Production - metered use)/ (Production) x 100%

AWWA has recommended against the use of the terms "unaccounted-for" water and "unaccounted-for water percentage." Instead, water utilities should employ the term "Non-revenue" Water and the performance indicators in the IWA/AWWA Water Audit Method.

The following percentages indicate the share of NRW in total water produced in some countries:

- Singapore 5%
- Denmark 6%
- Netherlands 6%
- Japan 7% (2007)
- Eastern Manila, Philippines 11% (2011), down from 63% in 1997
- MWA, Bangkok 25% (2012)
- Dhaka, Bangladesh 29% (2010)
- Eastern Jakarta, Indonesia 39% (2011)

Although all customers may be metered in a given utility, a fairly sizable portion of the water most utilities produce does not pass through customer meters. Unmetered water includes unauthorized uses, including losses from accounting errors, malfunctioning distribution system controls, thefts, inaccurate meters, or leaks. Some unauthorized uses may be identifiable. When they are not, these unauthorized uses constitute unaccounted-for water. Some unmetered water is taken for authorized purposes, such as firefighting and flushing and blow offs for water-quality reasons. These quantities are usually fairly small.

The primary cause of excessive unaccounted for water is often leaks.

There are several reasons which lead to the high % of UFW in a system, some of these areas under:

4.1. Inaccurate or Incomplete record keeping

It is important to always obtain as built maps of all lines installed on the water system. This will save water system, valuable time and money later as well as reduce stress. Maps should be updated constantly to provide valuable information when needed.

4.2. Meter error

Meters are the Cash Registers of the Utility system. If metering is not properly conducted the system loses valuable revenue as well as encountering unaccounted-for water problems.

In case of surface water sources, bulk ultrasonic metering is available at intakes on Rawal and Khanpur dams – flow meters are also installed in supply pipes thereafter.
In case of groundwater, glow meters were installed at most of RWASA's tube wells, but most of these meters were installed in chambers where it was very difficult to read them. These meters are not in use anymore. However, flow rates of tube wells are generally known and estimates of volume of groundwater pumped into the supply lines is made by knowing the pumping rates and hours of operation.

An attempt was made to fix flow meters at user ends so that billing may be done as per consumption rather than flat rates; however, there had been too many customer complaints because flow meters would also register air flow during intermittent supplies. Digital meters were too expensive to replace simple flow meters. There seemed no immediate fix for the intermittent supplies. The attempt was abandoned.

RWASA does generate some additional revenue by leasing out its un-used land, and renting out space for billboards on its elevated tanks etc.

In many systems meters are overlooked and are the source of most complaints. Proper metering can make or break a system literally.

4.3. Unmetered uses such as firefighting, line flushing, etc.

A Utility should supply simple daily-usage forms to the Fire Dept. and other bulk water users filling tanks from the system. Non-revenue water accounts for water points at public stand posts and mini-filtration plans. It is estimated that 2000 gals per day is being delivered to public through mini-filtration plants alone. Religious places are also being supplied water free of cost. Pilferage and theft of water though illegal connections also adds to non-revenue water.

Metered, Calculated or Estimated water used for line flushing and other bulk uses not involving a tank should be recorded.

These forms should be turned over to the billing dept. monthly so the water may be accounted for.

4.4. Water Theft and unauthorized use.

Under-reporting of usage by authorized bulk water users, or unauthorized bulk water use. Enforcement actions are needed to curtail this loss.

Unauthorized Taps. Can be found anywhere in the system. (Old dead taps or illegal taps)

Unauthorized reconnecting of disconnected service. Such as turning the unlocked valve on after cut-off day.

From a public health and drinking water quality point of view it is being argued that the level of real water losses should be as low as possible, independently of economic or financial considerations, in order to minimize the risk of drinking water contamination in the distribution network.

The World Bank recommends that NRW should be "less than 25%", while the Chilean water regulator SISS has determined a NRW level of 15% as optimal in its model of an efficient water company that it uses to benchmark service providers. In England and Wales NRW stands at 19% or 149 liter/property/day.*(Source - Non-revenue water Wikipedia, the free encyclopedia)*

4.5. Leaks.

Age and materials of a water system as well as population density served can affect the amount of unaccounted-for water.

The most of pipes in the distribution system are underground. A significant problem in Rawalpindi water supply system is the presence of services of abandoned pipes all over the City. A series of pipe laid over the last 30 years or so, has been abandoned over time, as new systems were put in place. Inter connection of the Tube Wells was also noted which is causing the pressure problems in the City.

At present in RWASA old and aging infrastructure contributes towards leakages. There is no mechanism to detect leakages from the buried pipes which have become old and rusted and have developed cracks. Only visible leakages can be fixed when observed. Illegal and unauthorized connections also add to unaccounted water which does not generate revenue.

Quality of construction and materials have a large impact on loss through leaks.

Taking care of meter problems will immediately increase revenue and is generally the most cost effective action to take

4.5.1. Types of Leaks

There are different types of leaks, including service line leaks, and valve leaks, but in most cases, the largest portion of unaccounted-for water is lost through leaks in supply lines.

Un authorized connections, thefts and leakages all contribute to unaccounted for water. Some efforts were made under World Bank's initiative for benchmarking during which WASA took a deliberate effort of identifying and regularizing unauthorized connections. It was also estimated during the same project that approximately 40% water goes unaccounted in the system. Leaking of water from old and aging water supply pipes is a prevalent issue. WASA teams fix any leak which is visually detected, mostly close to the surface. However, WASA neither has the ability, nor any equipment to detect underground leaks in the system. Currently there is no mechanism to locate hidden/underground leaks.

There are many possible causes of leaks, and often a combination of factors leads to their occurrence.

- **The material**,

The material selection of pipes has great importance in preventing leakages. The selection criteria for obtaining different types of material for water supply pipes depends on wall thickness, available lengths, non- corrosive properties of pipes, internal diameter, friction properties, carrying capacity, cost of water pipes, easy availability in the local market. It also depends on the installation procedures, transportation and topographical/geological nature of the terrain. The specifications for different types of Pipes are attached as **Annexure B.**

- **Age**,

The infrastructure for water delivery comprises pumping stations, overhead tanks, underground tanks and pipes network. While surface water supplies are generally going through the storage facilities, most tube wells pump directly into the water supply mains. Many water supply pipelines are old and leaking. Many water supply pipes are buried close to sewer lines/drains. Many households have suction pumps attached to water supply lines. Pollution from sewers around the water supply lines often gets sucked into the drinking water lines where suction pumps are used and/or where there is intermittent supply of water.

- **Water supply system**

In RWASA the system of water supply is intermittent and water is supplied for 8 hours daily. Intermittent systems and systems which require frequent valve operations are likely to affect equitable distribution of water mostly due to operator negligence.

During the supply period the water is stored in all sorts of vessels for use in non-supply hours, which might contaminate the water. Often, when the supply is resumed, the stored water is wasted and fresh water again stored. During non-supply hours polluted water may enter the supply mains through leaking joints and pollute the supplies. Further, this practice prompts the consumers to

always keep open the taps of both public stand posts and house connections leading to wastage of water whenever the supply is resumed.

Another related factor is the quality of the initial installation of distribution system components. Water conditions are also a factor, including temperature, velocity, and pressure. External conditions, such as stray electric current; contact with other structures; and stress from traffic vibrations can also contribute to leaks.

Signs of underground leaks include:

- ✓ Unusually wet spots in landscaped areas and/or water pooling on the ground surface.
- ✓ An area that is green, moldy, soft, or mossy surrounded by drier conditions.
- ✓ A notable drop in water pressure/flow volume.
- ✓ A sudden problem with rusty water or dirt or air in the water supply (there are other causes for this besides a leak).
- ✓ Heaving or cracking of paved areas.
- ✓ Uneven floor grade or leaning of a structure.
- ✓ Unexplained sudden increase in water use, consistently high water use, or water use that has been climbing at a fairly steady rate for several billing cycles.

4.6. Leak detection and Repair Strategy

There are various methods for detecting water distribution system leaks. These methods usually involve using sonic leak-detection equipment, which identifies the sound of water escaping a pipe. These devices can include pinpoint listening devices that make contact with valves and hydrants, and geophones that listen directly on the ground.

Large leaks do not necessarily constitute the greatest volume of lost water, particularly if water reaches the surface where they are usually found quickly, isolated, and repaired. However, undetected leaks, even small ones, can lead to large quantities of lost water since these leaks might exist for a long time.

Ironically, many small leaks are easier to detect because they are noisier and easier to hear using hydrophones. The most difficult leaks to detect and repair are usually those under stream crossings. Leak detection efforts should focus on that portion of the distribution system.

Leak detection efforts should focus on the portion of the distribution system with the greatest expected problems, including:

- Areas with a history of excessive leak and break rates;
- Areas where leaks and breaks can result in the heaviest property damage;
- Areas where system pressure is high;
- Areas exposed to stray electric current and traffic vibration;
- Areas near stream crossings; and

- Areas where loads on pipe exceed design loads.

4.6.1.1. Procedure for detecting leaks

Walking

Walking over the main looking for telltale signs of presence of water.

Sounding

Sounding is the cheapest and an effective method of detecting leaks in a medium - sized water supply system.

4.6.1.2. Procedure for detecting and quantifying invisible leaks

In the case of transmission mains the leaks become visible due to the high pressures. However if it is necessary to identify the invisible leaks procedures have to be established for detecting and locating non visible leaks. Selection and procurement of equipment for detection and location of leaks must take into account the cost effectiveness and the financial capability of the agency.

Management has to process the data and evaluate the work on detection and location of leaks and for dissemination of the results and initiate actions to control the overall problem of water loss.

Supply for short hours under low pressure is common in developing countries. Leak detection equipment's and meters do not function effectively under low pressure. Hence the necessity to increase pressure over a particular duration of time to measure leak flow.
In the selected area to be tested, obtain all details of the water supply system such as location and size of mains valves, consumer connections. If they are not readily available utilize road measurers to measurer length; pipe locators to detect the alignment of pipes; valve locators to locate the valves. Study their working condition and restore them to operational level.

Decide the isolation points of test area, either by closing the existing valves or by cutting the main and capping it during test. The consumer's connections may be isolated by closing the stop taps. If stop taps are not available they can be provided or connections can be temporarily plugged or capped.

Water is drawn from the tanker and injected into mains of test area by using a pump. A bypass pipeline returns the water partially to the tanker.

By manipulating the valves provided on the pump delivery and on the return lines, the desired pressure is maintained. The water that is pumped in, is measured by a meter with pulse head and a data logger for recording the flow. A pressure transducer is also provided to log the pressure at the injection points. Since all exit points are closed, the amount of water recorded by the meter as flowing is obviously the amount of leakage in the system.

Down loading of loggers is done into a computer and graphs of flow and pressure with time are obtained. Consequent to tests and repairs to leaks the reduction in leak flow and the improvement in pressure can be obtained from typical computer graphs.

4.7. Recording of Leaks

RWASA should maintain records for the reported leaks. RWASA has set up an on-line Complaint Cell for the customers where complaints are registered and monitored for progress/action on-line. Management Information System (MIS) has also been employed within RWASA offices with desktop computers and internet access throughout the offices. RWASA assets are being mapped recorded in GIS environment.

4.7.1. Repair/Replacement of Leakages/Damaged water supply pipe lines done by WASA Rawalpindi financial years 2013-2015.

WASA RDA has divided the entire boundary of water supply system in two zones.

