資料６：参考資料

目　次

参考資料－1　タフィーラ県及びマアン県対象地域の水質測定結果..... VI-2
参考資料－2　GIS 基本図及び送配水管データ VI-6
参考資料－3　社会経済調査..... VI-9
参考資料－4　タフィーラ県及びマアン県対象地域の計画給水人口及び計画給水量..... VI-30
参考資料－5　井戸の揚水試験結果..... VI-32
参考資料－6　タフィーラ県の送水システムの水理計算結果..... VI-33
参考資料－7　エラワスポンプ場の水撃防止対策の分析結果..... VI-34
参考資料－8　タフィーラ県の配水システムの水理計算結果..... VI-49
参考資料－9　土壌の腐食性試験結果..... VI-68
参考資料－10　既存減圧装置の検討..... VI-73
参考資料－11　「ヨ」国負担工事費（管路工事費）の概算..... VI-76
参考資料－12　マアン県対象地域の概略設計..... VI-77
参考資料－13　マアン県フシニエ地区、アシャリ地区、アブドネ地区水道計画のレビュー.....
..... VI-116
参考資料－14　環境・気候変動対策無償としての本プロジェクトの検証..... VI-125
参考資料－15　計画配水池用建設維持管理道路..... VI-132

参考資料－1　タフィーラ県及びマアン県対象地域の水質測定結果

Source: WAJ Water Quality Laboratory

(1)　Water Quality of Reservoirs in Target Area (1/2)

Location Description	Data	pH	Turbidity	Residual Chlorine	Ammonium	Nitrate	Nitrite	Hardness	Chloride	Sodium	Sulfate	Fluoride	Barium	Antimony	Cadmium
		unit	NTU	mg/L	mg/l as NH4	mg/L	mg/L	mg/L As CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Standards		6.5-8.5	5		0.1	50	2	500 (TH)	500	200	500	1.5	1	0.005	0.003
Tafieleh															
Erawath Booster	Max	8.24	0.70	1.20		18.30		249	62.13	39.79	31.68	0.37			
	Ave	8.18	0.51	1.01	<0.10	12.74		244	58.05	36.11	27.84	0.34	0.08		<.003
	Min	8.14	0.40	0.80		8.27		235	53.96	32.43	24.00	0.30			
Hasa No.3 Pump Station	Max														
	Ave	7.57	0.53	1.40	<0.10	11.27									
	Min														
Ain El Baidha Reservoir	Max	8.07	0.73	1.40		12.59		253	64.61	52.21	34.08	0.29			
	Ave	7.99	0.43	1.13	<0.10	10.63	<.2	240	60.35	43.93	30.96	0.29	0.08		<0.003
	Min	7.91	<.2	1.00		7.63		223	56.09	35.65	27.84	0.29			
Ise Reservoir	Max	8.09	0.90	1.50	<0.10	18.24		291	55.03	30.59	22.08				
	Ave			1.10											
	Min			1.00											
Tafieleh 1000 m3 Reservoir	Max	8.15	0.70	1.50											
	Ave	7.97	0.52	1.11		15.72		239							
	Min	7.79	0.23	0.80											
Tafieleh 4000 m3 Reservoir	Max	8.30	3.98	1.50	<0.10	14.36		267	68.87	37.26	35.52				
	Ave	8.14	0.98	1.10	<0.10	11.50	<0.20	243	62.13	37.15	31.20	<0.20	0.08		<0.003
	Min	8.00	0.20	0.80	<0.10	8.93		207	55.38	37.03	26.88				
Zabda Reservoir	Max	8.28	0.82	1.40	<0.10	7.42		412	46.15	28.52	51.84	0.59	0.10		<.003
	Ave	7.61	0.36	1.27	<0.10	6.16	<.2	390	44.73	27.22	50.56	0.53	0.09	<0.005	<.003
	Min	7.32	<0.20	1.00	<0.10	3.61		353	43.31	25.99	49.92	0.46	0.08		<.003
Maan															
Tahoonah new Reservoir	Max	8.12	1.01	1.50	<0.10	1.45		373							
	Ave	7.92	0.90	1.33	<0.10	0.94		336	86.62	38.87	44.16	0.76	0.09	<.005	<.003
	Min	7.73	0.79	1.00	<0.10	<.2		305							

(2) Water Quality of Reservoirs in Target Area (2/2)

Location Description	Data	Cyanide	Zinc	Arsenic	Chromium	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Total Coliforms
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MPN/100mL
Standards		0.07	4	0.01	0.05	1	1	0.01	0.1	0.07	0.07	0.01	0.1	
Tafieleh														
Erawath Booster	Max													<1.1
	Ave	<.05	<.06	<.005	<.01	<.01	<.1	<.01	<.01	<.01	<.01	<.005	<.01	<1.1
	Min													<1.1
Hasa No.3 Pump Station	Max													<1.1
	Ave													<1.1
	Min													<1.1
Ain El Baidha Reservoir	Max		0.07		<.02	<.02	0.14		<0.02		<.02			<1.1
	Ave	<.05	0.07	<0.005			0.14	<0.01		<.02		<.005	<.02	<1.1
	Min		<0.06		<0.01	<0.01	<0.10		<0.01		<0.01			<1.1
Ise Reservoir	Max		<0.06		<.02	<.02	<0.10		<0.02		<.02			<1.1
	Ave													<1.1
	Min													<1.1
Tafieleh 1000m3 Reservoir	Max													1.10
	Ave													1.10
	Min													<1.1
Tafilah 4000 m3 Reservoir	Max		<0.06		<.02	<.02	0.12		<0.02		<.02			<1.1
	Ave		<0.06	<0.005			0.12	<0.01						<1.1
	Min		<0.06		<0.01	<0.01	<.1		<0.02		<0.01			<1.1
Zabda Reservoir	Max		0.19	<0.005	<.02	0.03	0.18	<.01	<0.02	0.27	0.07	<.005	<0.02	>8
	Ave	<0.05	0.09	<0.005			0.14	<.01		0.24	0.06	<.005	<0.02	<1.1
	Min		0.04	<0.005	<.01	<.01	0.10	<.01	<.01	0.21	0.04	<.005	<0.02	Abscence
Maan														
Tahoonah new Reservoir	Max													<1.1
	Ave	<.05	<.06	<.005	<.01	<.01	0.18	<.01	<.01	0.01	<.01	<.005	<.01	<1.1
	Min													<1.1

(3) Water Quality of Wells Directly Supplied to Target Area (1/2)

Location Description	Treatment Stage	Note	Well No	pH	Turbidity	Residual Chlorine	Ammonium	Nitrate	Nitrite	Hardness	Chloride	Sodium	Sulfate	Fluoride	Barium	Boron	Antimony	Cadmium
				unit	NTU	mg/L	mg/l as NH4	mg/L	mg/L	mg/L As CaCO3	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	Standards			6.5-8.5	5		0.1	50	2	500(TH)	500	200	500	1.5	1	1	0.005	0.003
Samneh Well	Raw water	Max	G 4086	7.51	0.80	1.20		16.00		477	268.38	113.16	146.40					<0.003
		Ave		7.13	0.58	1.10	<0.10	8.52	<.2	452	222.66	108.56	121.54		0.06			<0.003
		Min		6.77	0.27	1.00		3.81		430	197.38	106.26	100.80					<0.003
Samneh No.2 Well	Raw water	Max	G 4096	7.74	2.29		<0.10	11.55	<0.50	495	217.97	100.51	116.16	0.80				<0.003
		Ave		7.51	1.27		<0.10	6.83		453	209.45	93.10	111.26	0.75	0.05			<0.003
		Min		7.39	0.61		<0.10	5.15	<.2	431	203.42	90.16	108.00	0.69				<0.003
Samneh No.4 Well	Wash out	Max	G 4099	7.65	13.20		<0.10	8.56	<0.50	464	235.37	113.39	121.92	1.03				<0.003
		Ave		7.49	4.57		<0.10	4.69		448	212.33	107.03	110.24	0.77	0.06	0.30		<0.003
		Min		7.39	0.50		<0.10	3.15	<.2	432	190.64	102.12	98.40	0.48				<0.003
Samneh No.5 Well	Raw water	Max	G 3206	7.72	22.10		<0.10	5.55	<.2	467	227.20	118.91	132.48	1.20				<0.003
		Ave		7.51	12.83		<0.10	4.92	<.2	449	214.95	111.44	122.40	0.78	0.05			<0.003
		Min		7.41	5.84		<0.10	4.54	<.2	434	209.45	104.65	111.84	0.39				<0.003
Tahoonah No.2 Well	Raw water	Max	G 1265	8.87				6.41		326	127.80	87.40	101.76					
		Ave		8.05				2.26		262	99.47	51.52	55.68					
		Min		7.62				0.31		101	68.16	25.76	19.20					
Fujaij No.3 Well	Raw water	Max	CF1085															
		Ave		7.7	<.2		<0.10	7.86	<.2	215	35.86	21.16	17.28					
		Min																
Hasa No.2 Well	Post chlorination	Max	CF1041	8.30	0.90	1.80	<0.10	11.83	<0.20	271	63.55	39.79	35.04	0.57				<0.003
		Ave		7.69	0.66	1.19	<0.10	9.62	<0.20	244	57.67	35.39	29.97	0.48	0.08		<0.005	<0.003
		Min		6.73	<.2	0.80	<0.10	7.36	<0.20	141	54.32	30.59	27.84	<0.20				<0.003
Jarf Daraweesh Well	Post chlorination	Max	CF1072	8.22		1.00		9.93		270	80.94	39.56	44.16					
		Ave		7.96		1.00		3.01		260	63.55	32.66	29.34					
		Min		7.60		1.00		<.2		252	54.32	25.30	21.60					
Juthah No.1 Well	Raw water	Max	G 3135	7.49				0.65	<.2	410	140.58	64.86	72.48	0.78				
		Ave		7.35				0.48	<.2	384	115.02	55.43	59.60	0.62				
		Min		7.22				<.2	<.2	316	72.07	44.62	48.00	0.45				
Manshiyeh Well	Raw water	Max	G 1344	8.13	0.30	1.50	<0.10	6.01		269	52.19	28.29	37.44	0.72	0.05			
		Ave		7.84	0.30	1.39	<0.10	3.20	<.2	248	48.20	25.70	32.28	0.64	0.05	<0.2		
		Min		7.58	0.30	1.10	<0.10	<.2		185	43.67	23.23	27.84	0.46	0.05			
Qa Maan No.2 Well	Raw water	Max	G 1231	8.06	2.50		<0.10	16.46	<.2	266	75.62	38.18	35.04	0.56	0.06			<.003
		Ave		7.84	2.04		<0.10	10.44	<.2	192	44.83	26.35	28.66	0.38	0.05	<0.2		<.003
		Min		7.59	1.52		<0.10	4.93	<.2	117	30.53	20.93	24.48	0.14	0.02			<.003
Unaizah Well	Raw water	Max	G 3167	8.03	16.60		1.50	4.56	<0.2	346	108.99	66.01	100.32	1.69	0.06			
		Ave		7.63	8.08		0.90	2.83	<0.2	323	94.51	60.59	83.04	1.44	0.06	<0.2		<0.003
		Min		7.46	2.27		0.15	<.2	<0.2	297	74.55	48.99	50.88	1.26	0.05			

(4) Water Quality of Wells Directly Supplied to Target Area (2/2)