- East Zone
- West Zone

After detailed analysis of available data, the following reasons are found against repair/replacement of water supply system.

1- Water Supply Pipe lines damaged due to construction activities like

- Rehabilitation, Widening or construction of new roads by different executing agencies like (RDA, TMA, Local Govt. District Govt.) The most recent example of Metro Bus System
- Deep excavation during construction of shopping malls along road
- Deep excavation during laying of utility services (Sewerage, Sui Gas, PTCL cables)

2- Complains received to WASA by different localities against polluted drinking water or shortage of water.

3- Leakages in old rusty laid network of water supply system in different areas which required time to time maintenance to meet the required pressure and flow.

4- Maintenance/replacement of leakages against specials fixed on water supply network like Sluice valve, butterfly valve and at joints.

5- Maintenance of chambers constructed for specials.

There are 79 schemes are reported against repair/replacement in east zone and 66 schemes of west zone for the years 2013-2015. The pipe dia of replaced or repaired network are ranging from 2’’ to 54” of different materials like G.I. HDPE, A.C, PRCC and M.S.

The detail of each scheme like is given in table below:

REPAIR/REPLACEMENT OF LEAKGAES/DAMAGED WATER SUPPLY PIPE LINES OF WASA RDA RAWALPINDI. YEAR (2013-2015)				
Sr. No.	Name of Work	Salient Features of Work		
		Replaced Pipe Material, Dia & Length	Replaced House Connection	Connection with Existing Main
1- EAST ZONE				
1	Repair/Replacement of Water Supply Pipe Line 24'' dia M.S at Murree Road, Rawalpindi.	M.S 24'' dia= 2250 Rft		
2	Replacement of Water Supply Main Pipe Line at Murree Road Underpass to Liaquat Bagh Chowk, Rawalpindi. (Metro Bus Project)	HDPE 12'' dia= 1160 Rft	40	
3	Welding of damaged Water Supply 24'' dia Pipe Line in teli Mohallah Murree Road, Rawalpindi. (Metro Bus Project)	Lump sum 1 No. Job		
4	Checking of joint of Water Supply 24'' dia PRCC Pipe Line Near kohati bazar, Murree Road, Rawalpindi. (Metro Bus Project)	Lump sum 3 No. Job		
5	Providing/ Fixing of Gibault joint 16'' dia opposite durbar shah di talian, Murree Road, Rawalpindi.	Gibault Joint on 16'' dia A.C Pipe Line 3 No. Job		
6	Providing/ Laying of M.S water supply pipe line opposite Grotto Gulabi, Murree Road, Rawalpindi. (Metro Bus Project)	18'' dia M.S Pipe Line 1 No. Job Lump Sum		
7	Replacement of 3'' dia HDPE Water Supply Pipe Line at Dhok ali Akbar Gali No. 11, Rawalpindi.	HDPE 3'' dia= 580 Rft	20	
8	Rectification/Rehabilitation of existing HDPE 3'' dia Water Supply Pipe Line at Chandani Chowk, Murree Road, Rawalpindi. (Metro Bus Project)	HDPE 3'' dia= 675 Rft	8	6'' dia= 1 No. 10.'' dia= 1 No.
9	Replacement of old leaks Water Supply Pipe Line for redress the complaint against polluted drinking water, in street no. 5, awan colony, Dhok kala khan, UC-21, Rawalpindi.	HDPE 3'' dia= 800 Rft	50	6'' dia= 2 No.
10	Rectification/Rehabilitation of damaged Water Supply Pipe Line during the construction of nullah 6th road Allah Din shadi hall to Khyber hotel, Murree Road, Rawalpindi.	HDPE 3'' dia= 230. Rft	10	
11	Providing/ Fixing of U-Type clamp on 24'' dia PRCC Water supply pipe line Asghar mall chowk, Murree Road , Rawalpindi. (Metro Bus Project)	3 U Type clamps of 3 feet long on 24'' dia Pipe Line 1 No. Job Lump Sum		
12	Providing/Laying of Water Supply Pipe Line for making connection of Dhok munshi with A-Block Tube well for Redress the complaint against shortage of water, UC-26, Rawalpindi.	HDPE 3'' dia= 1650 Rft		6'' dia= 6 No.
13	Providing/Laying of Water Supply Pipe Line in street# 7 Dhok khaba for Redress the complaint against polluted drinking water, UC-44, Rawalpindi.	HDPE 3'' dia= 750 Rft	7	6'' dia= 4 No.
14	Repair of leakages in 3'' and 4'' dia Water Supply Pipe Line at Girja Road, Dhok sayydan, PP-06, Rawalpindi.	Lump sum 1 No. Job		
15	Replacement of 3'' dia HDPE Water Supply Pipe Line at Nai abadi Dhok Jalal din street# 19, Girja Road, PP-06, Rawalpindi.	HDPE 3'' dia= 700 Rft	20	6'' dia= 3 No.

16	Repair of leakages in 8'' dia Water Supply Pipe Line at Islamabad express way due to cutting of trenches by CDA at Gangal stop, Islamabad.	Lump sum 1 No. Job		
17	Replacement of 3'' dia HDPE Water Supply Pipe Line in Bhatti street, Sadiq Abad, UC-25, Rawalpindi.	HDPE 3'' dia= 450 Rft	32	6'' dia= 2 No.
18	Shifting of Sluice Valve from chamber of tube well no. 29 for prevention of Dengue virus, Muslim Town, UC-27, Rawalpindi.	HDPE 3'' dia= 150 Rft	20	6'' dia= 6 No.
19	Repair of leakages of Water Supply Pipe line near Jamia Masjid Allah Dad Mohallah Raja Fiaz Street and OHR Bihari colony, Rawalpindi.	Lump sum 1 No. Job		
20	Repair of butterfly valve of 42'' dia water supply line shamas Abad OHR, Rawalpindi.	Lump sum 1 No. Job		
21	Repair of 6'' Dia A.C Water Supply Pipe Line at street #15 near park Gulzar-e- Quaid, Rawalpindi.	Lump sum 1 No. Job		
22	Providing/ Fixing of Gibault joint 24'' dia near Nawaz shareef park, Murree Road, Rawalpindi.	Lump sum 1 No. Job		
23	Repair of Main Water Supply Pipe Line at central area, Rawalpindi.	M.S 24'' dia= 1180 Rft	Butterfly Valve 24'' dia= 1 No.	
	1. Disconnection of Existing 27'' dia PRCC Water supply line from feeding main 36'' dia and 27'' dia PRCC line at Asghar mall and Banni chowk 1 No. Job			
	2. Connection of new pipe line of 24'' dia M.S with existing main 36'' and 27'' at Asghar mall and Banni chowk 1 No. Job			
24	Shifting of water supply line from sewerage line in street#7 Dhok khaba, Rawalpindi.	HDPE 3'' dia= 110 Rft	16	
25	Replacement of damaged butterfly valve of 20'' dia water supply line opposite Nawaz shareef park, Rawalpindi.	Butterfly Valve 20'' dia= 1 No.		
26	Blockage of 12'' dia A.C Water Supply Pipe Line at commercial market, Rawalpindi.	Lump sum Job		
27	Repair of leakage at kural chowk, Ghori town, Phase-II, Marble factory, Rawalpindi.	G.I 6'' dia= 30 Rft		
28	Repair of leakage of 4'' dia G.I water supply line at street # 10 mohallah chahudrian hukam dad chah sultans, Rawalpindi.	Lump sum Job		
29	Repair of leakage of 3'' dia HDPE water supply line at murgh mandi road, Rawalpindi.	Lump sum Job		
30	Replacement of old leaks rusty Water Supply Pipe Line for tube well no. 13-C Pandora road, Rawalpindi.	HDPE 3'' dia= 210 Rft		
31	Repair of leakage of water supply line at 6th road, city lab, D-Block near Total petrol pump, UC-19, 20, Rawalpindi.	Lump sum Job		
32	Repair of leakage of water supply line at different visits sirajia park, dhobi ghaat and commercial market, Rawalpindi.	Lump sum Job		
33	Repair of 24'' dia water supply pipe line at OHR and GST at Hashmat ali collage, Farooq-e- Azam road, Rawalpindi.	Lump sum Job		
34	Repair of 6'' dia A.C Water Supply Pipe Line at main bazar, Al Noor colony, PP-06, Rawalpindi.	A.C 6'' dia= 15 Rft		
35	Repair of leakage of Water Supply Pipe Line at street# 11, House No. NE-2957 Amar pura, UC-32, Rawalpindi.	G.I 4'' dia= 25 Rft		

36	Repair of leakage of Water Supply Pipe Line at street# 07, Amar pura, UC-32, Rawalpindi.	HDPE 3'' dia= 15 Rft G.I 3'' dia= 22 RfT		
37	Repair of leakage of 28'' dia A.C Water Supply Pipe Line at Service road, Gujarat Bakers, Rawalpindi.	Lump sum Job		
38	Repair of leakage of 4'' dia HDPE Water Supply Pipe Line at mohallah Islam pura, Shakrial, WASA Rawalpindi.	HDPE 4'' dia= 21 Rft		
39	Repair of leakage of 28'' dia A.C Water Supply Pipe Line at Data Gunj Bakhsh road near kyani bazar chowk, UC-23, Rawalpindi.	Lump sum Job		
40	Repair of leakage of Water Supply Pipe Line in commercial market back side of plazas, Rawalpindi.	HDPE 3'' dia= 30 Rft		
41	Replacement of 6'' dia Water Supply Pipe Line at OHR Farooq-e-Azam road to dhok kashmirian, UC-23, Rawalpindi.	HDPE 6'' dia= 600 Rft		
42	Repair of leakage of Water Supply Pipe Line at double road near Mubarak hotel, Rawalpindi.	HDPE 4'' dia= 30 Rft		
43	Repair of 24'' dia A.C water supply pipe line kyani bazar near Quality CNG, Rawalpindi.	Lump sum Job		
44	Repair of leakage of water supply pipe line Sohan village.	Lump sum Job		
45	Repair of 4'' dia HDPE water supply pipe line near arshi masjid, Sohan village.	Lump sum Job		
46	Repair of 6'' dia HDPE water supply pipe line in street no. 57 near Amar pura, Rawalpindi.	Lump sum Job		
47	Repair of 6'' dia G.I water supply pipe line Near Tube well no. 17, Indus collage, Kyani bazar, Dhok kashmirian, Rawalpindi.	G.I 6'' dia= 20 Rft		
48	Repair of leakage of 6'' dia water supply pipe line Near Makki Masjid, Zafar-ul-Haq road, Rawalpindi.	G.I 6'' dia= 17 Rft		
49	Repair of leakage of 3'' and 4'' dia HDPE water supply pipe line at dhok kala khan, UC-79, WASA Rawalpindi.	HDPE 3'' dia= 40 Rft HDPE 4'' dia= 20 Rft		
50	Repair of leakage in G.I 6'' Dia water supply pipe line in Gulzar-e-Quaid, WASA Rawalpindi.	G.I 6'' dia= 90 Rft		
51	Repair of damaged 4'' and 8'' dia A.C Water Supply Pipe Line at flyover, chandani chowk both side of Murree road, Rawalpindi.	HDPE 4'' dia= 100 Rft G.I 4'' dia= 50 Rft		
52	Repair of leakage of Water Supply Pipe Line opposite side of WAPDA office collage road, Rawalpindi.	HDPE 4'' dia= 20 Rft		
53	Replacement of old leaking rusty Water Supply Pipe Line 3'' dia in Kathmandu street near wahab-ul-khair park, B-Block, commercial market, Rawalpindi.	HDPE 3'' dia= 350 Rft		
54	Replacement of damaged Water Supply Pipe line of Tube well no. 45-A to dhok hukam dad, UC-33, Rawalpindi.	HDPE 4'' dia= 140 Rft	15.00	
55	Disconnection of illegal Water Supply connection from Rising main, Sohan village.	Dewatering of 24'' dia M.S Pipe line and removal of 40 feet length		