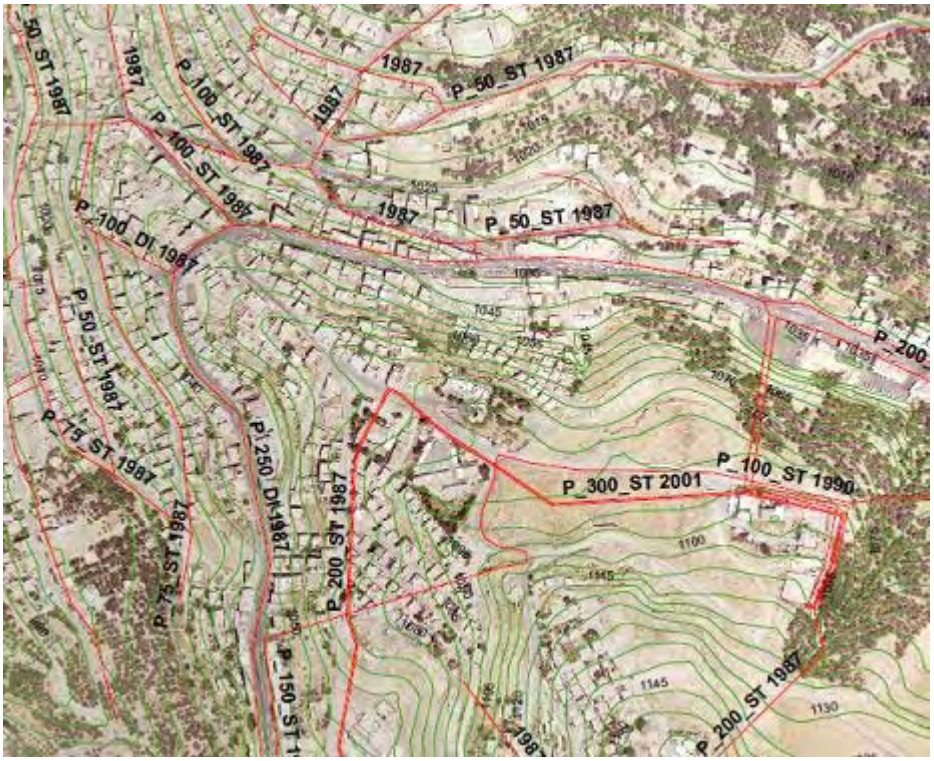
Location Description	Treatment Stage	Note	Well No	Cyanide	Zinc	Arsenic	Chromium	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Total Coliforms	Escherichia coli
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MPN/100mL	MPN/100mL
	Standards			0.07	4	0.01	0.05	1	1	0.01	0.1	0.07	0.07	0.01	0.1		
Samneh Well	Raw water	Max	G 4086		<0.06	<0.01	<0.02	<0.04	<0.10	<0.01	<0.04		<0.02	<0.01		23.00	<2
		Ave		<0.05					0.07	<0.01		<0.02			<0.02	11.14	2.00
		Min			<0.04	<0.005	<0.01	<0.02	0.06	<0.01	<0.02		<0.01	<0.005		<1.1	<1.8
Samneh No.2 Well	Raw water	Max	G 4096		<0.06	<0.01	<0.02	<0.02	0.48	<0.01	<0.02		<0.02	<0.01	<0.02	27.00	<2
		Ave		<0.05				0.01	0.24	<0.01	0.01	0.02			<0.02	14.83	<2
		Min			<0.04	<0.005	<0.01	<0.01	<0.10	<0.01	<0.01		<0.01	<0.005	<0.02	<1.8	<2
Samneh No.4 Well	Wash out	Max	G 4099	<0.05	0.35	<0.01	0.04	<0.04	1.76		0.06	<0.02	0.22	<0.01	<0.02	7.80	<2
		Ave		<0.05	0.35		0.04		0.49		0.04	<0.02	0.12		<0.02	6.32	2.00
		Min		<0.05	0.35	<0.005	<0.01	<0.02	0.10		<0.02	<0.02	<0.01	<0.005	<0.02	<1.8	<1.8
Samneh No.5 Well	Raw water	Max	G 3206		<0.06	<0.005	<0.02	0.15	0.88	<0.01	<0.02	<0.02	<0.02	<0.005		17.00	<2
		Ave		<0.05	0.04	<0.005		0.12	0.53	<0.01	0.01	<0.02		<0.005	<0.02	6.42	<1.8
		Min			<0.04	<0.005	<0.01	<0.02	0.17	<0.01	<0.01	<0.02	<0.01	<0.005		<1.8	<1.8
Tahoonah No.2 Well	Raw water	Max	G 1265														
		Ave															
		Min															
Fujaij No.3 Well	Raw water	Max	CF1085													4	
		Ave			<.06	<.005	<.02	<.02	<.1		<0.02	<.02	<.02	<.005	<.02	<1.8	0
		Min															
Hasa No.2 Well	Post chlorination	Max	CF1041		<0.06	<0.01	<0.01	<0.01	<0.10	<0.01	<0.01		<0.01			2.60	<1.1
		Ave		<.05	0.04		<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<.02	<1.1	<1.1
		Min			<0.04	<0.005	<0.01	<0.01	<0.06	<0.01	<0.01		<0.01				<1.1
Jarf Daraweesh Well	Post chlorination	Max	CF1072													<1.1	
		Ave														<1.1	
		Min														<1.1	
Juthah No.1 Well	Raw water	Max	G 3135		<.06	<.005	<.02	<.02	0.19		<0.02	<.02	<.02	<.005			
		Ave			<.06	<.005	<.02	<.02	0.17		<0.02	<.02	<.02	<.005		13.00	<1.8
		Min			<.06	<.005	<.02	<.02	0.16		<0.02	<.02	<.02	<.005		<1.8	
Manshiyeh Well	Raw water	Max	G 1344		<0.06	0.01	<0.02	0.08	0.44		<0.02	<0.02	<0.02	<0.005		1600.00	
		Ave			<0.06	0.01	<0.02	0.07	0.33		<0.02	<0.02	<0.02	<0.005	<0.02	356.50	2.00
		Min			<0.06	0.01	<0.02	<0.02	0.23		<0.02	<0.02	<0.02	<0.005		<1.1	<1.8
Qa Maan No.2 Well	Raw water	Max	G 1231		0.45	<.005	<0.02	<0.02	0.72	<.01	0.02	0.02	0.02	<.005	<0.02	23.00	<1.8
		Ave		<0.05	0.22	<.005			0.34	<.01				<.005	<0.02	7.66	<1.8
		Min			<.06	<.005	<.01	<.01	<0.10	<.01	<.01	<.02	<.01	<.005	<0.02	<1.8	<1.8
Unaizah Well	Raw water	Max	G 3167		0.09	<0.01	<0.02	<0.02	1.92		0.12	<0.02	0.04	<0.01	<0.02	7.80	<1.8
		Ave			0.09				0.98	<0.01	0.05	<0.02			<0.02	3.98	<1.8
		Min			0.08	<.005	<0.01	<0.01	0.15	0.00	0.03	<0.02	<0.01	<0.005	<0.02	<1.1	<1.8

参考資料－2　GIS 基本図及び送配水管データ

(1)　GIS ベースマップの種類と数量

調達先	GIS データの種類	内容
国立地理センター（RJC）	航空写真を購入し、ベースマップとして使用する。	○タフィーラ県 航空写真：146km^2（2007 年）1/2,500 航空写真：14km^2（2000 年）1/25,000 ○マアン県 航空写真：40km^2（2007 年）1/2,500 航空写真：134km^2（2000 年）1/2,500
	タフィーラ県の等高線	5m 間隔の等高線を 146km^2 を購入し使用
	マアン県マアン市の等高線	5m 間隔の等高線を 174km^2 購入、134km^2 を新たに作成依頼し購入。
ヨルダン土地・測量局（DLS）	公図	無償で WAJ より入手

(2)　作成した GIS 施設地図（サンプル）



タフィーラ市内既存配管及び等高線（5m 間隔）の状況

（3） 各地域の管網データ

Length of Distribution Pipeline in AL-Mansoora (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	0	0	1,850	0	0	0	0	0	0	0	0	0	1,850
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	4,023	0	0	0	0	0	0	0	0	0	4,023
150	0	0	0	0	0	3,991	0	0	0	0	0	0	0	3,991
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	56	0	0	0	0	0	0	0	0	0	56
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	5,929	0	3,991	0	0	0	0	0	0	0	9,920

Length of Distribution Pipeline in Tafieleh City (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	0	0	6,455	0	0	0	0	0	0	0	0	0	6,455
75	0	0	0	2,090	0	0	0	0	0	0	0	0	0	2,090
100	0	0	0	4,478	0	0	0	0	0	0	0	0	0	4,478
150	0	0	1,834	637	0	531	0	0	0	0	0	0	0	3,002
200	0	0	97	0	0	0	0	0	0	0	0	0	0	97
250	0	0	0	5,369	0	0	0	0	0	0	0	0	0	5,369
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	1,931	19,029	0	531	0	0	0	0	0	0	0	21,491

Length of Distribution Pipeline in Sanfah (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	0	4,593	0	0	386	0	854	0	0	0	0	0	5,832
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	3,922	0	0	1,852	0	0	0	0	0	0	0	5,775
150	0	0	774	0	0	0	0	0	0	0	0	0	0	774
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	9,289	0	0	2,239	0	854	0	0	0	0	0	12,381

Length of Distribution Pipeline in Nemati (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	0	0	0	0	4,322	0	0	0	0	0	0	0	4,322
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	4,322	0	0	0	0	0	0	0	4,322

Length of Distribution Pipeline in Ain-El Baidha (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	7,699	0	0	0	7,700	0	0	0	0	0	0	0	15,399
75	0	1,043	0	0	0	1,813	0	0	0	0	0	0	0	2,855
100	210	0	0	0	0	5,100	0	0	0	0	0	0	0	5,310
150	146	0	0	0	0	838	0	0	0	0	0	0	0	984
200	0	1	0	0	0	0	0	0	0	0	0	0	0	1
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	356	8,743	0	0	0	15,450	0	0	0	0	0	0	0	24,549

Length of Distribution Pipeline in Bsaira (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	11,350	0	0	0	0	0	0	0	0	0	0	0	11,350
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	3,860	0	0	0	0	0	1,553	0	0	0	597	976	6,986
150	0	0	0	0	0	0	0	0	0	1,788	792	0	0	2,580
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	15,210	0	0	0	0	0	1,553	0	1,788	792	597	976	20,916

Length of Distribution Pipeline in Gharandal (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	0	0	0	5,047	0	0	0	0	0	0	0	0	5,047
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	5,823	0	0	0	0	0	0	0	0	5,823
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	0	332	0	0	0	0	0	0	0	0	0	0	0	332
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	332	0	0	10,870	0	0	0	0	0	0	0	0	11,201

Length of Distribution Pipeline in Qhadesiyeh (m)

Dia	1960	1970	1985	1987	1989	1990	1995	1998	2001	2005	2008	2009	2010	Total
50	0	10,889	0	0	0	0	0	0	0	0	0	0	0	10,889
75	0	1,047	0	0	0	0	0	0	0	0	0	0	0	1,047
100	0	4,216	0	0	0	0	0	0	0	0	0	0	0	4,216
150	0	927	0	0	0	0	0	0	0	0	0	0	193	1,120
200	0	0	0	0	0	0	0	0	0	0	0	0	267	267
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	401	0	0	0	0	0	0	0	0	0	0	0	401
Total	0	17,480	0	0	0	0	0	0	0	0	0	0	459	17,940

Length of Distribution Pipeline in Ma'an city (m)

Dia.	1970	1980	1986	1989	1990	1991	1996	1999	2000	2002	2004	2005	2006	2007	2009	2010	Total
50	2,847	0	5,541	7,038	19,451	265	8,368	3,411	956	288	0	92	0	0	2,148	0	50,406
63	0	0	0	0	0	0	4,142	0	0	0	0	0	0	0	0	0	4,142
75	0	0	0	0	62	451	0	0	0	0	0	0	0	0	0	0	512
80	0	0	2,255	565	137	1,746	0	0	0	0	0	0	0	0	0	0	4,702
100	292	574	16,326	3,671	10,396	3,299	3,748	241	1,470	44	75	478	1,616	238	6,965	0	49,432
150	0	0	3,003	605	13,516	0	3,664	0	0	0	0	0	0	0	2,401	104	23,294
200	0	0	0	471	491	808	4,824	0	0	0	0	0	0	0	0	1,925	8,520
250	0	0	0	0	36	760	0	0	0	0	0	0	0	0	0	0	796
300	0	0	0	0	0	0	5,389	0	0	0	0	0	0	0	5,572	0	10,960
350	0	0	0	0	0	0	463	0	0	0	0	0	0	0	0	0	463
400	0	0	0	0	0	0	4,839	0	0	0	0	0	0	0	0	0	4,839
Total	3,139	574	27,125	12,350	44,089	7,328	35,438	3,653	2,426	332	75	570	1,616	238	17,086	2,029	158,068

参考資料－3　社会経済調査

Survey Report for the Socio-economic and Willingness to Pay Survey for the Project of Rehabilitation and Expansion of Water Facilities in Southern Governorates of Tafileh and Ma'an

1.0 INTRODUCTION

Located in the heart of the Middle East, Jordan is a small country with a present population of nearly 6 million people. Since its independence in 1946, Jordan has had one of the fastest growing populations in the world; with a population of only 0.25 million in 1946 expected to reach 9.7 million by year 2025. Inadequate supplies of water and other natural resources, international debt, poverty, and unemployment have become fundamental problems in Jordan. Nearly 10% of the population earns less than $2 per day, placing approximately 30% of the population in below-the-poverty line living conditions. Furthermore, nearly 70 % of the population lives in only three urban governorates; Amman, Zarqa and Irbid. Access to municipal and other vitally important services is unevenly distributed, and rural areas/municipalities in the south and northeast of the country are under-served. These shortfalls in service delivery have reduced development opportunities, which in turn have decreased people's ability to pay for services.