56	Repair of M.S 20'' dia Water Supply pipe line at service road, Rawalpindi.	Lump sum Job		
57	Repair of 10'' A.C dia Water Supply pipe line in Sadiq Abad chowk, Rawalpindi.	Lump sum Job		
58	Repair of leakage at kali tanki, said pur road, Rawalpindi.	HDPE 3'' dia = 40 Rft		
59	Repair of 20'' A.C dia Water Supply pipe line at Zafar-ul-Haq road, UC-31, Rawalpindi.	Lump sum Job		
60	Repair of 20'' dia A.C Water Supply pipe line near Bilal hospital, A-Block satellite town Mughal plaza, UC-26, Rawalpindi.	Lump sum Job		
61	Repair of leakage G.I 6'' dia Water Supply pipe line in rising main in Gulzar-e-Quaid, Rawalpindi.	Lump sum Job		
62	Repair of 20'' dia A.C Water Supply pipe line near chamara godam, chah sultan near Amar pura, UC-30, Rawalpindi.	Lump sum Job		
63	Repair of leakages at Behari colony OHR chungi No.8, Rawalpindi.	G.I 3'' dia= 15 Rft G.I 4'' dia= 20 Rft		
64	Repair of leakages of 6'' dia of OHR at Usman-e-Ghani park, Asghar mall scheme, Rawalpindi.	HDPE 2'' dia = 38 Rft		
65	Repair of 8'' dia A.C Water Supply pipe line Street no. 1, Rafiq Abad, UC-22, Rawalpindi.	Lump sum Job		
66	Repair of leakage of Water Supply pipe line, Iqbal town, Rafiq Abad, UC-22, Rawalpindi.	G.I 8'' dia= 10 Rft		
67	Repair of 20'' dia A.C Water Supply pipe line at 6th road, Rawalpindi.	Lump sum Job		
68	Repair of leakage at 4'' and 8'' dia A.C Water Supply pipe line Jamshaid market, Iqbal town, Rawalpindi.	Lump sum Job		
69	Repair of leakage at 6'' dia G.I Water Supply pipe line in tube well no. 122, B-Block and Umar-e-Farooq Masjid, Rawalpindi.	Lump sum Job		
70	Repair of 24'' dia Water Supply pipe line at Data Gunj bakhsh road near asim kyani street, UC-23, Rawalpindi.	Lump sum Job		
71	Repair of leakage of 10'' dia G.I Water Supply pipe line in front of Madrassa Sohan village.	Lump sum Job		
72	Repair of leakage of 16'' dia Water Supply pipe line in Sohan village.	Lump sum Job		
73	Repair of leakage of 24'' dia A.C Water Supply pipe line, kyani bazar, Dhok kashmirian, Rawalpindi.	Lump sum Job		
74	Repair of leakage of 24'' dia A.C Water Supply pipe line service road near Tarlai wal Hakeem, Dhok kashmirian, Rawalpindi.	Lump sum Job		
75	Repair of leakage of 24'' dia M.S Water Supply pipe line near new Muhammadi autos Sohan village.	Lump sum Job		
76	Repair of leakage of 6'' dia A.C Water Supply pipe line at service road, Pepsi depot, Muslim town, Tube well no. 37, Rawalpindi.	Lump sum Job		
77	Repair of 24'' dia M.S Water Supply pipe line at margallah road near Tube well, Sohan village.	Lump sum Job		

78	Repair of 18'' dia A.C Water Supply pipe line in Iqbal pura, Chaklala road near G.M Frontier Rawalpindi.	Lump sum Job		
79	Repair of Water Supply pipe line leakage at 6th road near Suzuki center, UC-20, Rawalpindi.	Lump sum Job		
	2- WEST ZONE			
1	Providing/Laying Water Supply Pipe Line in service station street Dhok Dalal, UC-37, Rawalpindi.	HDPE 3'' dia= 185 Rft		
2	Providing/Laying of 3'' dia HDPE Water Supply Pipe Line in Nai abadi, Hayat Abad, Dhok Hassu, Rawalpindi.	HDPE 3'' dia= 570 Rft	40	
3	Providing/Laying of 3'' dia HDPE Water Supply Pipe Line in Street No. 1, Near Faisal Masjid, Holy Family Road, Rawalpindi.	HDPE 3'' dia= 220 Rft	11	
4	Providing/Laying of Water Supply Pipe Line in Street No. 10, New Katarian WASA, Rawalpindi.	HDPE 3'' dia= 380 Rft	30	
5	Providing/Laying of 3'' dia HDPE Water Supply Pipe Line from House No. 746/E to 775/E, Khyban-e- Sir Syed Sector-III, Rawalpindi.	HDPE 3'' dia= 390 Rft	30	
6	Providing/Laying Water Supply Pipe Line in Utility store street, Said Pur Road, UC-34, Rawalpindi.	HDPE 3'' dia= 400 Rft	50	
7	Redress the complaint against shortage of water in street no. 57, Dhok mangtal, boring road, UC-04, Rawalpindi.	HDPE 3'' dia= 450 Rft		6'' dia= 2 No. 20'' dia= 1 No.
8	Providing/Laying of Water Supply Pipe Line Street No. 2, Dhok Hassu, fauji Colony, UC-8, Rawalpindi.	HDPE 3'' dia= 130 Rft	4	
9	Providing/Laying Water Supply Pipe Line for Redress complaint of polluted drinking water in street no. 9 and totka wali gali, Ghazni Road, UC-35, Rawalpindi.	HDPE 3'' dia= 700 Rft	60	6'' dia= 2 No. 24'' dia= 2 No.
10	Providing/Laying of 3'' dia HDPE Water Supply Pipe Line at sher pao colony, committee chowk, Rawalpindi.	HDPE 3'' dia= 175 Rft		6'' dia= 2 No.
11	Providing/Laying Water Supply Pipe Line and making connection at toheedi Road, UC-2, Rawalpindi.	HDPE 3'' dia= 240 Rft		6'' dia= 4 No.
12	Providing/Laying Water Supply Pipe Line 3'' dia in safdarabad, UC-37, Rawalpindi.	HDPE 3'' dia= 200 Rft	15	6'' dia= 2 No.
13	Replacement of rusty water supply pipe line in street no. 5 Mohallah Raja sultan, Rawalpindi.	HDPE 3'' dia= 350 Rft	25	6'' dia= 2 No.
14	Providing/Laying Water Supply Pipe Line for redress complaint of polluted drinking water in alamabad, UC-5, Rawalpindi.	HDPE 3'' dia= 510 Rft	20	6'' dia= 8 No.
15	Providing/Laying Water Supply Pipe Line near Jamil Mughal residence for Redress the complaint against shortage of water in Dhok dalal, UC-37, Rawalpindi.	HDPE 3'' dia= 400 Rft	10	6'' dia= 6 No.
16	Providing/Laying Water Supply Pipe Line for Redress complaint of polluted drinking water near ziarat budahu shah Dhok dalal, UC-37, Rawalpindi.	HDPE 3'' dia= 350 Rft	20	
17	Replacement of damaged Water Supply Pipe Line near cheema plaza, Khyban-e- Sir Syed Sector-II, Rawalpindi.	HDPE 3'' dia= 650 Rft G.I 4'' dia= 100 Rft		

18	Redress complaint of polluted water of tube well no. 74, Rawalpindi.	HDPE 3'' dia= 120 Rft		6'' dia= 3 No.
19	Redress the complaint against shortage of water in milad street near collage chowk, Eid gah road, UC-16, Rawalpindi.	HDPE 3'' dia= 150 Rft		6'' dia= 1 No. 24'' dia= 1 No.
20	Providing/Laying Water Supply Pipe Line for Redress the complaint against shortage of water in street opposite Masjid Ahl-e-Hades, Circular road , UC-33, Rawalpindi.	HDPE 3'' dia= 250 Rft G.I 4'' dia= 10 Rft		6'' dia= 1 No. 24'' dia= 1 No.
21	Replacement of old leaking Water Supply Pipe Line teli mohallah, Murree road, UC-39, Rawalpindi.	HDPE 3'' dia= 625 Rft G.I 4'' dia= 20 RfT	20	6'' dia= 6 No.
22	Replacement of old leaking M.S 8'' Dia Water Supply Pipe Line near under pass committee chowk, Murree road, Rawalpindi.	M.S 8'' dia= 100 Rft		
23	Providing/Laying Water Supply Pipe Line for Redress complaint of polluted drinking water in street 24, 25, Khyban-e- Iqbal, UC-9, Rawalpindi.	HDPE 3'' dia= 1500 Rft	120	
24	Shifting of Sluice Valve of tube well no. 146 for Redress complaint of polluted drinking water in different street of shagufta colony dhok dalal UC-37, Rawalpindi.	HDPE 3'' dia= 540 Rft G.I 4'' dia= 20 RfT		
25	Providing/Laying Water Supply Pipe Line for Redress the complaint against shortage of water near tube well 96-A, Bangish colony, UC-9, Rawalpindi.	HDPE 3'' dia= 600 Rft G.I 4'' dia= 20 RfT	40	
26	Repairing of leakage of HDPE 8'' dia Water Supply Pipe Line at Pir wadahie bridge near safdarabad UC-37, Rawalpindi.	Lump sum Job		
27	Providing/Laying Water Supply Pipe Line for Redress the complaint against non-availability of drinking water in street Masjid Umar Farooq and disposal street no. 3 ,Sector-III, Khyban-e- Sir Syed, Rawalpindi.	HDPE 3'' dia= 600 Rft	60	
28	Shifting of Sluice valve from chambers for the prevention of Dengue virus of tube well no. 142-A, Ghazni colony, UC-37, Rawalpindi.	HDPE 3'' dia= 380 Rft G.I 3'' dia= 40 RfT		
29	Shifting of Sluice valve from chambers for the prevention of Dengue virus of tube well no. 143-A, safdarabad, Ghazni colony, UC-37, Rawalpindi.	HDPE 3'' dia= 200 Rft G.I 3'' dia= 40 RfT		
30	Replacement of 3'' dia water supply pipe line in street Jhanday wali gali, mohallah eid gah, Rawalpindi.	HDPE 3'' dia= 300 Rft	25	
31	Repair of 12'' dia AC water supply pipe line at toheedi road, Dhok ratta, UC-2, Rawalpindi.	A.C 12'' dia= 20 Rft		
32	Repair of 14'' dia AC water supply pipe line at Dhok Hassu, Rawalpindi.	A.C 14'' dia= 24 Rft		
33	Replacement of 4'' dia G.I and 3'' dia HDPE water supply pipe line at tube well no. 64 to liaquat bagh OHR, Rawalpindi.	HDPE 4'' dia= 350 Rft	20	

34	Replacement of old leaks Water Supply Pipe Line for redress the complaint against polluted drinking water at said pur road, UC-15, Rawalpindi.	HDPE 3'' dia= 750 Rft	25	
35	Replacement of old leaks Water Supply Pipe Line in street No. 29, Sector-II, Khyaban-e-Sir Syed, UC-10, Rawalpindi.	HDPE 3'' dia= 350 Rft	25	
36	Replacement of old leaks Water Supply Pipe Line in street No. 2, 3, 4, 5 Sector-III, Khyaban-e-Sir Syed, UC-11, Rawalpindi.	HDPE 3'' dia= 1000 Rft G.I 4'' dia= 40 RfT	100	
37	Replacement of old leaking Water Supply Pipe Line in Gali No. 3, Nawab colony, Dhok Hassu, UC-6, Rawalpindi.	HDPE 3'' dia= 300 Rft	35	
38	Replacement of 3'' dia HDPE Water Supply Pipe Line in Sector-III, Khyaban-e-Sir Syed, UC-11, Rawalpindi.	HDPE 3'' dia= 620 Rft	35	
39	Replacement of 3'' dia old damaged Water Supply Pipe Line in street no. 12 near Sirajia park, UC-15, Rawalpindi.	HDPE 3'' dia= 400 Rft	35	
40	Providing/Laying Water Supply Pipe Line for Redress complaint of polluted drinking water in different street bagh sardaran, UC-35, Rawalpindi.	HDPE 3'' dia= 600 Rft	60	
41	Repair of leakage and P/F of butterfly valve water works No. 1 and making connection at House No. 51-E, Satellite town, Rawalpindi.	HDPE 3'' dia= 10 Rft HDPE 4'' dia= 15 RfT		
42	Repair of leakage in Street No. 23, Sector-IV-B KSS, Street No. 5-A, Boring road, dhok mangtal, azeemabad, Dhok hassu, Gali no. 18, Sector-III KSS, Rawalpindi.	G.I 4'' dia= 20 Rft		6'' dia= 8 No.
43	Repair of supply leakages in UC-35, Bagh sardaran OHR and UC-38, Kashmir Colony, Rawalpindi.			
44	Repair of leakage in UC-8, Street No. 2, 18, 20 and 28, Fauji colony, Pir wadahie, UC-7, Bokra road, Rawalpindi.	G.I 4'' dia= 20 Rft		6'' dia= 8 No.
45	Replacement of 24'' dia A.C water supply pipe line near shahnai shaadi haal at bagh sardaran main road, UC-35, Rawalpindi.			
46	Repair of leakage At sufaid tanki and khawaja colony, mohallah Eid gah, Asghar mall road, Rawalpindi.	HDPE 3'' dia= 35 Rft	2	
47	Repairing of leakage of HDPE 3'' and 6'' dia Water Supply Pipe Line at tube well no. 106 and mohalla Raja sultan street no. 8, Rawalpindi.			
48	Redress the complaint against shortage of water in different streets opposite darbar, Eid gah shareef, UC-16, Rawalpindi.	HDPE 3'' dia= 800 Rft	20	
49	Replacement of rusty Water Supply Pipe Line near Dy. Feroz line/Nullah lai, New parain, Rawalpindi.	HDPE 3'' dia= 402 Rft	38	
50	Replacement of rusty Water Supply Pipe Line 3'' dia near house no. F-458 to F-469, F-Block, Satellite town, Rawalpindi.	HDPE 3'' dia= 595 Rft	30	
51	Replacement of rusty Water Supply Pipe Line 3'' dia in SanaUllah colony, Pir panjar chowk, Rawalpindi.	HDPE 3'' dia= 690 Rft	55	

52	Repairing of leakage of 3'' and 4'' dia Water Supply Pipe Line at akal garh gulshan abad street 6, 14 and ghazni colony, UC-37, Rawalpindi.	HDPE 3'' dia= 25 Rft		
53	Redress the complaint against shortage of water in Madrassa wali gali, kohati bazar, UC-33, Rawalpindi.	HDPE 3'' dia= 580 Rft	30	
54	Repair of Water Supply Pipe leakage at water works no. 1, Rawalpindi.	36'' Dia M.S Pipe Line, 1 Job		
55	Repair of 54''dia A.C Water Supply Pipe line leakage near water works no. 1, Said pur road, Rawalpindi.	Lump sum Job		
56	Redress the complaint against shortage of water in street no. 57, Dhok mangtal, Boring road, UC-4, Rawalpindi.	HDPE 3'' dia= 360 Rft		
57	Redress the complaint against shortage of water in street no. 58, Dhok mangtal, Boring road, UC-4, Rawalpindi.	HDPE 3'' dia= 280 Rft		
58	Repair of leakage and making connection in Arjun nagar street no. 1 and ghazni colony, Delhi dawakhana, Rawalpindi.			
59	Repair of Water Supply Pipe leakage in khyban-e Sir syed scheme, Rawalpindi.	HDPE 3'' dia		
60	Repair of Water Supply Pipe leakage at Saba medical store street, Rawalpindi.	HDPE 3'' dia		
61	Repair of Water Supply Pipe line 3'' and 4'' dia leakage Pir wadahie, Fauji colony, Rawalpindi.	HDPE 3'' dia		
62	Repair of Water Supply Pipe line 3''dia PVC leakage at nawab khan wali gali UC-37, Rawalpindi.	HDPE 3'' dia		
63	Repair of Water Supply Pipe line 3''dia HDPE leakage at Dhok dalal near Mola dad hotel, Saeed public school and sector 4-A Dhok najju, Rawalpindi.	HDPE 3'' dia		
64	Repair of leakage Gunj mandi bridge mohan pura, ratta road, Rawalpindi.	HDPE 3'' dia		
65	Replacement of 6'' dia A.C pipe line near tube well no. 122, Katarian market, Rawalpindi.			
66	Repair of leakage of water supply connection near Sunday bazar damaged due to construction of road.	HDPE 3'' dia= 35 Rft		

Schemes of major leakages ranging dia of pipe 8" to 54" are highlighted in green color.

4.8. Impacts of water losses

RWASA is facing two types of impacts on the water supply system due to leakages one is the apparent losses and other is real losses. The apparent losses are due to unavailability of correct data - Water supply planning suffers from inaccurate consumption data for customer populations and analysis of conservation savings is hindered. Further, Paying customers effectively subsidize those who under-pay or don't pay at all for water service due to improper billing and non-availability of customer metering.

The real losses are affecting in a way that more water is withdrawn from sources than customer population needs and Water supply infrastructure is effectively oversized.

4.8.1. Benefits of Leakage control

The economic benefits of leak detection and repair can be easily estimated. For an individual leak, the amount lost in a given period of time, multiplied by the retail value of that water will provide a dollar amount. Remember to factor in the costs of developing new water supplies and other "hidden" costs.

Some other potential benefits of leak detection and repair that are difficult to quantify include:

- Increased knowledge about the distribution system, which can be used, for example, to respond more quickly to emergencies and to set priorities for replacement or rehabilitation programs ;
- Lowered water system operational costs;
- Extended life of facilities;
- More efficient use of existing supplies and delayed capacity expansion;
- Improved relations with both the public and utility employees;
- Reduced potential property damage and water system liability;
- Recovers production capacity lost to leaks and unauthorized use;
- Improved environmental quality;
- Increased firefighting capability;
- Reduced risk of contamination;

4.9. Water Conservation

Human body is 66% water, living tree is about 75% water and almost 80% of the earth's surface is covered with water but only 1 % of earth's water is usable. Water keeps us alive, moderates climate, sculpts the land, removes and dilutes wastes and pollutants, and moves continually through the hydrologic cycle. We waste about two-thirds of the water we use, but we could cut this waste to 15%.

- 65-70% of the water people use throughout the world is lost through evaporation, leaks, and other losses.
- Water is underpriced through government subsidies.
- The lack of government subsidies for improving the efficiency of water use contributes to water waste.

We can use water more sustainably by cutting waste, raising water prices, preserving forests and wetlands in water basins, and slowing population growth. One of the easiest steps we can take to help mitigate the impacts of drought is conserving water. If we use water wisely at all times, more

water will be available to us and to plants and wildlife when a drought happens. Few simple ways you and your community can conserve water.

- **Make Every Drop Count**

  We can lose a lot of water doing simple everyday tasks. Did you know that turning off the water while you brush your teeth can save more than 100 gallons of water a month? If you have a leaky faucet, the drips can add up to 300 gallons of waste water a month.

- **Water-saving Devices**

  Just shutting off the faucet or fixing a leak can save a lot of water. Another way to save water is to install devices that use less water to perform everyday tasks. For example, we use the most water in our homes when we take a shower or flush the toilet. Companies now sell low-flow toilets and showerheads that can cut the amount of water used in half. People are even beginning to use composting toilets that require no water. Also, new washing machines and dishwashers use much less water than older machines.

- **Landscaping**

  Native plants usually need less water to grow or can make better use of the water that is available to them than other types of grasses, trees, and shrubs. People who do this type of landscaping also find creative ways to use rocks or other types of ground covers in their yards or even in front of their businesses.

- **Rainwater harvesting**

  It is the accumulation and deposition of rainwater for reuse on-site, rather than allowing it to run off. Its uses include water for garden, water for livestock, water for irrigation, water for domestic use with proper treatment, and indoor heating for houses etc.

4.10. Water Audit

Water Audit of a water supply scheme can be defined as the assessment of the capacity of total water produced by the Water Supply Authority and the actual quantity of water distributed throughout the area of service of the Authority, thus leading to an estimation of the losses.

The objective of water audit is to assess the following.

- Water produced,
- Water used,
- Losses both physical and non-physical,
- To identify and priorities areas which need immediate attention for control.

The major activity during the overall water audit will be bulk meter installation at those points on the distribution network where water enters the system. It is expected that bulk meters will be required at the following locations:

- All major system supply points.
- All tube wells which supply the system directly.
- Major transfer mains which are expressly required for audit.

The assessment of the leakage rates through the various features of the water supply system should be undertaken. These will include:

- Raw water transmission system.
- Reservoirs.
- Treatment Plant.
- Clear-water transmission system.
- Inter zonal transmission system.
- Tube wells.

The methodology adopted to make an assessment of the level of losses in the transmission system is to install insertion probes/bulk meter at both ends of each section of main being monitored, thus monitoring both the inflow and outflow of the section. This monitoring should be done for a minimum period of 7 days. The difference of inflow and outflow will indicate the losses in the transmission main. The advantage of this method is that the trunk main need not be taken out of service.

Another way to measure leakage is to close two valves on the main. 25mm tapping are made on either side of the upstream valve and a small semi-positive displacement flow meter is connected between the two tapping. Flow through this meter will indicate the leakage in the main between the two closed valves. It must be ensured that the downstream valve is leak proof.

The approximate position of any leakage measured can be determined by the successive closing of sluice valves along the main in the manner of a step test.

To reduce or avoid any leakage or consequent contamination in reservoirs, the reservoirs should be periodically tested for water tightness, drained, cleaned, washed down and visually inspected.
The losses in water storage structures can be monitored for a particular period noticing the change in the level gauges when the structure is out of use i.e. there is no inflow and outflow of water during this monitoring period.

The losses in treatment plant can be monitored by measuring the inflow into the plant and outflow from the plant with the help of mechanical/electronic flow recorders. The difference of inflow and outflow for the monitoring period will indicate the water losses in the plant.
Water audit provides fairly accurate figures of both physical and non-physical losses in the different waste metering areas of city. Accordingly the areas with higher percentage of losses can be identified for carrying out the leakage control exercise for reduction of water losses.