The most valuable natural resource available to mankind is water. This is particularly true in the Middle East and North Africa Region (MENA), which is the most water scarce region in the world. Home to almost 6.5% of the world's population, the region contains barely 1.5% of the world's renewable fresh water resources. This makes the MENA Region one of the poorest locations in the world in terms of water resources. In the region, Israel, Jordan and Palestine, are considered to be particularly deficit in water scarcity. Most experts consider Countries with a "per capita" water consumption rate below 1,000 cubic meters per year to be water-poor countries. In the year 2000, the per capita water resource potentials in Israel, Jordan, and Palestine were 250 m^3, 234 m^3 and 115 m^3, respectively. Placing these countries at nearly 20 % of the water poverty level. The current water situation in the three countries is expected to worsen over the next twenty years. In the year 2020 for example, the per capita water availability is expected to be almost one-half of what was available in the year 2000. Several political analysts believe that conflicts in the Middle East region will arise over water in the coming years. In fact, previous wars and confrontations in the region have already been related to water. Despite the Jordan/Israeli and Palestinian/Israeli peace treaties, conflicts over water have arisen again in the past few years. It was the newly signed peace agreements alone that prevented those conflicts

Box 1: Water Scarcity Statistics in Jordan

The Water Poverty Index (WPI) was designed to measure the availability of water resources in various countries. It indicates the richness or poverty of an area in terms of the volume of water resources (renewable and non-renewable) available to meet domestic and irrigation requirements necessary to cover a country's food needs.

Based on this definition, and under the assumption that all rain fed areas within a country are productive, Jordan is considered water poor since its water resources cover only 15.5 % of the country's food needs.

The Water Stress Index (WSI) is another indicator of the availability of water within a certain area. A WSI of less than 1700 m^3/capita/year indicates water stress; a WSI of less than 1000 m^3/capita/year indicates water scarcity, while a WSI of less than 500 m^3/capita/year indicates absolute scarcity. With a WSI of 234 m^3/capita/year, Jordan is categorized as a country with absolute scarcity.

from escalating any further. With the projected water shortages, and unless serious water management measures are taken, the recurrence of such conflicts over water is inevitable.

1.1 Tafieleh and Ma'an Governorates

Ma'an Governorate is located south of the capital Amman. With 36% of the country's total area located within Ma'an, it is the largest Jordanian governorate. In contrast, Ma'an's population constitutes a mere 1.4% of the total population. However, the percent of Ma'an's population constitutes 1.4% of the total population. On the other hand, Tafieleh governorate is located south-west of Amman. Its area constitutes 2.5% of Jordan's total area, hosting about 1.6 % of Jordan's population.

According to the ministry of Planning, 2006 there is 22 regions identified as poverty pockets in Jordan. One of those poverty pockets is Busaira in Tafileh Governorate. The percent of population below poverty line is 31.9. In addition, two regions in Ma'an are considered as poverty pockets which are Mareigha and Al Jafer with a poverty percentage of 27.1 % and 26.6 % respectively.

2.0 BACKGROUND

The overall objective of the study in Tafieleh and Ma'an is to understand present social conditions including water use, household characteristics, and willingness to pay for water supply. The target sample size was 300 households. Interviews were carried out using a tailor made survey tool in the form of a questionnaire. The questionnaire consisted of multiple sections relating to various indicative measures for the study. The following table lists the sections of the questionnaire:

Table 1. Lists the sections of the survey tool

#	Section Title
1	Information about respondent
2	Family structure and economic condition
3	Condition of Water Usage
4	Awareness of people about water supply service
5	Condition of Toilet
6	Sanitary Conditions

The components of the survey contained comprehensive quantitative and qualitative analysis. The main component of each section is described below.

1- Information of Respondent

This information includes name, gender, house type and size.

2- Family Structure and Economic Condition

This information includes family size, income source and employment patterns. The goal is to have basic household information that might explain some of the results and suggest preferences toward certain options.

3- Condition of Water Usage

This information covers issues related to the water availability, water bills, and water consumption

patterns.

4- Awareness of People about Water Supply Service

Along with the previous section, this information should help in identifying the urgent needs of households, and would provide a preliminary understanding of their willingness to pay for better services.

5- Condition of Toilet

This section would give an indication of social level awareness of using the toilet and sanitation facilities.

6- Sanitary Condition

The assessment of the sanitation utilities will help in understanding the water consumption pattern.

3.0 SAMPLING

The sampling locations and sample size were classified into three household's surveyed areas which are Tafileh City, Tafileh South and Ma'an. Table 2 presents the sample sizes and locations in the three surveyed household's areas.

Table 2. Sampling Locations and Sample Size

	Abbreviation	Population in 2009	Sample Size
Tafileh Governorate	TA		
Tafiela city	TAC	26,147	76
Ezhaigah	EZH	65	2
Sanfahah	SAN	661	5
Tal'et Hussain	TAH	218	3
Arafah	ARA	1,208	7
Erqayyem/Erwayyem	ERA	1,935	9
Ain El-baidha	AEB	9,227	26
Namteh	NMT	71	2
Abel	ABE	750	6
Sel'e	SEL	10	2
Bsaira	BSR	7,647	22
Um Essarab	UES	558	5
Gharandal	GHA	4,439	15
Rashadiyyeh	Ras	1,007	6
Dhana	DHA	91	2
Qhadesiyeh	QHA	7,712	22
SubTotal		**61,746**	**134**
Ma'an Governerate	MA		
Ma'an city	MAC	36,370	90
Total		**98,116**	**300**

4.0 Methodology of Implementation

In total, the survey was conducted for 300 households randomly selected and distributed according to the sampling locations and sizes presented in Table 2. Three teams were involved; two in Tafieleh and one in Ma'an. It included participants from both genders; females and males. In addition, each team consisted of two persons, and the survey teams collected data on a daily basis throughout the duration of the study. Given that the study area consists of the southern part of Tafieleh City and Tafieleh City centre, the survey team started with the southern part of Tafieleh City then moved into Tafieleh City centre. The team chose the highest volume residential areas in those two areas to carry out the survey. Similarly, the survey was implemented in Ma'an. However, the Ma'an study area was limited to the City centre only.

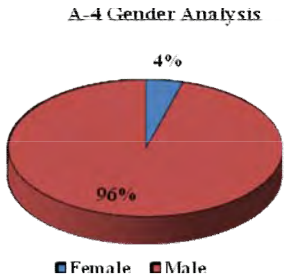
Once a household was approached, a member of the survey team gave them a little background on the survey; its purpose, what the data collected is to be used for, and the importance of their cooperation in providing accurate answers to the various questions. A very few families expressed their concern on who the survey was conducted for, however, the I*d*RC engineer assured them that it was eventually for the benefit of their communities.

The field work was carried out from the May 18 to June 3, 2010. The survey tool is included in the Appendix, and the results of the survey are presented in the following section.

5.0 SURVEY RESULTS

5.1 Information of Respondent

Given the conservative nature of the study area, it was the male head of the household that chose to conduct the interview in most cases. Thus, the majority of respondents were males with a proportion of 96 % and only 4 % of females accepted to conduct the survey as presented in Figure 1. In addition, the table shown in Figure 1 presents the percent of respondents out of the entire sample (300 surveyed households) of males and females in Tafileh City, Tafieleh South, and Ma'an City. The entire surveyed sample indicated the availability of the WAJ water meter in their houses as presented in Figure 2.



Sample Area	% of Males	% of Female
Tafieleh City	25%	0.3%
Tafieleh South	44%	0.6%
Ma'an City	27%	3.0%
Total	**96%**	**4%**

Figure 1. Gender Analysis

Figure 2. Availability of WAJ Water Meter in Respondents' Houses

5. 2 Family Structure and Economic Condition

Figure 3 illustrates the family structure distribution according to gender. The Figure indicates that the distribution of females and males in the entire surveyed sample is approximately the same with a percentage of about 50% each. In addition, the distribution of adult males and females as well as child males and females is approximately the same. In addition, Figures from 4 through 6 present the gender age decomposition in Tafileh City, Tafileh South, and Ma'an City.

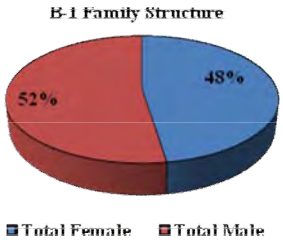


Figure 3. % of Total Females and Males out of the Entire Sample

While the average family size in Tafileh South is 7 members, the average family size in Tafileh and Ma'an cities is 6 members.

Figures 4 through 6 present the males and females decomposition in the three household's surveyed areas. The % of each age decomposition category is taken out of the total numbers of males and females in each household surveyed sample.

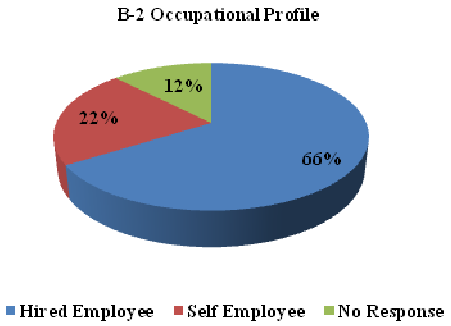
Figure 4. Males and Females age Decomposition in Tafileh City

Figure 5. Males and Females age Decomposition in Tafileh South

Figure 6. Males and Females age Decomposition in Ma'an City

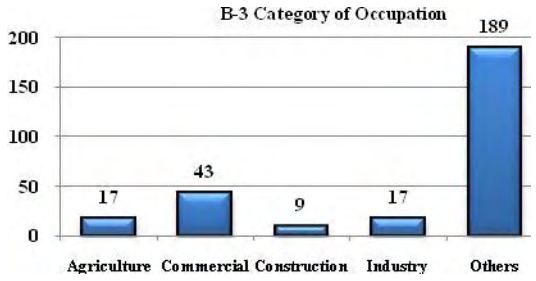
Figure 7 shows that 66 % of the entire respondents (300) are hired employees while 22% are self employed and the reminder have no response. Also, the Table in the Figure illustrates the % of the main income source for the three surveyed households' samples. The occupational profile of the surveyed sample showed that the majority work in the "other sector" rather than the prevailing major sectors such as agricultural, industrial, commercial, and construction as presented in Figure 8. Also, the Table in Figure 8 indicate the category of occupation for the three surveyed areas.

If the category of the respondents indicating employment in "Other Category" is removed, it can be concluded that the majority of the sample works for the commercial sector. The second dominant occupational profile is distributed evenly between the industrial and agricultural sectors. Finally, a small portion of the households in the surveyed sample works in the construction sector.



Sample Area	% of Hired Employee	% of Self Employed	% No Response
Tafieleh City	16%	7%	2%
Tafieleh South	25%	10%	10%
Ma'an City	25%	5%	0%
Total	**66%**	**22%**	**12%**

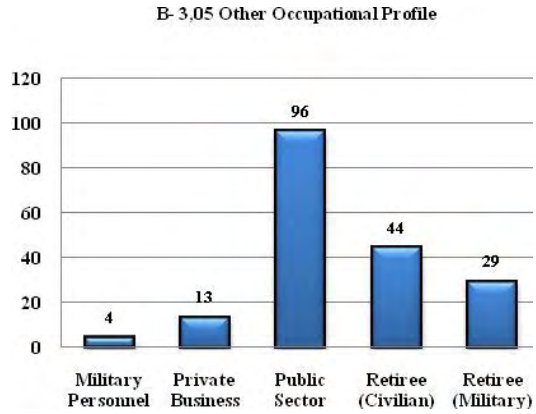
Figure 7. Main Income Source Distribution



Sample Area	Tafieleh City	Tafieleh South	Ma'an City	Total
Agriculture	6	11		**17**
Commercial	17	15	11	**43**
Construction	1	7	1	**9**
Industry	2	10	5	**17**
Others	35	81	73	**189**

Figure 8. Occupational Profile

On the other hand, if the category of the respondents indicating employment in "Other Category" is further examined, it can be concluded that 96 out of 189 respondents indicated that they work for the public sector. Nevertheless, 73 respondents indicated that they are retirees, of which 44 respondents are civilian retirees and the remaining 29 respondents are military retirees. In addition, 13 respondents own private businesses and 4 respondents are military personnel as presented in Figure 9. In addition, the Table in the figure presents further illustration of the "other category" occupation in the three surveyed sample.