4.10.1. Problems during water audit

- Proper network details in the shape of maps are not available. If at all some maps are available, these are not updated with proper indication of appurtenances.
- By and large, water authorities are not equipped with the necessary equipment.
- Proper budgetary provision is not available for carrying out continuous and effective water audit.
- Lack of co-ordination between the Water Audit unit and operational and maintenance staff.

4.10.2. Energy audit and conservation

Energy is very scarce commodity particularly in developing and underdeveloped countries. Cost of energy is spirally increasing day-by-day. Generally pumping installations consume huge amount of energy wherein proportion of energy cost can be as high as 40 to 70% of overall cost of operation and maintenance of water works. Need for conservation of energy, therefore cannot be over emphasized.

Conservation of energy is also important and necessary in national interest as the nation is energy deficit due to which problems of low voltage, load shedding and premature failures of equipment's are encountered.

Some adverse scenarios which require conservation of energy are;

- Energy consumption is higher than optimum value due to reduction in efficiency of pumps.
- Operating point of the pump is away from best efficiency point (b.e.p.).
- Energy is wasted due to increase in head loss in pumping system e.g. clogging of strainer, encrustation in column pipes, and encrustation in pumping main.
- Selection of uneconomical diameter of sluice valve, butterfly valve, reflux valve, column pipe, drop pipe etc. in pumping installations.
- Energy wastage due to operation of electrical equipment's at low voltage and/or low power factor.

Frequency of energy audit recommended is as follows:

- Large Installations Every year
- Medium Installations Every two years
- Small Installations Every three years

4.11. Strategy

RWASA should do the following for improving the efficiency:

- Promoting water supply efficiency as a standard business practice
- Promoting water conservation strategies
- Ensure Low water leakage losses by conducting Energy audit on yearly basis

- Ensure Minimal unbilled water consumption by providing bulk metering and consumer metering.
- Minimal unauthorized consumption by legal framework so that persons involved in un authorized consumption are punished.

Besides leak detection and repairs, efficiency in the use of water at all levels can prevent loss. From awareness campaigns (especially in schools) to promotion of water-efficient devices (toilet flushing systems, faucets, washing machines), all contribute to prevention of water losses.

Generally as per rule of power supply authority, average power factor (PF) of 0.9 or so is to be maintained in electrical installations. If average PF is less than 0.9 or specified limit over the billing period, generally penalty at rate of 0.5% of bill per each 1% (may vary) shortfall in PF is charged. It is, therefore, obligatory to maintain PF to level of 0.9 or specified limit. Improving PF above the limit is beneficial for conservation of energy.

Leak detection and repair must be a continuous effort. The water system shall reduce system leakage to an economic minimum and repair leaks when reported and cost-effective to repair. In addition to repairing all reported leaks, the water system should consider the following intervention measures to reduce components of un-reported leakage and background leakage:

- Sonic Leak detection surveys;
- Installation of acoustic data loggers;
- Accelerated repair of reported leaks;
- Regular measurement of District Metered Area flows, when applicable;
- Replacement of leaky water mains and laterals; and
- Pressure management.

Part II

Prepare detailed plan for 24/7 water supply.

5. Prepare detailed plan for 24/7 water supply.

Water has been consecrated as a public good by United Nations wherein the access to water is regarded a human right. Providing access to a certain minimum quantity of water for meeting basic human needs is one of the fundamental responsibilities of the State. In the era of rising consumption and resource depletion, water is moving towards becoming an economic commodity. However, despite the prevailing circumstances one cannot deny the social relevance of water.

Urban water service delivery in Rawalpindi can be identified with limited coverage of house to house connections, inadequate supplies and poor quality.

Unfettered withdrawal of ground water has meant that many parts of the country have witnessed a sharp fall in the water table.

Availability of subsidised power has also accelerated uncontrolled withdrawal of water.
Low pressure in the distribution system encourages consumers to install booster pumps thereby increasing energy consumption. Intermittent water supply calls for incremental investment in storage tanks thereby pushing the costs up.

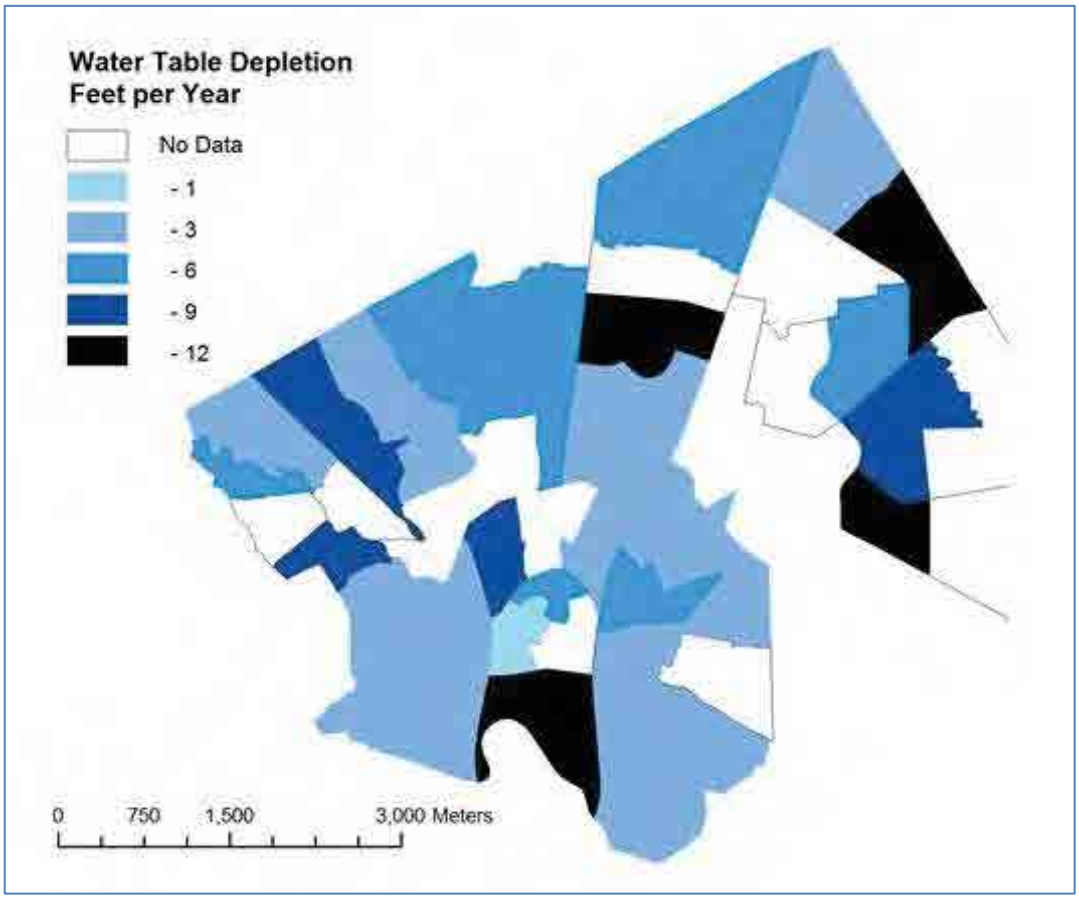
Another significant externality of poor service delivery is the attendant social and health costs. For cities to achieve world-class public health status, it is imperative that they move from an intermittent water supply system to a continuous (24/7) supply regime. Twenty-four hour water supply, seven days a week is an accepted global practice and is prevalent not only in cities of developed countries but also in cities of less developed countries. People in Kampala (Uganda), Singapore, Malaysia, Phnom Penh (Cambodia), Dhulikel (Nepal) and Rabat (Morocco) all have ready access to clean potable water available 24 hours per day 7 days a week at less cost. The upfront benefit is that the 24/7 access to tap-water reduces the costs for households, who no longer need to buy water from street vendors and water tankers.

5.1. Issues for water supply system

Currently, Rawalpindi Water and Sanitation Agency (RWASA) are supplying a total of 67 million gallons per day (MGD) of water through surface and groundwater resources. Surface water supplies come from Rawal Dam and Khanpur Dam which the groundwater supply comes from 376 (363 in working condition) deep tube wells. The plot in Figure 1 summarizes the distribution of these waters.

Rawal Dam supplies 23 MGD against the installed capacity of 28 MGD. Khanpur Dam supplies 6 MGD against an allocation of 14.6 MGD due to shortage of water in Khanpur Reservoir. The installed capacity of the reservoir is 51 MGD. Deep tube wells currently cater for the maximum supply at 38 MGD.

Using depth to water table data from the tube wells in the study area, the average depth to water tables is 280 feet or so. The water table in the study area is going down at an average of 6 feet per year at the current abstraction rates. Figure 6 shows how aquifer levels are going down in the old 46 UCs in Rawalpindi. RWASA is pumping 38 MGD using deep tube wells from the aquifer. The pumping though private tube wells is not accounted for. The current situation suggests abstraction is exceeding the safe yield of the aquifer is depleting.



Groundwater depletion per year in old 46 UCs

RWASA is facing the following issues in the water supply system:

- Overall availability and equitable distribution
- Contamination due to aging network
- Intermittent supply vs. 24X7 supply
- Physical as well as revenue losses due to un accounted for water
- Issues pertaining to Customers' relationship management

5.2. 24/7 Water supply system possibility

24 X 7 water supply is an achievable objective with proper technical & Managerial reforms. The main questions which arise are:

- Needs more water
- Expensive

- Is it necessary?
- Is it achievable?

But fact is that the intermittent water supply Consumes more water, associated with the water pollution & leakage management problems, system is never designed for intermittent supply thus reduces the asset life. Intermittent water supply system has following disadvantages:

- Consumer taps are usually kept open.
- There is a tendency to store more water what is required.
- The 'STALE' water is thrown to store 'FRESH' water.
- Water supply systems do not operate as designed. Therefore, reservoir capacities are often underutilised. The valves suffer wear and tear.
- During non-supply hours, pipes are empty and dirt water enters pipelines at vulnerable spots and water is contaminated. Large doses of chlorine or other disinfectants are required to make water safe from microbial pollution.
- High peak needs strong network and more capital investment. Large size of storage is required and consumers have to pay for pumping.
- Low pressures increases the coping cost of the consumer
- Leak detection & management is difficult.

5.3. Benefits of 24/7 Water Supply system

- ✓ Improved public health through reduction of water pollution.
- ✓ Better system: Demand management by efficient metering and rationalization of tariff
- ✓ Guaranteed water quality as constant pressure in the distribution system prevents contamination of the water from the surrounding ground (as is the case with intermittent supply), which prevents waterborne illnesses, and hence lowers public health costs;
- ✓ Better leak detection & control measures.
- ✓ Higher consumer satisfaction: willingness to pay more and on time.
- ✓ Investments in the network can be optimized.
- ✓ Consumer can utilize his time more productively.
- ✓ Reduction in the coping cost on the consumers.
- ✓ The unregulated ground water exploitation and its negative environmental impact prevented.
- ✓ Overall economic boost: Improved infrastructure attracts Industry / Commerce.