Sample Area	Tafieleh City	Tafieleh South	Ma'an City	Total
Military Personnel		4		**4**
Private Business	3	4	6	**13**
Public Sector	19	18	69	**96**
Retiree (Civilian)	15	28	1	**44**
Retiree (Military)	4	24	1	**29**

Figure 9. Other Categories of Occupation

5.3 Condition of Water Usage

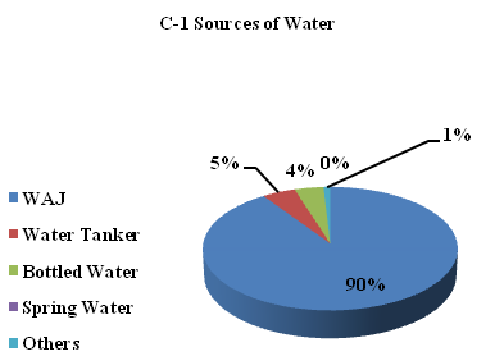
While most of the households in the surveyed sample receive water from WAJ, small numbers of respondents depend on water tankers and bottled water. Figure 10 shows that 98.7 % of the respondents depend on WAJ as the main source of water. Nevertheless, 1% of respondents depend on other sources of water, and none of the households in the surveyed sample depend on springs or well water. In addition the Table in the figure further illustrates the water source among the three surveyed sample areas. Indeed, the Department of Statistics (DoS) in

Jordan, 2006 indicated that

100 % of Tafileh Households depend on public Network "WAJ" as a main source for the supply of water. On the other hand, 94% of Ma'an City households depend on Public network "WAJ", while

2.8% depend on water tanker, and 3.5 depends on other resources [1].

http://www.dos.gov.jo/dos_home_a/main/index.htm



Sample Area	Tafieleh City	Tafieleh South	Ma'an City	Total
WAJ	25.3	43.7	29.7	98.7
Water Tanker	1.3	2.3	1.3	5.0
Bottled water	0.7	0.0	3.7	4.3
Spring	0.0	0.0	0.0	0.0
Others	0.3	0.7	0.0	1.0

Figure 10. Sources of Water

Respondents who use water tankers indicated an average usage of 6.4 m^3 per month. On the other hand, respondents who use bottled water reported an average usage of 7.5 units per month; each unit has a volume of 20 litres. On average, respondents consume 52.5 m^3 per quarter in the summer, while in the winter their consumption increases to reach an average of 56.5 m^3 per quarter. The averages of water consumption for different sources of water utilized by the households in different surveyed areas are presented in Table 3.

Table 3. Averages of water consumption of different sources of in the three surveyed areas

Averages Consumption	TafilehCity	Tafileh South	Ma'an City
WAJ Summer Average m^3/Quarter	53	52.6	49.44
WAJ Winter Average m^3/Quarter	56	55.3	57.0
Water Tanker(m^3/month)	8.2	5.0	6.62
Bottled Water (Unit =20 Liter)	5	6.0	7
Spring or Well Averages	0	0	0

Respondents indicated that they receive water from WAJ twice a week in the summer for 47.07 hours and three times a week in the winter for an average of 78 hours. Table 4 illustrates the average days and hours of the water received by the three surveyed areas.

Table 4. presents the days and hours of the water received by the three surveyed areas

Surveyed areas	Tafilefh		Tafileh South		Ma'an	
	days	Hour	days	Hour	days	Hour
Summer	2.0921	35.03	1.2612	26.16	3.7556	88.85
winter	2.723	65.37	1.3731	32.96	6.3889	156.4

For further illustration of the water consumption in different region in Tafileh and Ma'an Governorates, the

household surveyed sample is categorized into four study areas; Tafieleh city area, Ain Al Baida and surroundings, Southern of Tafileh, and Ma'an Governorate as presented in Table 5. Then, a 95% confidence interval for each of the four categorized survey sample constructed. The results of confidence interval calculation is presented in Table 6.

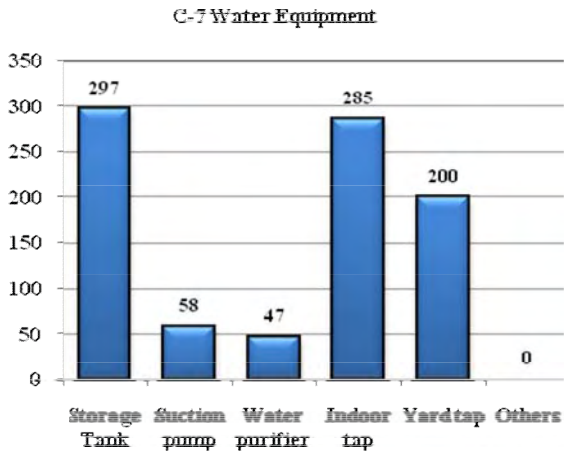
Table 5 .Grouping for Comparative analysis by area

Tafieleh Governorate	TA	Population	Samples	Category
Tafiela city	TAC	26,147	76	
Ezhaigah	EZH	65	2	1. Tafielah city area
Sanfahah	SAN	661	5	
Tal'et Hussain	TAH	218	3	
Arafah	ARA	1,208	7	
Erqayyem/Erwayyem	ERA	1,935	9	
Ain El-baidha	AEB	9,227	26	2. Ain El-baidah and surroundings
Namteh	NMT	71	2	
Abel	ABE	750	6	
Sel'e	SEL	10	2	
Bsaira	BSR	7,647	22	
Um Essarab	UES	558	5	
Gharandal	GHA	4,439	15	
Rashadiyyeh	Ras	1,007	6	
Dhana	DHA	91	2	3. South of Tafieleh
Qhadesiyeh	QHA	7,712	22	
SubTotal		61,746	210	
Ma'an Governerate	MA			4. Ma'an Governorate
Ma'an city	MAC	36,370	90	

Table 6. Confidence interval calculation

Categorized Surveyed Sample	**Average Water Consumption in JOD per Quarter**		**95% Lower Limit Water Consumption in JOD per Quarter**		**95% Upper Limit Water Consumption in JOD per Quarter**	
	Winter	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**
Tafieleh City Area	19.02	24.87	16.118	21.42	21.92	28.32
Ain Al Baida and Surrounding	19.144	25.185	16.596	22.074	21.691	28.29
South of Tafielh	17.896	23.820	15.05	19.73	20.743	27.90
Ma'an Governerate	18.73	24.65	16.352	21.74	21.11	27.56

It can be concluded from the above table that the entire averages of the categorized surveyed sample lies between the highest value and the lowest value. Therefore, statistically there is uniformity in water consumption within each categorized households surveyed sample. Also, the similarity of the averages of water consumption for the four regions indicates the cultural homogeneity in the southern governorates of Jordan.



Water Outlet	Tafilefh City	Tafileh South	Ma'an City	Total
Storage Tank	76	133	88	**297**
Suction Pump	2	0	56	**58**
Water Purifier	7	10	30	**47**
Indoor tap	68	128	89	**285**
Yard Tap	45	94	61	**200**
Others	0	0	0	**0**

Figure 11. Water Outlet Used by the Surveyed Sample

In terms of water outlets in the household, the surveyed sample indicated that the average number of bathrooms per household is two, and the majority of respondents use Turkish toilets. On the other hand, only 100 respondents use regular toilets. In addition, half of the surveyed sample households have a garden with an average area of 510 m^2. Furthermore, the average area of a garden per the surveyed households in Ma'an is about 237 m^2, 681m2 per household in Tafieleh South and 592.4 m^2 in Tafileh City. In addition, each household in the three surveyed area has one car on an average, and the respondents in the three surveyed areas indicated that they wash their car once a week.

Figure 11 shows that 300 respondents frequently use storage tanks as an in-door water source in the surveyed sample. The respondents indicated that the average volume of the tank is three cubic meters. The second mostly used in-door water source is the indoor tap, followed by the yard tap. Finally, the respondents indicated that suction pumps and water purifiers are almost equally used among the surveyed sample. The suction pumps are used to lift the received water from WAJ and collected in house water wells to their storage tanks on the roof of their houses. In addition, the figure illustrates different types of water outlets used in the three surveyed sample.

5.4 Awareness of People about Water Supply Services

This section of the survey was designed to measure the awareness of people about water supply services. Responses indicate that 87 % of the total sample has seen water leakages on the road. The percentage of household's awareness of the water leakage in the three surveyed areas is presented in Figure 12.

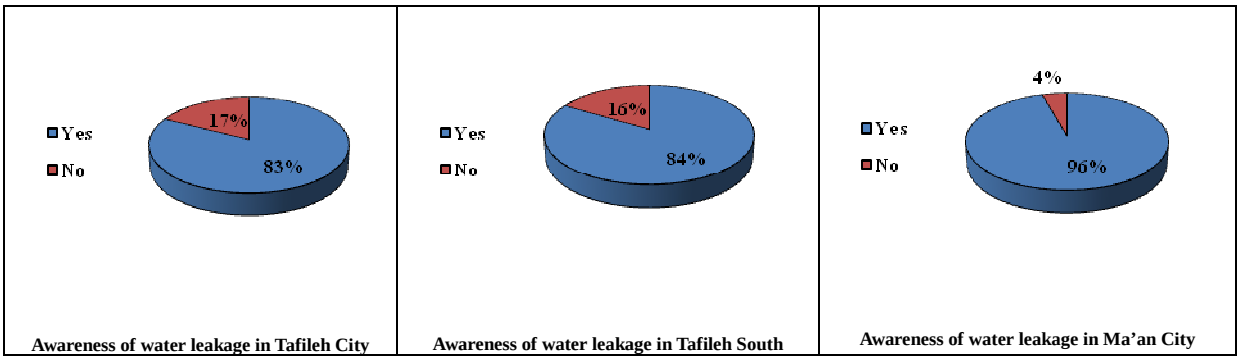


Figure 12. Presents the Awareness of the Households Surveyed sample in the Three Areas the Water Leakage[2]

[2] It must be noted that the percentages were taken out of the total number of households in each area. For example, the sample size in Tafileh City is 76, in Tafileh South is 134, and in Ma'an City is 90.

In addition, 92% of the sample indicated that water is precious in Jordan. Figure 13 Presents the awareness of the households in the three surveyed sample of the water scarcity in Jordan.

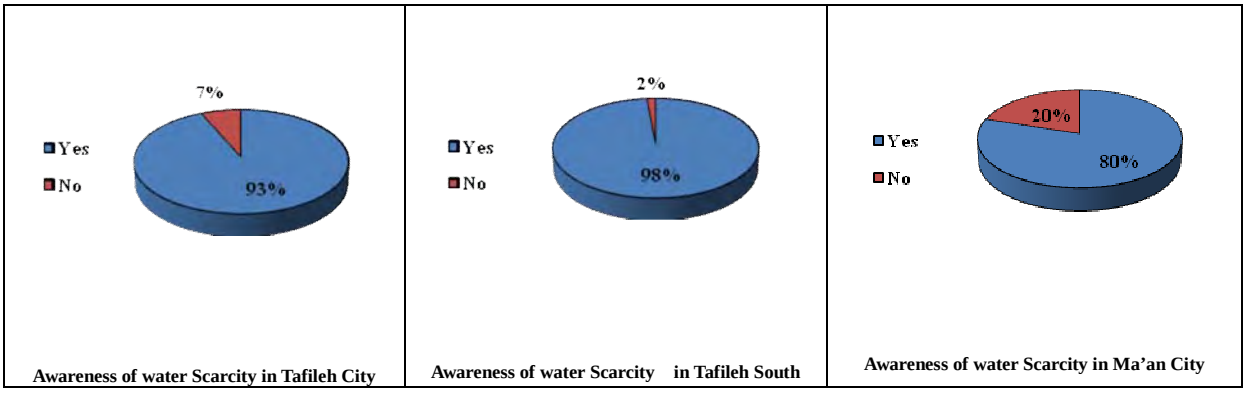


Figure 13. Presents the Awareness of the Households Surveyed sample in the Three Areas about Water Scarcity [2]

[2] It must be noted that the percentages were taken out of the total number of households in each area. For example, the sample size in Tafileh City is 76, in Tafileh South is 134, and in Ma'an City is 90.

Approximately 100 % of the sample thinks that water saving is important. Figure 14 Presents the awareness of the households surveyed sample in the three surveyed areas.