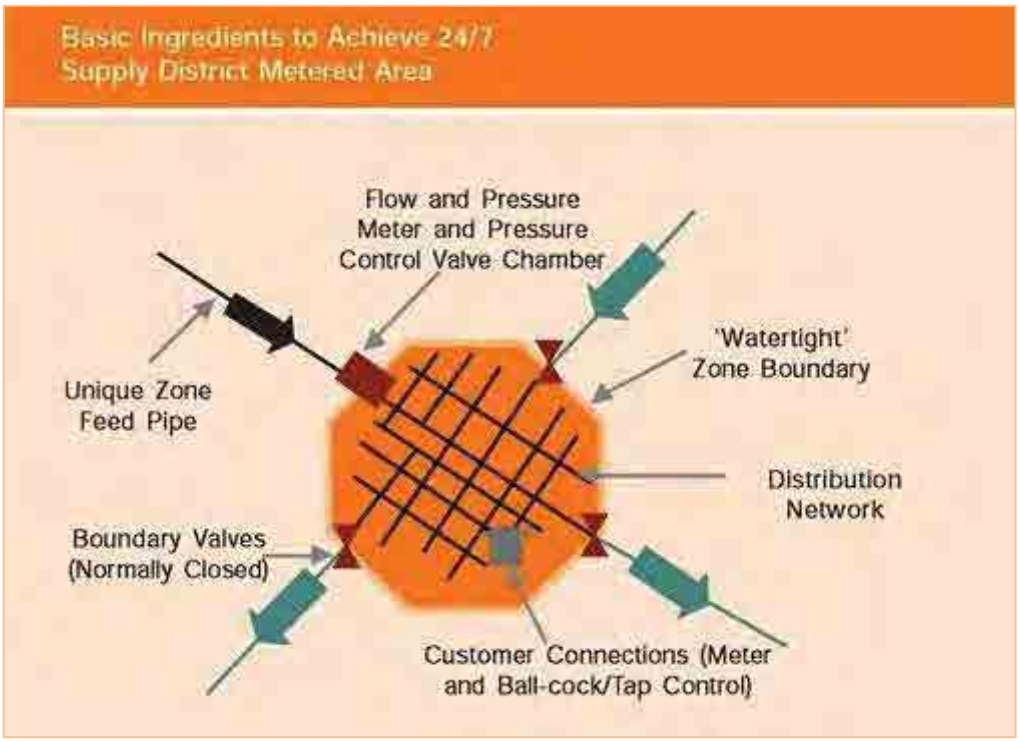
5.4. Strategy/ Plan for 24/7

The first key to convert an intermittent water supply system into 24x7 continuous systems is to understand the water balance, i.e., inflow of water into the system, its consumption and loss in the system.

For most of the cities, quantum of water is finite and hence requires judicious demand management through proper design and operation strategies.

Strategies for conversion from intermittent to 24/7 supply will vary between cities; however, essential building blocks will be common to all. These are:

- Credible data on bulk supply and distribution infrastructure, and accurate customer records.
- A hydraulic model of the supply system which would ensure that bulk water fed into the system can be distributed equitably to all parts of the urban area. The system would be divided into operational zones which may be defined on the basis of service reservoirs, main or booster pumping stations, pressure zones or other operational considerations. The operational zones would then be further sub-divided into DMAs,
- Installation of bulk meters at all critical points on the transmission system in order to monitor and control supply to the operational zones.



Transforming the disorderly distribution system into a well disciplined and properly designed system (pressurized pipelines with optimum pressures) is the task of 24x7 supply system. For that, it needs to meet the present and future requirements. Unless a proper hydraulic model is prepared, it is not possible to convert old intermittent system into a 24x7 system.

- ✓ Digital mapping of the RWASA on GIS compatible base maps.
- ✓ Hydraulic modeling of the entire network.
- ✓ Hydraulic model of DMA, each comprising about 15000 to 25000 connections.
- ✓ 100% Consumer metering, Bulk metering and District Metering set-up.

- ✓ Water balance and estimation of NRW/UFW
- ✓ Leakage detection, Repairs / Rehabilitation / Replacement plan
- ✓ Water balance. If NRW within limits, implement 24X7 supply
- ✓ Introduce pressure regulating devices for equitable distribution
- ✓ Introduce / upgrade Distribution management tool 'SCADA'

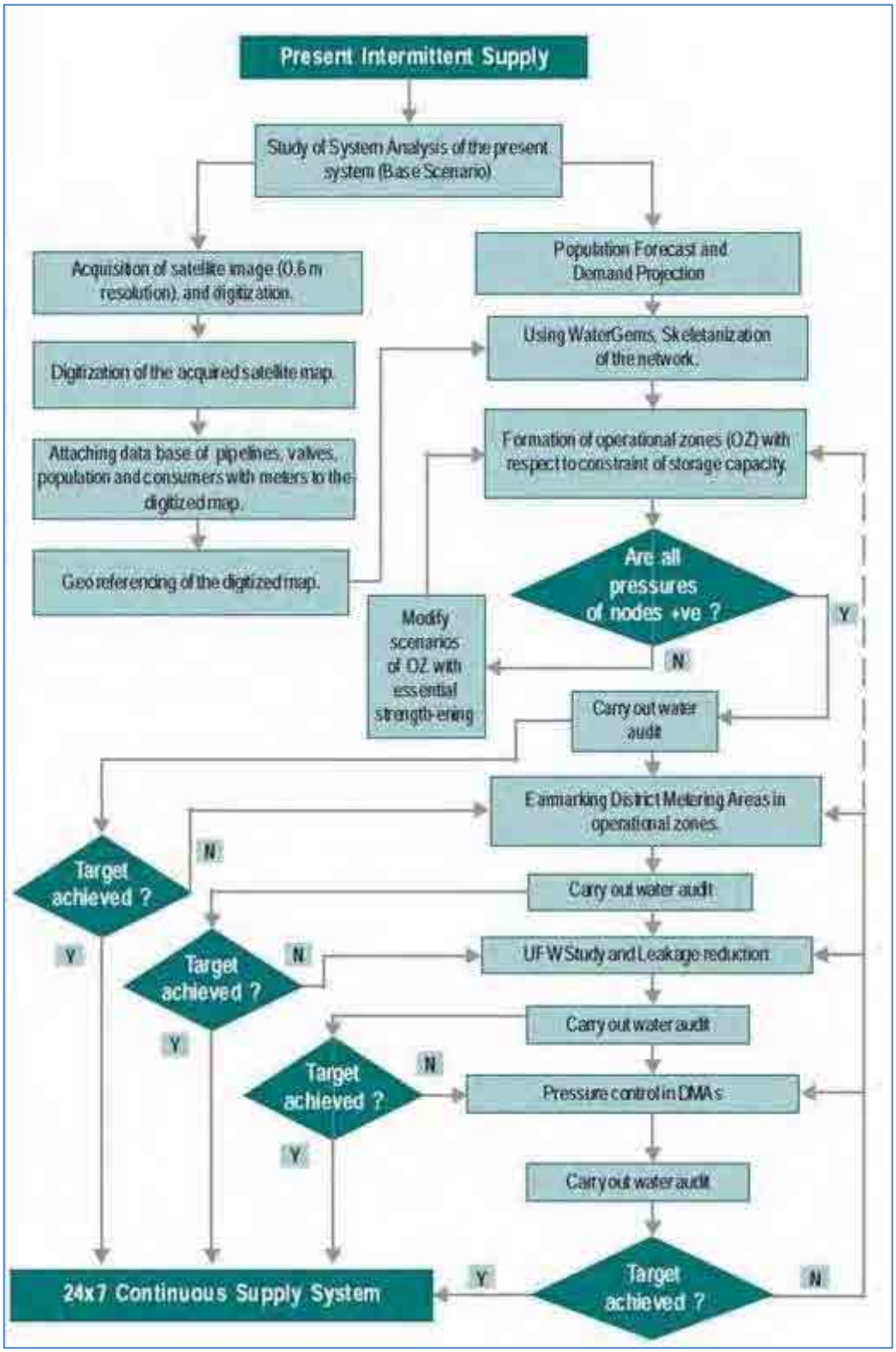
5 Easy Water Saving Tips

Wash laundry & dishes with full loads
Always turn off running water
Take shorter showers
Eliminate any and all leaks
Reduce the flow of toilets & showerheads

RWASA should introduce Universal metering to enable the citizens pay as per their consumption and water connections with prepaid meters to be given to the inhabitants of un-authorized slums & structures so as to avoid stealing of water & tampering of the water mains and thereby cut down the wasteful use of water.

It is important to upgrade customer connections as 60 to 70 percent of leakage appears to take place from these connections. Badly leaking customer connections should be replaced using LDPE or MDPE pipe and a good quality saddle connection, and the customer meter certified for accuracy (or replaced if needed). This operation should be supervised by the RWASA.

Action Plan for Transformation into 24x7 Water Supply System already used by Maharashtra's Badlapur city for supplying pure drinking water round the clock is as under and can also be adopted by RWASA:

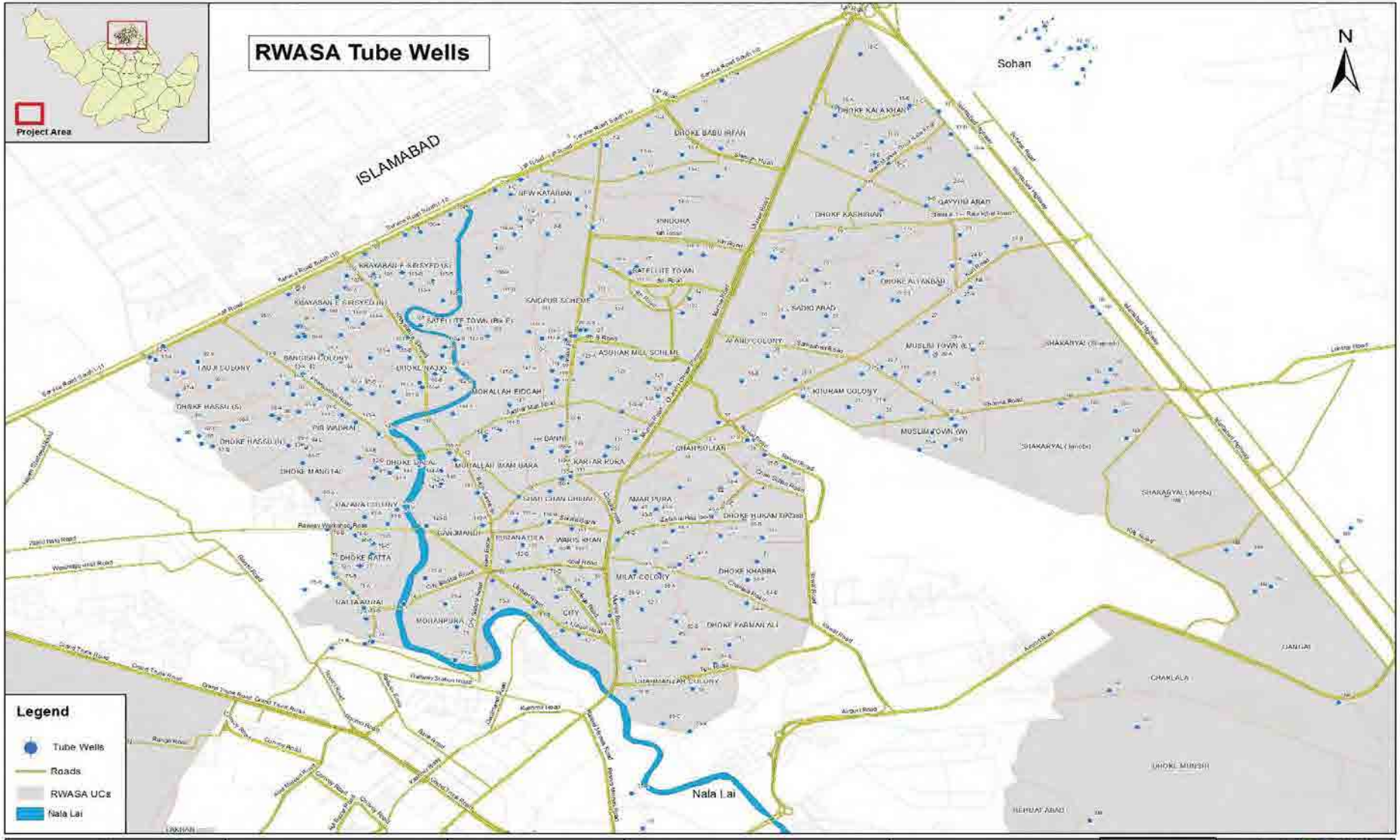


Action Plan for 24/7 water supply system

Annexure-A

GIS Mapping of RWASA Assets

1. **Tube Wells**
2. **Over Head Reservoir's**
3. **Filtration Plants**
4. **Water Supply Network**