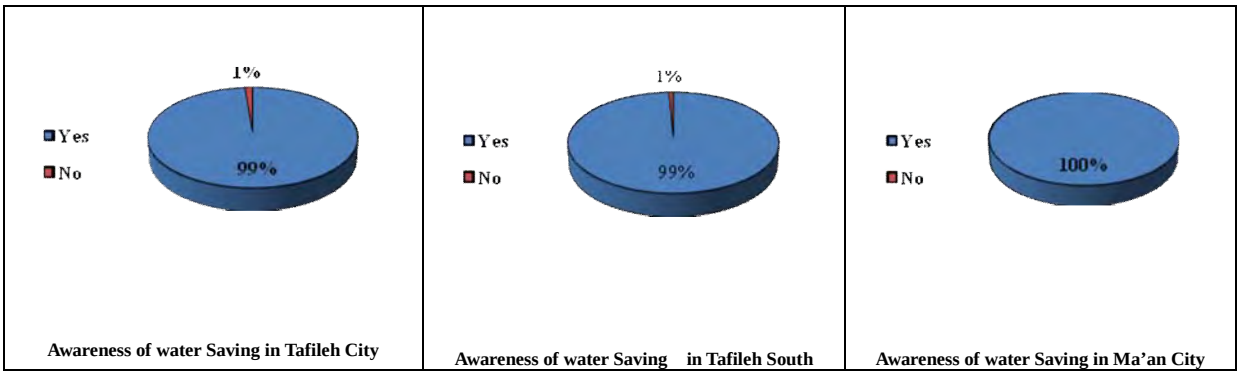
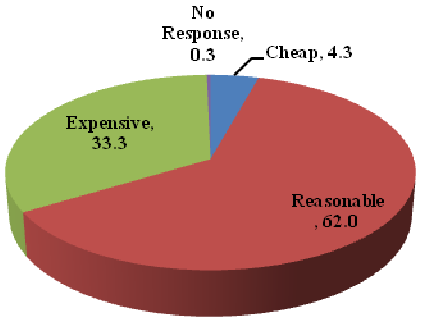


Figure 14. Presents the Awareness of the Households Surveyed sample in the Three Areas about Water Saving[2]

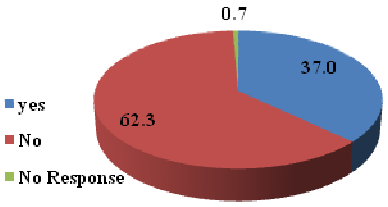
Figure 15 presents the sample's perspective of the water cost. As can be seen, 62% of the surveyed sample thinks that water cost is reasonable, 34 % thinks that it is cheap, and the reminder believes that it is expensive. Moreover, the Table in the Figure presents the sample perspective of water cost in the three surveyed areas. It must be noted that the percentage representation in both the entire sample and the subcategorized surveyed sample were taken out of the total sample (300).

Figure 16 shows that 66 % of the respondents are not satisfied with the current water supply service. In addition, the Table in the Figure presents the households satisfaction with the current water service in the three surveyed areas. It must be noted that the percentage representation in both the entire sample and the subcategorized surveyed sample were taken out of the total sample (300).



Sample Perspective	% of Respondents in Tafileh City	% of Respondents in Tafeileh South	% of Respondents in Ma'an City	Total
Cheap	1.0%	2.0%	1.3%	**4.3%**
Reasonable	16.3%	27.3%	18.3%	**62%**
Expensive	8.0%	15.3%	10.0%	**33.3%**
			0.3%	**0.3%**
			Total	**100%**

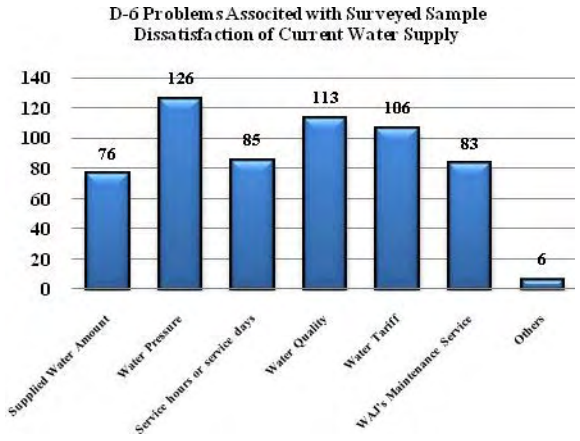
Figure 15. Sample Perspective of Water Cost



Sample Satisfaction	% in Tafileh City	% in Tafeileh South	% in Ma'an City	Total
Yes	9%	24%	4%	**37.0%**
No	16%	20.3%	26	**62.3%**
No Response	0.33%	0.33%	0	**0.7%**
				100%

Figure 16. Survey Sample Satisfaction of Water Service

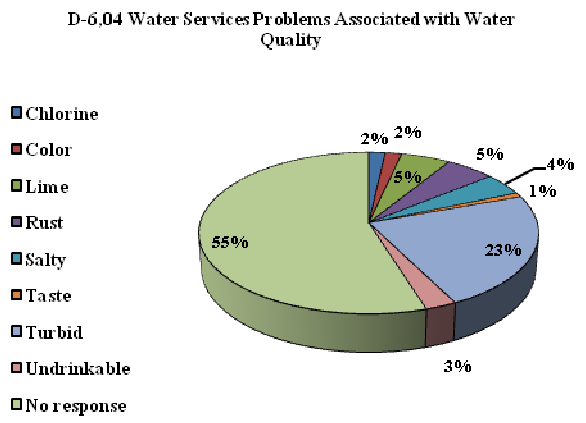
In addition, the unsatisfied respondents indicated that this is related to many problems as presented in Figure 17. The Figure11 illustrates the problems related to the surveyed sample's dissatisfaction of water supply service. The main three problems are the water pressure, water quality, and the water tariff. The Figure shows that 126, 113 and 106 respondents indicated that they are not satisfied with water supply pressure, quality, and tariff, respectively. On the other hand, approximately the same number of respondents related their dissatisfaction to the supplied water amount, WAJ's maintenance services, and water service hours and days. Further illustration of different water problem related to the household's dissatisfaction in the three surveyed areas is presented in the table shown in the Figure 17.



Sample Area	Tafieleh City	Tafieleh South	Ma'an City	Total
Supplied Water Amount	11	18	47	**76**
Water Pressure	21	47	58	**126**
Service Hours or service days	13	28	44	**85**
Water Quality	17	22	74	**113**
Water Tariff	19	45	42	**106**
WAJ's Maintenance Services	10	16	56	**83**
Others	1	1	4	**6**

Figure 17. Problems Associated With Sample Satisfaction of the Water Supply

Figure 18 shows that 27 out of 113 respondents, who confirmed that they are not satisfied with water quality, believe that water turbidity is the major problem associated with water quality.



Sample Area	Tafieleh City	Tafieleh South	Ma'an City	Total
Chlorine			1.77%	**1.77%**
Color	0.855		0.885	**1.74%**
Lime			5.31%	**5.31%**
Rust			5.31%	**5.31%**
Salty	1.77%	1.77%	0.855%	**4.4%**
Taste		0.885		**0.855%**
Turbid	1.77%	2.655%	18.6%	**23.025%**
Undrinkable	1.77%		0.885%	**2.655%**
No Response				**54.87%**
				100%

Figure 18. Water Supply Dissatisfaction Associated With Water Quality

Respondents' opinion about the WAJ services is indicated by 16 out of 83 respondents who illustrated that WAJ's maintenance services is one of the problems associated with the water supply service. While 10 respondents think that the response of WAJ's maintenance service is slow, the remaining 6 respondents state that there is no response at all from the WAJ maintenance services. The percentage of respondents in Ma'an Households sample who think that a water maintenance service is slow is about 80%. While only 10% of the households surveyed in each of Tafileh City and Tafileh South thinks that the water maintenance is slow. On the other hand, around 66.7 % in Ma'an Households sample thinks that there is no response from WAJ's maintenance service. While 16.7 % in each of Tafileh City and Tafileh South thinks that there is no response from WAJ's Maintenance service.

Furthermore, the problems associated with water supply are categorized into first and second orders of priority as presented in Figure 19. Respondents ranked water service problems according to their priority. For first priority rankings, water pressure comes in first place, followed by water quality in second place, and finally supplied water amount in third place. For second priority rankings water quality came in first place, while water tariff and maintenance services tied in second place. The Tables in the figures present the first and second orders of priorities in the three surveyed households' areas.

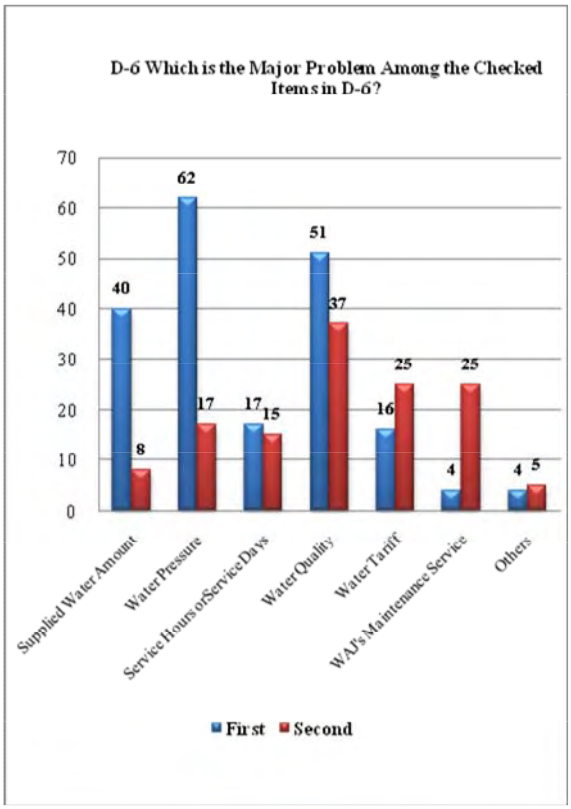


Figure 19. First and Second Orders of Priority of the Related Problems With the Current Water Service

First Order of Priority of the Related Problems With the Current Water Service				
Sample Area	**Tafieleh City**	**Tafieleh South**	**Ma'an City**	**Total**
Supplied Water Amount	8	10	22	**40**
Water Pressure	13	31	18	**62**
Service Hours or service days	7	5	5	**17**
Water Quality	10	10	31	**51**
Water Tariff	5	10	1	**16**
WAJ's Maintenance Services	3	1	1	**4**
Others	2	1	1	**4**

Second Order of Priority of the Related Problems With the Current Water Service in the Three Areas				
Sample Area	**Tafieleh City**	**Tafieleh South**	**Ma'an City**	**Total**
Supplied Water Amount	1	2	5	**8**
Water Pressure	4	7	6	**17**
Service Hours or service days	2	7	6	**15**
Water Quality	2	4	31	**37**
Water Tariff	6	12	7	**25**
WAJ's Maintenance Services	5	6	14	**25**
Others	1	2	2	**5**

Figure 20 presents the weighted average of the first and the second orders of priority. The Figure suggests that water pressure, supplied water amount, and water quality are the major problems associated with the current water supply service as perceived by our target sample.

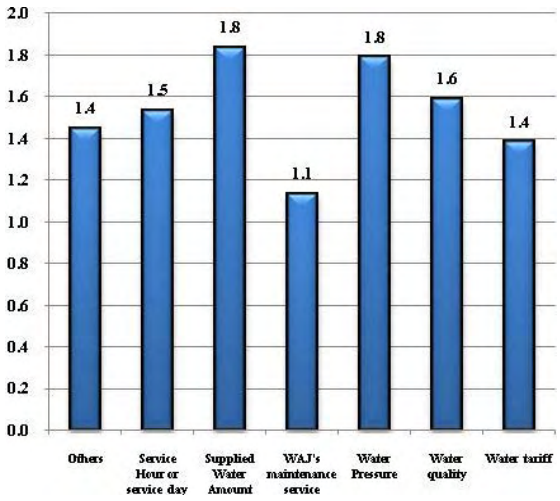
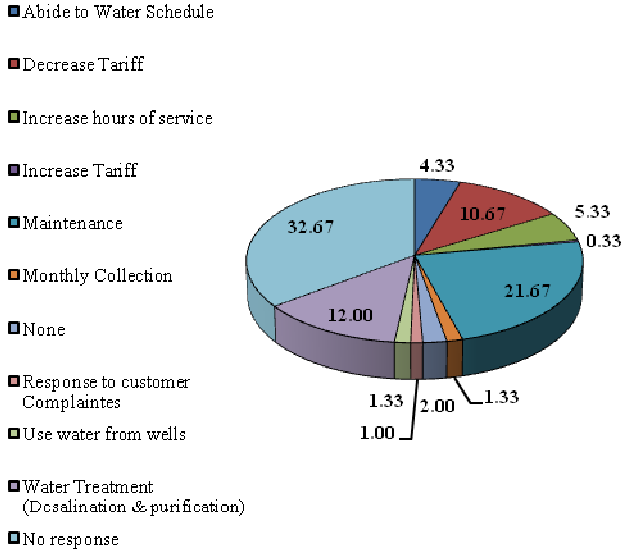


Figure 20. Weighted Average for the First and Second Orders of Priority

To improve the level of satisfaction with the current water supply service, the respondents indicated that there are many services to be improved. The percentages of those services are shown in Figure 21. About 22% of the respondents state that improving maintenance services would improve the overall water service. In addition, 12% thinks that desalination and water treatment would improve the current water service. Also, 1.33 % of respondents indicated that the use of water from wells would help in improving water service. Also, 11% indicated that the decreasing tariff would improve water service, and 4 % identified that abiding to the water schedule would improve water service.