CLIENT: WATER AND SANITATION AGENCY (WASA) RAWALPINDI DEVELOPMENT AUTHORITY (RDA)	PROJECT: Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi	Map Code:3040120615	Disclaimer: Sources of information presented in this map is Based on data provided by WASA, RDA and other Sources.	Scale 0 1 Kilometers	Date Created
		Map version 02			12 June 2013

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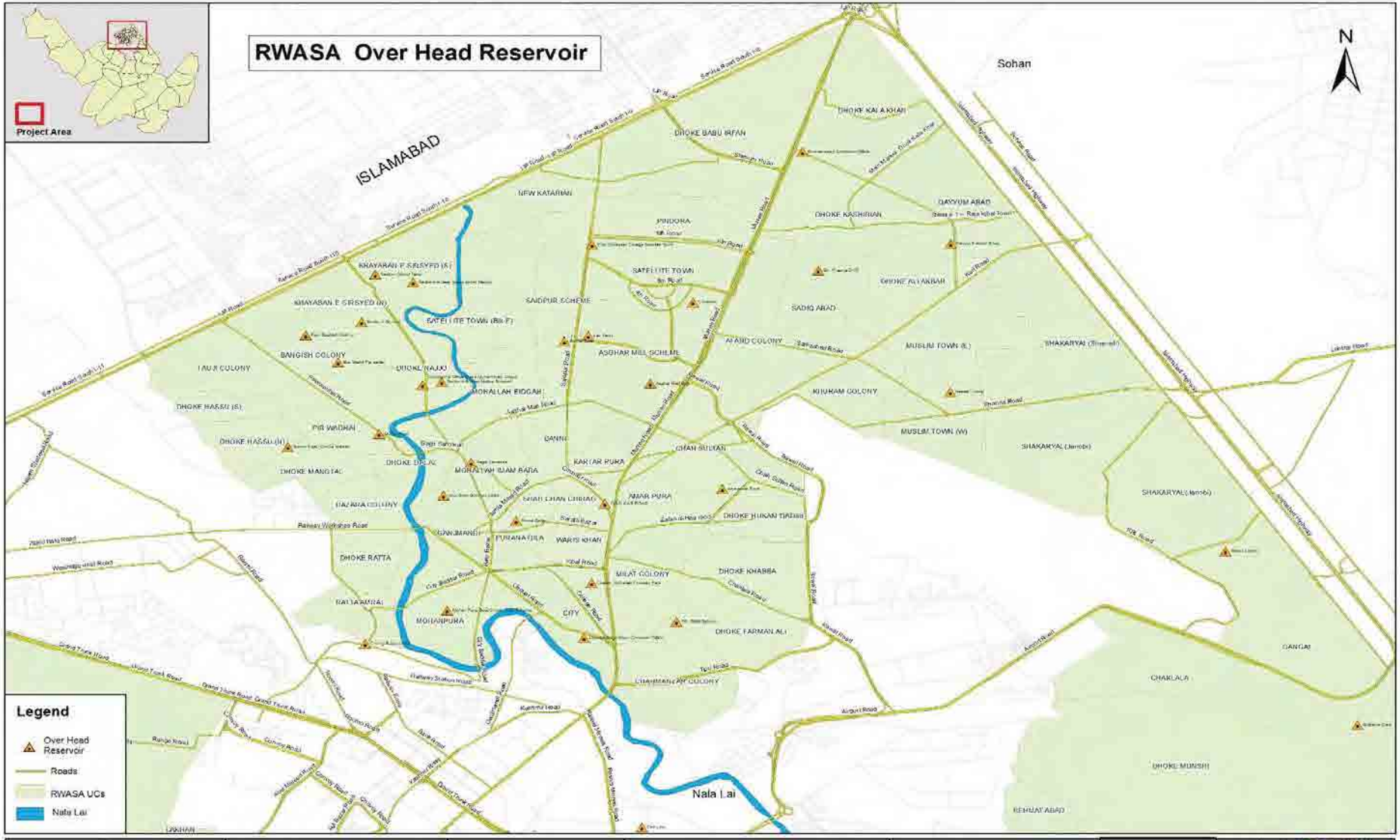

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		Map version 02			12 June 2015

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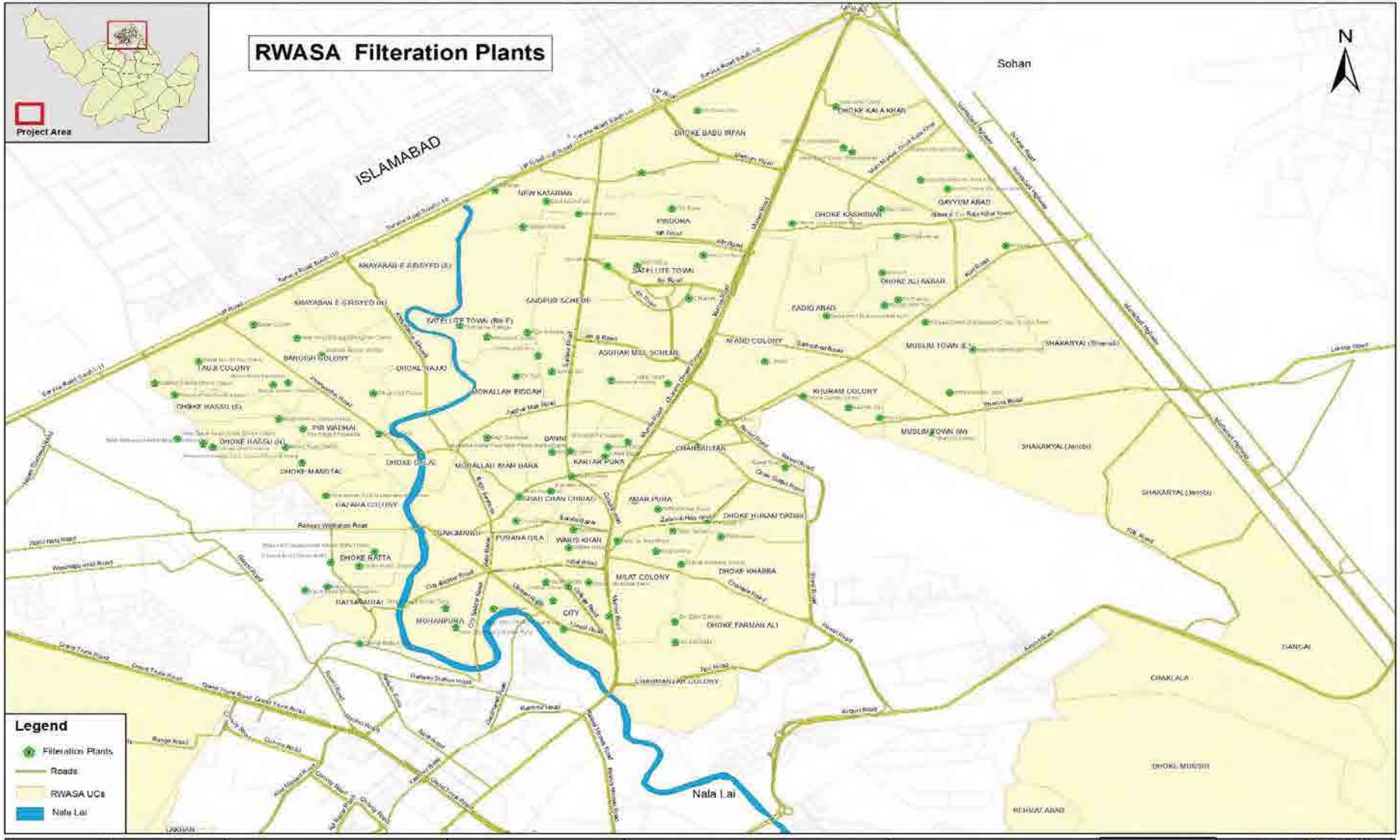

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		Map version 03			12 June 2015

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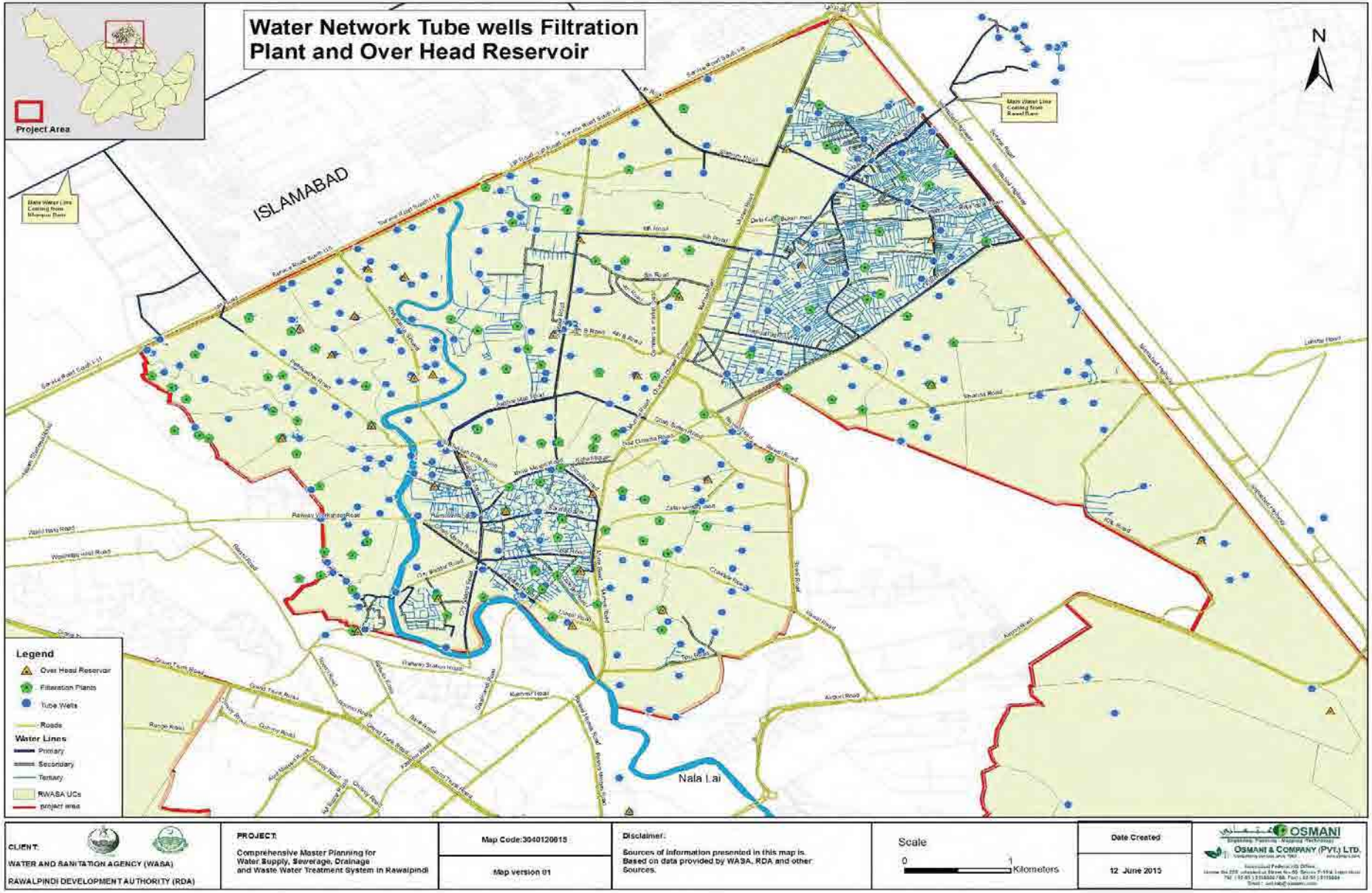
Water Network Tube wells Filtration Plant and Over Head Reservoir
Project Area
ISLAMABAD
N
Nala Lai
Legend
Over Head Reservoir
Filtration Plants
Tube Wells
Roads
Water Lines
Primary
Secondary
Tertiary
RWASA UCs
project area
CLIENT:
WATER AND SANITATION AGENCY (WASA)
RAWALPINDI DEVELOPMENT AUTHORITY (RDA)
PROJECT:
Comprehensive Master Planning for Water Supply, Sewerage, Drainage and Waste Water Treatment System in Rawalpindi
Map Code:3040120615
Map version 01
Disclaimer:
Sources of information presented in this map is. Based on data provided by WASA, RDA and other Sources.
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Annexure-B