	Tafieleh City	Tafieleh South	Ma'an City	Total %
Abide to Water Schedule	1.67	1.00	1.67	**4.33**
Decrease Tariff	3.33	5.33	2.00	**10.67**
Increase hours of service	4.00	0.00	1.33	**5.33**
Increase Tariff	0.33	0.00	0.00	**0.33**
Maintenance	4.33	3.67	13.67	**21.67**
Monthly Collection	0.33	0.33	0.67	**1.33**
None	1.00	1.00	0.00	**2.00**
Response to customer Complaintes	0.33	0.00	0.67	**1.00**
Use water from wells	0.00	0.00	1.33	**1.33**
Water Treatment (Desalination & purification)	0.67	3.00	8.33	**12.00**
No response	24.33	8.00	0.33	**32.67**

Figure 21. Water Service Suggested Improvement

Smaller percentages of respondents pointed to other suggestions to improve water services. This included using water from wells, monthly collection, and improvement to WAJ customer services. Furthermore, 2% of respondents expressed their apathy towards improvements of the water services since they stated that no action can make a difference. The Table in the Figure presents the percentage of different services to be improved in the three households' surveyed areas.

Respondents expressed their willingness to pay an average of 9.24 JOD per quarter for the water service under the current conditions.

Table 7. Average amount of money to be Paied Under the Current Conditions of Water Supply in the Three Households' surveyed Areas

Sample Area	Number of Respondents	JOD/Quarter
Tafileh City	33	12.15
Tafileh South	87	14
Ma'an City	50	20.0

However, they expressed their willingness to pay up to 13.05 JOD per quarter on an average granted good water quality as well as continuous supply. Nevertheless, currently the household survey sample pays an average of 20.99 JOD per quarter in summer and an average of JOD 24.65 in winter.

Figure 22, illustrates the reasons of respondents who refused to pay under the current water service. Three respondents are not willing to pay due to bad water quality, four respondents are not willing to pay due to financial inability and one respondent is not willing to pay due to the existing high tariff.

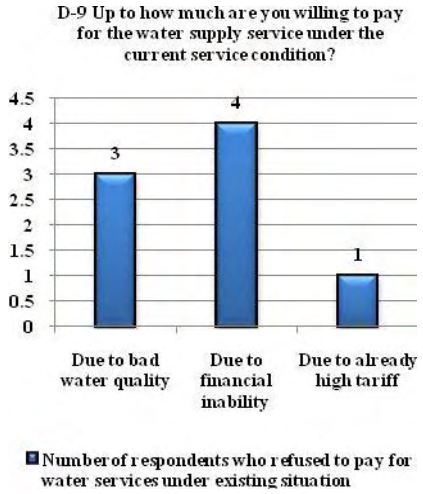


Figure 22. Number of Respondents who Refused to pay for the Current Water Services

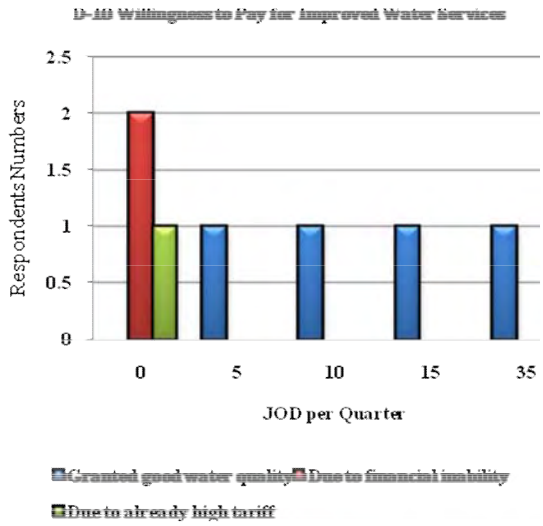
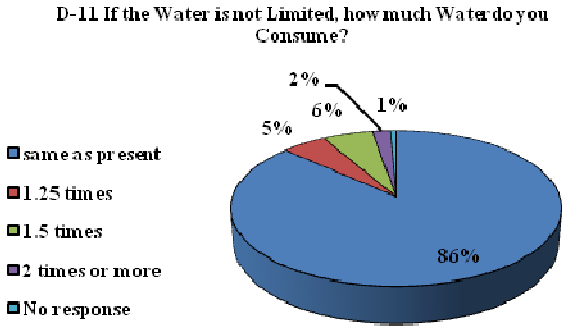


Figure 23. Willingness to pay for Improved Water Services

In addition, Figure 23 illustrates some comments of the respondents who are willing to pay. Only one respondent in each proposed price category, that represents the amount of JOD to be spent per quarter, indicated their willingness to pay granted good water quality. It can be concluded from the Figure that the minimum and maximum amount of money to be paid granted good water quality is 5 JOD per quarter and 35 JOD per quarter respectively. On the other hand, two respondents are not willing to pay due to financial inability. In addition, one respondent refused to pay due to existing high tariff of water service.

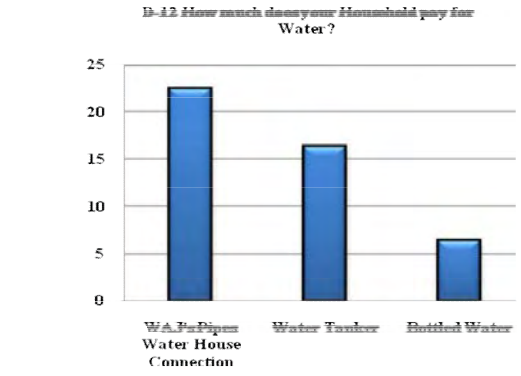
Figure 24 shows that 86% of respondents would keep the same pattern of water consumption even if the water is not limited. However, 6% of respondents would increase their water consumption by one and a half times the current consumption of water. Moreover, 5% would consume one and a quarter times the current consumption. Finally, 2% of the respondents would consume twice as much of the current consumption pattern.



Sample Area	Tafileh City	Tafileh South	Ma'an City	Total
same as present	23.33	41.00	22.33	**86.67**
1.25 times	1.33	1.33	2.33	**5.00**
1.5 times	0.33	1.33	4.00	**5.67**
2 times or more	0.33	0.33	1.33	**2.00**
No response		0.67		**0.67**
				100%

Figure 24 Water Consumption if the Water is not Limited

Figure 25 presents the average amount of money to be paid for the supply of water from different water sources. In addition, Figure 26 presents the percentage of respondents from the total surveyed sample who answered for specific water supply source. The Figure indicates that 99% of the sample is paying 22.5 JOD per quarter for WAJ's piped water house connection, in addition 11.7% are paying 16.34 JOD per month for water supplied by water tanker, and 22.3 % are paying 6.4 JOD per month for bottled water.



	Public Network		Water Tanker	Bottled Water	T per Month
	JOD/Q	JOD/Month	JOD/month	JOD/Month	
Tafileh City	22	7.33	22	6.57	**35.9**
Tafieleh South	23.42	7.801	14.25	8.4	**30.5**
Ma'an City	21.5	7.16	16.16	10	**33.3**
					99.7

Figure 25. Amount of Money to be Paid for the Supply of Water

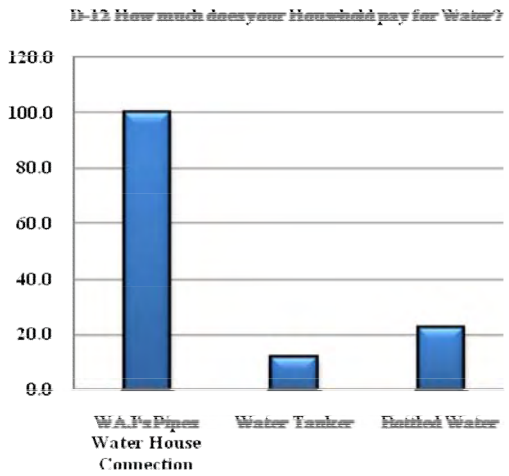
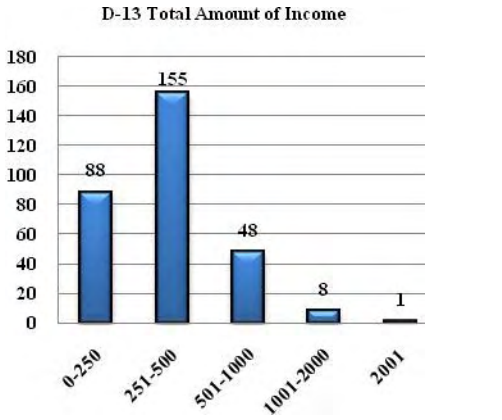


Figure 26. Percentage of Respondents to pay the Amount of Money Presented in Figure 25

In terms of monthly income, the majority of respondents reported an average monthly income in the range of 251 JOD to 500 JOD per month. In addition, 48 respondents have an average monthly income in the range of 501 to 1000 JOD per month. Only eight respondents have an average income in the range of 1001 to 2000 JOD per month as presented in Figure 27. Figure 28 illustrates that meal expenses is the largest expense among other expenses in the surveyed sample of households. The average household spends about 164 per month on meals. On the other hand, the average water expenditure is about 10.3 JOD per month which represents the lowest expenditure. Other expenses are education, housing, fuel, and clothing. The Average water expense from the total amount of income is 3.2%. Furthermore, Table 7. Presents the categorized expenditures for the three household's surveyed areas.



	Tafileh City	Tafileh South	Ma'an City	Total
0-250	21	50	17	**88**
251-500	49	65	41	**155**
501-1000	5	17	26	**48**
1001-2000	1	2	5	**8**
>2001		0	1	**1**

Figure 27. Income Ranges in JOD per Month

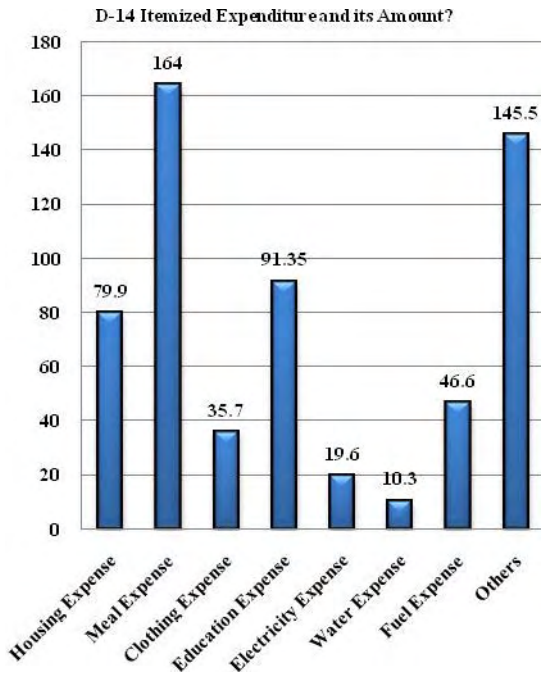


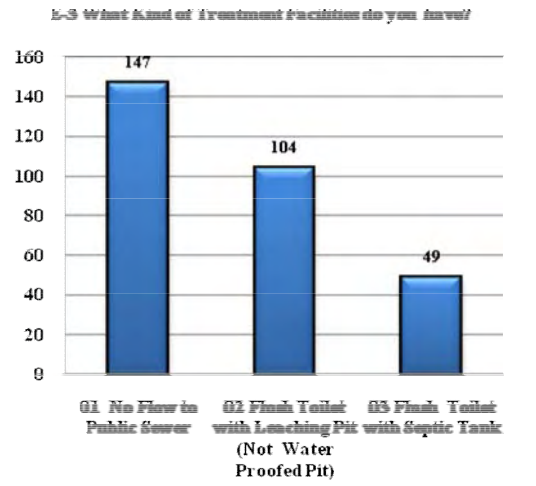
Figure 28. Expenditure of Household in JOD/ Month

Table 7. The Categorized Expenditures for the Three Household's Surveyed Areas.