Specification for Providing, Laying, Testing and Jointing Water Supply Pipe Lines

1. **Ductile Iron Pipe And Fittings**
2. **Polyethylene (PE) Pipes And Pipe Fittings**
3. **Steel Pipes And Fittings**
4. **Unplasticised Polyvinayle Chloride (UPVC) Pipes And Pipe Fittings**

DUCTILE IRON PIPE AND FITTINGS

1. General

[illegible]

2. Applicable Codes and Standards

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

3. Manufacture of Pipe & Fittings

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

4. Design of Ductile Iron Pipe

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

4.1 Pipe Joints

Joints on spigot and socket pipes shall be 'push-in' type. The joints shall be flexible [illegible]

[illegible]

Joint rubber ring shall be suitable for 'push-in' type flexible joint manufactured from [illegible]

[illegible] manufacture's instruction shall provide a positive seal within the allowance angular [illegible]

[illegible] (DN), class of pipe, manufacturer's name or logo and year of manufacture.

[illegible]

[illegible]

[illegible]

4.2 Ductile Iron Fittings

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

4.3 Interior Linings

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Nominal Size (DN)	Thickness (mm)
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

4.4 Repair of Defective or Damaged Areas of Linings

[illegible]

4.5 External Corrosion Protection

Zinc Layer

- [illegible]
  [illegible]
  [illegible]
- [illegible]
  [illegible]
- [illegible]
  [illegible]
  [illegible]

[illegible]

Finishing Layer

- [illegible]
- [illegible]
- [illegible] II [illegible]
- [illegible]

4.6 Protection with Polyethylene Encasement

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

Polyethylene sleeving

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Adhesive Tape

[illegible]

Lubricant Paste (Soap)

[illegible]

[illegible]

[illegible]

[illegible]

5. Installation of Ductile – Iron Pipe

5.1 Introduction

[illegible]

5.2 Pipe Inspection, Storage, Handling, and Delivery

[illegible] [illegible]

[illegible] iron pipe & fitting and appurtenances at the manufacturer's plant by the Engineer [illegible] and recorded on the delivery receipt or similar document by the carrier's agent. Test may [illegible]

[illegible] [illegible]

[illegible]

[illegible]

Maximum stacking heights* for ductile-iron pipe

Nominal Pipe Size, *in.*	Number of Tiers

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Note: To convert inches (in.) to millimeters (mm), multiply by 25.4.
** For 18 or 20 ft. (5.5 or 6.1 m) lengths*

[illegible] [illegible]

[illegible]

5.3 Trenching, Embedment, Pipe Installation, and Backfilling

[illegible] [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Suggested trench widths at the top of the pipe

[illegible] *in* [illegible]	[illegible] *in.*
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Note: To convert inches (in.) to millimeters (mm), multiply by 25.4.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Type 1. [illegible] † [illegible]

Type 2. [illegible] † [illegible]

Type 3. [illegible] ‡ [illegible]

Type 4. [illegible] ⅛ [illegible] § [illegible]

Type 5. [illegible] ‡ [illegible] § [illegible]

[illegible] [illegible]

[illegible]

[illegible] manufacturer's recommendations. The lubricant is furnished in sterile containers, and [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] <u>[illegible]</u>

[illegible]

[illegible]

[illegible]

[illegible] anufacturer's recommendation. Cut ends and rough edges must be ground smooth. For [illegible]

[illegible]

Maximum joint defection* full-length pipe – push-on type joint pipe

Nominal Pipe Size, *In.*	Deflection Angle – θ deg.	Maximum Offset – S,† *In.*		Approximate Radius of Curve - R† Produce by Succession of Joints, *ft.*	
		L† = 18 ft	L† = 20 ft	L† = 18 ft	L† = 20 ft
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□□	□□		□□		□□□

Maximum joint defection full-length pipe – mechanical type joint pipe

Nominal Pipe Size, *In.*	Deflection Angle – θ Deg. – min.	Maximum Offset – S,* *In.*		Approximate Radius of Curve – R* Produce by Succession of Joints, *ft.*	
		L* = 18 ft	L* = 20 ft	L* = 18 ft	L* = 20 ft
□	□– □□	□□	□□	□□□	□□□
□	□– □□	□□	□□	□□□	□□□
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[illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible]

5.4 Pipeline Accessories

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

5.5 Thrust Restraint

[illegible]

POLYETHYLENE (PE) PIPES AND PIPE FITTINGS

1. SCOPE

[illegible]

2. GENERAL REQUIREMENTS

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

3. SPECIAL REQUIREMENTS

[illegible]

[illegible]

4. MATERIALS

4.1. General

4.2. Manufacturing

[illegible]

4.3. Pipe

[illegible]

4.4. Quality

[illegible]

4.5. Fittings

[illegible]

5. TESTING REQUIREMENT

5.1. Pipe Testing Requirements

[illegible]

[illegible]

5.2. Fittings Test Requirements

[illegible]

[illegible]

6. HANDLING AND STORAGE

6.1. General

[illegible] manufacturer's [illegible]

6.2. Transport

[illegible]

6.3. Off-loading

[illegible]

6.4. Storage

[illegible]

6.5. Stringing and Inspection

[illegible]

[illegible]

7. JOINTING

[illegible]

7.1. Flanged Jointing

[illegible]

[illegible]

8. HYDRAULIC TESTING REQUIREMENTS

[illegible]

8.1. General

[illegible]

[illegible]

[illegible]

[illegible] remain in the Engineer's possession for the duration of the Contract.

[illegible]

The Contractor's arrangements for testing shall include a suitable means of quick installation and removal of the Engineer's gauges during testing.

8.2. Procedure

[illegible] manufacturer's confirmation shall be obtained tha[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

8.3. Test Pressure

[illegible]

[illegible]

8.4. Sectional Hydraulic Test

[illegible]

[illegible]

8.5. Hydraulic Test on Completion

[illegible]

9. PIPELINE DISINFECTION

9.1. General

[illegible]

[illegible]

9.2. Disinfection Process

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] the Engineer's approval to the method to be adopted for [illegible]

10. MEASUREMENT AND PAYMENT

10.1. General

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

10.2. Measurement of Polyethylene Pipe

[illegible]

10.3. Payment

[illegible]

STEEL PIPES AND FITTINGS

1. GENERAL

[illegible]

[illegible]

[illegible]

2. STEEL PIPES AND FITTINGS

[illegible]

[illegible]

2.1 Pipes and Fittings

[illegible]

[illegible]on type couplings. They shall be marked 'truly circular' and [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

2.2 Wall Thickness

Steel Pipe thicknesses shall be not less than the minimum values indicated below[illegible]

DN mm	Outside Diameter mm	Wall Thickness mm
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

2.3 Joints

2.3.1 General

[illegible]

2.3.2 Butt Joints

[illegible]

2.3.3 Slip-on Type Joints

[illegible]

2.3.4 Fittings

[illegible]

[illegible]

[illegible]

2.4 Lining

[illegible]

[illegible] in the manufacturer's works.

2.4.1 Lining Placed after Pipe Laying

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

2.4.2 Centrifugally Works Applied Lining

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

2.5 General

[illegible]

[illegible]

[illegible]

2.6 Pipe and Fitting External Coating

2.6.1 Coal Tar Enamel Fibrous Glass

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

2.6.2 Testing of coating and Lining

[illegible]

[illegible]

[illegible]

2.7 External Coating on Bends, Tees and Specials

2.7.1 Scope

[illegible]

[illegible]

2.7.2 Coating Application

[illegible]

[illegible] presence of the Engineer's staff who will certify the applicator as acceptable for [illegible]

2.7.3 Inspection, Testing and Repair Procedure

a) General

- [illegible]
- [illegible]
- [illegible]

b) Test and inspection Requirements

- [illegible]

2.8 Transport of Pipes and Fittings

[illegible]'s recommendations.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

2.9 Storage of Pipeline Materials

[illegible]

[illegible]

[illegible] accordance with the manufacturer's instructions.

[illegible]

[illegible] manufacturer's recommendations.

2.10 Welded Joints for Steel Pipes

[illegible]

[illegible]

[illegible] the Engineer's approval details of t[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] Contractor's expense.

[illegible]

2.11 Welder Performance Test

[illegible]eer's approval the names of persons whom [illegible]

[illegible] the Engineer's opinion is below a reasonable standard of quality o[illegible]

2.12 Inspection and Testing of Welded Joints

[illegible]

a). Reporting

[illegible]

b). Inspection of Welds

[illegible]

c). Non-destructive testing of welds

[illegible] r, at the Contractor's own expense.

[illegible]

d). Non-destructive testing methods

[illegible]

2.13 Cutting of Pipes

[illegible]

[illegible]

[illegible]

UNPLASTICISED POLYVINAYLE CHLORIDE (uPVC) PIPES AND PIPE FITTINGS

1. SCOPE

[illegible]

2. GENERAL REQUIREMENTS

[illegible]

3. APPLICABLE CODES AND STANDARDS

[illegible]

[illegible]

[illegible]

[illegible]

4. SPECIAL REQUIREMENTS

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

5. MATERIALS

1.1 Pipe

[illegible]

5.2 Fittings

[illegible]

5.3 Material

[illegible]

[illegible]

5.4 Joints

[illegible]

6 TRENCHING

[illegible]

7 INSTALLATION

7.1 Transportation, Handling and Storage

[illegible]

[illegible]

[illegible]

7.2 Laying and Jointing

7.2.1 Above Ground (Unburied)

[illegible]

[illegible]

[illegible]

[illegible]

7.2.2 Below Ground (Buried)

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

8 MEASUREMENT OF uPVC PIPE

[illegible]

9 Payment

[illegible]