Expenses	Number of Respondents	Tafileh City	Number of respondents	Tafileh South	Numbers of Respondents	Ma'an City
Housing	25	84.55	36	67.7	43	84.5
Meal Expense	76	165.66	133	142	87	195.5
Clothing	60	28	104	32.26	85	45.3
Education	41	78.53	65	103.4	54	86.75
Electricity	71	19.7	126	18	82	22.5
Water	68	8.276	124	8.4	79	14.85
Fuel expense	50	38.7	70	51.154	49	49.21
others			6	257	3	45

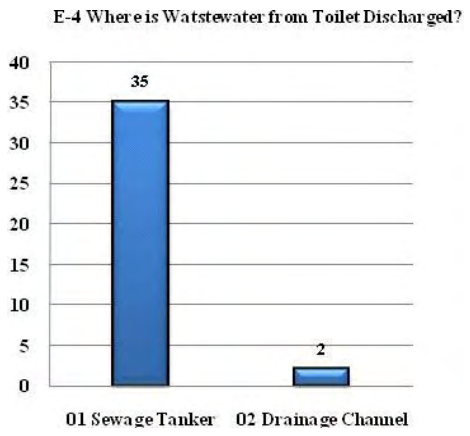
5.4 Condition of Toilet

All the surveyed families have in-house toilet facilities. In addition, Figure 29 presents that 147 of the surveyed families are using public sanitation, 104 families are using flush toilet with leaching pit (not water proofed pit), and 49 families are using flush toilet with septic tank. Out of the 49 families who are using flush toilet with septic tank, 35 families use sewage tanker to empty their septic tank. Figure 30 shows that only two families are using drainage channels to empty the septic tank. Further illustration of the types of treatment facilities and the end destination of wastewater discharge for the three households' surveyed areas are presented in the Tables below Figures 29 and 30.



	Tafileh City	Tafileh South	Ma'an City	Total
No Flow to Public Sewer	65	5	77	147
Flush Toilet with Leaching Pit	7	92	5	104
Flush Toilet with Septic Tank	4	37	8	49

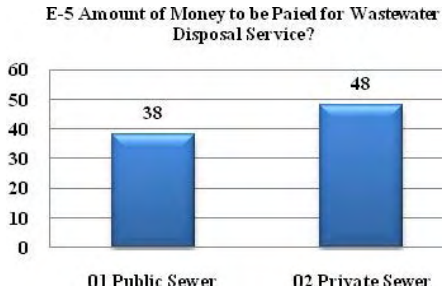
Figure 29. Types of Treatment Facilities



	01 Sewage Tanker	02 Drainage channel
Tafileh City	4	
Tafileh South	27	1
Ma'an City	4	1
Total	35	2

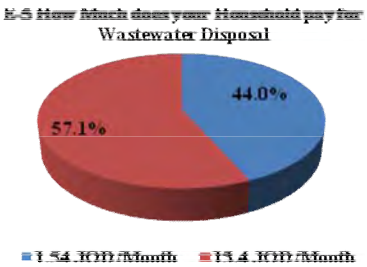
Figure 30. The end Destination of Wastewater Discharge

Figure 31 indicates the numbers of respondents who pay for both public and private sewers. In addition, Figure 32 shows the break down of the percentage of the respondents who are paying for both public sewer and private services (Suction Truck). The Figure shows that 44% of respondents pay 1.54 JOD per month for public sewer and 57% are paying 13.4 JOD per month for private sewer service. Further illustration of the Distribution of Respondents who pay for Both Private and Public Sewer and the average amount paid for both public and private are presented in Tables below Figures 31 and 32.



	Public Sewer	Private Sewer
Tafileh City	22	4
Tafileh South	4	35
Ma'an City	12	9
	38	48

Figure 31. Distribution of Respondents who pay for Both Private and Public Sewer

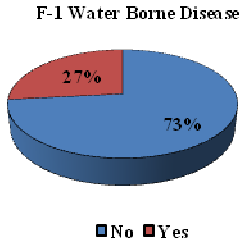


	Public Sewer	Private Sewer
Tafileh City	1.4	17.5
Tafileh South	1	13.03
Ma'an City	1.9	13.11

Figure 32. Amount of Money Which is Paid for Both Public and Private Sewer

5.5 Sanitary Conditions

It can be concluded from Figure 27 that 27% of the families in the survey sample indicated that their members have been infected by water borne disease. The Table under the Figure illustrates the % of households' member infected of water borne disease in the three households' surveyed sample. Yearly, the average infection rate is two members per family. The sample indicated that the average cost of treatment per family member is around JOD 110 per year of which the average cost of treatment of infected member of 10 households in Tafileh City is JOD 28.5, the average cost of treatment of infected member of 27 households in Tafileh South is JOD 72.3, and the average cost of treatment of infected member of 37 households in Tafileh City is JOD 164.32



	% of No	% of Yes
Tafileh City	5.33	20
Tafileh South	9.0	35.67
Ma'an City	12.33	17.67
Total	**27**	**73**

Figure 33. Availability of Water Borne Disease

参考資料－4　タフィーラ県及びマアン県対象地域の計画給水人口及び計画給水量

タフィーラ県対象地域の計画給水人口及び計画給水量

配水区	担当配水池	計画給水人口（人）				計画一日平均使用水量 (m3/日)				計画一日平均給水量 (m3/日)				計画一日最大給水量 (m3/日)				時間最大配水量 (m3/日) 日換算			
		2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025
Al Mansoura	Tafieleh 低区	4,199	4,577	4,978	5,351	470	573	622	669	628	674	732	787	943	1,012	1,099	1,182	1,886	2,024	2,197	2,364
Tafieleh 低区東		12,432	13,373	14,004	14,504	1,392	1,672	1,751	1,813	1,857	1,967	2,060	2,133	2,786	2,952	3,090	3,201	5,572	5,903	6,180	6,401
Tafieleh 低区西		5,859	6,363	6,917	7,429	656	795	865	928	875	936	1,018	1,092	1,313	1,405	1,527	1,639	2,627	2,810	3,054	3,278
	小計	22,490	24,313	25,899	27,284	2,519	3,040	3,238	3,411	3,359	3,577	3,809	4,013	5,043	5,369	5,716	6,022	10,085	10,737	11,432	12,043
Tafieleh 高区東	Tafieleh 高区	2,073	2,252	2,414	2,556	232	282	302	320	310	332	355	376	465	498	533	564	929	995	1,066	1,128
Tafieleh 高区西		1,464	1,599	1,739	1,868	164	200	217	234	219	235	256	275	329	354	384	413	658	707	768	825
	小計	3,537	3,851	4,153	4,424	396	482	519	553	528	567	611	651	794	851	917	977	1,587	1,702	1,834	1,953
Tafieleh 最高区	Ain-El Baidha	70	77	84	91	8	10	11	11	10	11	12	13	16	17	19	20	31	34	37	40
Sanfahah		3,450	3,762	4,089	4,394	387	471	511	549	516	554	601	646	775	833	903	971	1,551	1,666	1,805	1,941
Nemta		159	174	189	204	18	22	24	26	24	26	28	30	36	39	42	45	72	77	84	91
Ain-El Baidha		10,918	11,893	12,935	13,900	1,224	1,488	1,618	1,739	1,632	1,752	1,902	2,045	2,452	2,631	2,857	3,071	4,903	5,261	5,714	6,142
Ain-El Baidha-Bsaira 間		1,273	1,393	1,517	1,636	143	175	190	205	191	207	223	241	289	312	335	363	577	623	670	725
	小計	15,870	17,299	18,814	20,225	1,779	2,165	2,353	2,530	2,373	2,550	2,766	2,976	3,567	3,831	4,155	4,470	7,135	7,661	8,309	8,939
Bsaira	Bsaira	9,522	10,378	11,222	11,997	1,068	1,298	1,404	1,500	1,424	1,528	1,651	1,764	2,140	2,295	2,479	2,649	4,279	4,590	4,958	5,298
Gharandal	Gharandal	4,739	5,169	5,625	6,045	531	646	703	756	709	761	827	889	1,065	1,142	1,243	1,335	2,130	2,285	2,485	2,669
Qhadesiyeh	Qhadesiyeh	7,660	8,348	9,078	9,754	858	1,045	1,135	1,220	1,145	1,230	1,335	1,435	1,721	1,847	2,004	2,155	3,442	3,694	4,008	4,309
Erawath-Qhadesiyeh 間	Erawath ポンプ場	77	84	91	98	9	11	11	12	12	13	13	15	18	19	20	22	35	38	40	44
給水区域外		605	658	718	773	68	82	90	97	91	97	106	114	137	146	159	171	273	292	318	342
合計		64,500	70,100	75,600	80,600	7,228	8,769	9,455	10,080	9,640	10,322	11,118	11,856	14,483	15,500	16,692	17,799	28,966	30,999	33,384	35,598

マアン県対象地域の計画給水人口及び計画給水量

配水区	地域詳細	計画給水人口（人）				計画一日平均使用水量 (m3/日)				計画一日平均給水量 (m3/日)				計画一日最大給水量 (m3/日)				時間最大配水量 (m3/日) 日換算			
		2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025	2010	2015	2020	2025
Tahoonah																					
Tahoonah0dura 中部配水区	①0durah	2,073	2,332	2,586	2,840	423	467	491	511	603	622	634	639	906	937	952	959	1,813	1,873	1,905	1,919
	②市中部	1,742	1,955	2,164	2,373	356	391	411	427	508	521	531	534	762	782	797	802	1,524	1,565	1,594	1,603
Tahoonah 市北部中部配水区	③市中部	2,359	2,647	2,929	3,211	481	529	557	578	687	706	718	723	1,031	1,059	1,077	1,084	2,063	2,119	2,155	2,168
	④市北部	1,691	1,910	2,118	2,326	345	382	403	419	492	510	519	524	741	768	780	787	1,482	1,535	1,559	1,573
Tahoonah 旧市街配水区	⑤旧市街	12,001	12,951	13,851	14,652	2,448	2,590	2,632	2,637	3,497	3,051	3,100	3,105	5,247	4,578	4,651	4,658	10,494	9,156	9,302	9,316
Samneh																					
Samneh 南西配水区	⑧市西部	248	282	315	348	50	56	60	63	71	76	76	78	109	115	116	118	217	228	232	236
	⑥市中部	1,578	1,773	1,962	2,151	322	355	373	387	460	473	481	484	690	710	722	726	1,380	1,420	1,443	1,453
	⑩市南西部	4,036	4,528	5,014	5,500	823	906	953	990	1,176	1,207	1,230	1,238	1,766	1,812	1,846	1,858	3,532	3,624	3,692	3,717
Samneh 南東配水区	⑦旧市街	3,941	4,305	4,563	4,820	804	861	867	868	1,149	1,013	1,020	1,021	1,723	1,520	1,531	1,531	3,446	3,040	3,061	3,062
	⑨市南東部	3,131	3,517	3,898	4,279	638	703	741	770	911	938	956	963	1,370	1,410	1,436	1,447	2,739	2,820	2,871	2,893
合計		32,800	36,200	39,400	42,500	6,690	7,240	7,488	7,650	9,554	9,117	9,265	9,309	14,345	13,691	13,908	13,970	28,690	27,380	27,814	27,940
配水区別																					
Tahoonah 配水区																					
Tahoonah0dura 中部配水区		3,815	4,287	4,750	5,213	779	858	902	938	1,111	1,143	1,165	1,173	1,668	1,719	1,749	1,761	3,337	3,438	3,499	3,522
Tahoonah 市北部中部配水区		4,050	4,557	5,047	5,537	826	911	960	997	1,179	1,216	1,237	1,247	1,772	1,827	1,857	1,871	3,545	3,654	3,714	3,741
Tahoonah 旧市街配水区		12,001	12,951	13,851	14,652	2,448	2,590	2,632	2,637	3,497	3,051	3,100	3,105	5,247	4,578	4,651	4,658	10,494	9,156	9,302	9,316
小計		19,866	21,795	23,648	25,402	4,053	4,359	4,494	4,572	5,787	5,410	5,502	5,525	8,687	8,124	8,257	8,290	17,376	16,248	16,515	16,579
Samneh 配水区																					
Samneh 南西配水区		5,862	6,583	7,291	7,999	1,195	1,317	1,386	1,440	1,707	1,756	1,787	1,800	2,565	2,637	2,684	2,702	5,129	5,272	5,367	5,406
Samneh 南東配水区		7,072	7,822	8,461	9,099	1,442	1,564	1,608	1,638	2,060	1,951	1,976	1,984	3,093	2,930	2,967	2,978	6,185	5,860	5,932	5,955
小計		12,934	14,405	15,752	17,098	2,637	2,881	2,994	3,078	3,767	3,707	3,763	3,784	5,658	5,567	5,651	5,680	11,314	11,132	11,299	11,361
合計		32,800	36,200	39,400	42,500	6,690	7,240	7,488	7,650	9,554	9,117	9,265	9,309	14,345	13,691	13,908	13,970	28,690	27,380	27,814	27,940
地区別																					
0durah		2,073	2,332	2,586	2,840	423	467	491	511	603	622	634	639	906	937	952	959	1,813	1,873	1,905	1,919
市中部		5,679	6,375	7,055	7,735	1,159	1,275	1,341	1,392	1,655	1,700	1,730	1,741	2,483	2,551	2,596	2,612	4,967	5,104	5,192	5,224
市北部		1,691	1,910	2,118	2,326	345	382	403	419	492	510	519	524	741	768	780	787	1,482	1,535	1,559	1,573
旧市街		15,942	17,256	18,414	19,472	3,252	3,451	3,499	3,505	4,646	4,064	4,120	4,126	6,970	6,098	6,182	6,189	13,940	12,196	12,363	12,378
市西部		248	282	315	348	50	56	60	63	71	76	76	78	109	115	116	118	217	228	232	236
市南東部		3,131	3,517	3,898	4,279	638	703	741	770	911	938	956	963	1,370	1,410	1,436	1,447	2,739	2,820	2,871	2,893
市南西部		4,036	4,528	5,014	5,500	823	906	953	990	1,176	1,207	1,230	1,238	1,766	1,812	1,846	1,858	3,532	3,624	3,692	3,717
合計		32,800	36,200	39,400	42,500	6,690	7,240	7,488	7,650	9,554	9,117	9,265	9,309	14,345	13,691	13,908	13,970	28,690	27,380	27,814	27,940

参考資料－5　井戸の揚水試験結果

Well Pumping Test of Water Sources in Tafieleh Project Area

IDN	Station Name	Station Name	Duration (hr)	Yield (m^3/hr)	Static Water Level (m, bmp)	Pumping water Level (m, bmp)	Drawdown (m)	Specific Capacity (m^3/hr/m)	Yield (m3/day)
CF3015	Al Hasa 1	WADI RUWAK 1/HASA	24	115	46.9	47.43	0.53	216.98	2,300
CF3022	Al Hasa 2	WADI RUWAK 2 /HASA 6							2,664
CF3023	Al Hasa 3	WADI RUWAK 3 /HASA 5	48	143	47.65	47.8	0.15	953.33	2,860
CF3024	Al Hasa 4	WADI RUWAK 4 /HASA 7	48	130	68	68.35	0.35	371.43	2,600
CF3025	Al Hasa 5	WADI RUWEIHI/HASA	41	165	29.3	30.8	1.5	110	3,300
CF3014	Al Hasa 6	WADI ABU DHIBA/HASA	40	113	53.7	53.85	0.15	753.33	2,260
Subtotal				666					15,984

Source: WAJ HQ Groundwater Div.
Note: The data of well IDN CF3022 is not available and yield is estimated based on the average yield of other wells in the table.

Well Pumping Test of Water Sources in Ma'an Project Area

Station ID	Station Name	Duration (hr)	Yield (m^3/hr)	Static Water Level (m, bmp)	Pumping water Level (m, bmp)	Drawdown (m)	Specific Capacity (m^3/hr/m)	Yield (m3/day)
Tahoonah								
G 3186	TAHOUNEH NO 1A	89	50	73.4	76.7	3.3	15.2	1,000
G 1265	TAHOUNEH NO 2	24	98	55.2	57.05	1.85	52.97	1,960
G 3021	TAHOUNEH NO 3	24	139	29.87	47.6	17.73	7.84	2,780
G 3005	TAHOUNEH NO 4	40	66	9.7	47.9	38.2	1.73	1,320
G 3077	TAHOUNEH NO 5	43	70	64.85	77	12.15	5.76	1,400
G 3078	TAHOUNEH NO 6	48	65	64.52	75.32	10.8	6.02	1,300
G 3148	TAHOUNEH NO 7	100	22	93.55	110.6	17.05	1.29	440
G 3178	TAHOUNEH 8	28	65	85.4	92.88	7.48	8.7	1,300
G 3179	TAHOUNEH 9	41	64	83.75	95.8	12.05	5.3	1,280
G 3181	TAHOUNEH 10	44	100	46.8	51.2	4.4	22.7	2,000
G3246	TAHOUNEH 11		60	44		72.55		1,200
Subtotal								14,980
Samneh								
G 4086	SAMNEH 1	72	70	59	59.7	0.7	100	1,400
G 4096	SAMNEH 2	48	91	71.8	73.8	2	0	1,820
G 4099	SAMNEH 4	50	85	47.4	0	1.65	0	1,700
G 3206	SAMNEH 5	120	75	53.2	0	2.6	0	1,500
Sutotal								6,420
Total								20,200

Source: WAJ HQ Groundwater Div.

参考資料－6　タフィーラ県の送水システムの水理計算結果

NODE	Transmission pipeline			
ID	Elevation	Head	Demand	Pressure
	m	m	m3/d	m
Junc 24	1309.0	1314.5	2649.0	5.5
Junc 25	1265.0	1317.7	0.0	52.7
Junc 26	1296.0	1312.6	3512.0	16.6
Junc 30	1250.0	1345.4	0.0	95.4
Junc 31	1250.0	1334.6	0.0	84.6
Junc 32	1255.0	1341.8	0.0	86.8
Junc 33	1250.0	1332.4	0.0	82.4
Resvr 23	1353.0	1353.0	-6161.0	0.0

LINK	Transmission pipeline						
ID	Length	Diameter	Roughness	Flow	Velocity	Unit head loss	Status
	m	mm		m3/d	m/s	m/km	
Pipe 24	454.98	200	110	2649	0.98	7.07	Open
Pipe 25	359.08	200	100	3512	1.29	14.21	Open
Pipe 29	2890.2	300	110	4517.87	0.74	2.64	Open
Pipe 30	10136.07	200	100	1643.13	0.61	3.48	Open
Pipe 23	1360.35	300	110	4517.87	0.74	2.64	Open
Pipe 31	2733.47	300	110	4517.87	0.74	2.64	Open
Pipe 32	2297.16	250	110	4517.87	1.07	6.4	Open
Pipe 33	822.05	300	110	4517.87	0.74	2.64	Open

WATER HAMMER ANALYSIS　　NO. P10011　　PAGE 1

Qhadesiyyeh

BASIC LEVEL 1292.000 m
DELTA T .06252 sec

【 PIPELINE DATA 】

PIPELINE NO	LENGTH m	MATE-RIAL	DIA. mm	THICK-NESS mm	ELASTIC MODULUS (LONG.)	UPSTREAM NO.	CONDITION PIPE -	CONDITION PUMP-	CONDITION	CONDITION SURGE	CONDITION VALVE	CONDITION END	FLOW RATE m3/m	LOSS PIPE-LINE	LOSS END VALVE	INTERVAL TIME sec	PIPELINE CONSTANT	DIVI-SION
001	4560.0	FCD3	200	10.0	2.100		1	0	0	0	0	0	1.500	45.000	.000	7.0025	35.2700	112
002	2440.0	FCD3	200	10.0	2.100	001	0	0	0	0	0	1	1.500	24.000	.000	3.7470	35.2700	60

【 PUMP DATA 】

NO	Q'TY	TYPE	TYPE OF VALVE CLOSING	V-NO	TOTAL HEAD m	FLOWRATE m3/m	MOTOR kw	MOTOR POLE	TYPE	GD2 kg-m2	GD2 (WHEEL) kg-m2	SPEED min-1	EFF. %	k	START CONDITION HEAD m	START CONDITION FLOW RATE m3/m	START CONDITION SPEED	START CONDITION TORQUE
1	1	1	1	0	380.000	1.500	200.0	2	0	5.000	.000	2950	62	1.2589	380.000	1.500	1.000	1.000

【 PIPELINE ROUTE 】

001 002

【 PROFILE OF PIPELINE 】

NO	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m
001	.0	1290.00	2500.0	1475.90	2840.0	1477.90	4360.0	1566.20
	4560.0	1568.50	5020.0	1561.50	6320.0	1567.50	6400.0	1567.20
	6620.0	1565.50	6820.0	1572.00	7000.0	1582.50		

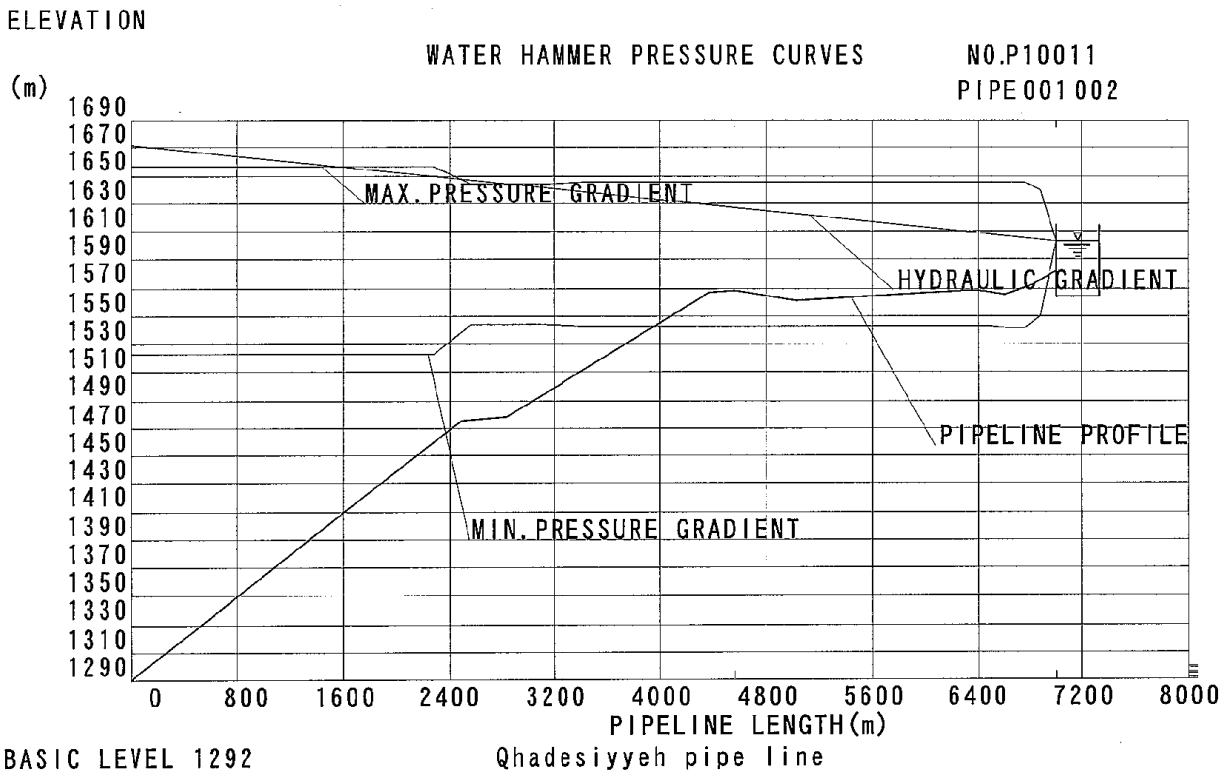
1. CALCULATION INTERVAL 4

3. PRESSURE OF PIPELINE

NO	LENGTH m	MAX TIME sec	MAX FLOW RATE m3/m	MAX HEAD m	MAX WATER LEVEL m	MIN TIME sec	MIN FLOW RATE m3/m	MIN HEAD m	MIN WATER LEVEL m
001	.0	21.008	.000	364.120	1656.120	7.253	.000	231.059	1523.059
001	285.0	20.789	.000	364.120	1656.120	7.471	.000	231.059	1523.059
001	570.0	20.570	.000	364.120	1656.120	7.690	.000	231.059	1523.059
001	855.0	20.351	.000	364.120	1656.120	7.909	.000	231.059	1523.059
001	1140.0	20.132	.000	364.120	1656.120	8.128	.000	231.059	1523.059
001	1425.0	19.913	.000	364.120	1656.120	8.347	.000	231.059	1523.059
001	1710.0	19.820	.002	364.001	1656.001	8.566	.000	231.059	1523.059
001	1995.0	19.976	.002	363.903	1655.903	8.784	.000	231.059	1523.059
001	2280.0	19.757	-.001	363.741	1655.741	9.003	.000	231.059	1523.059
001	2565.0	15.974	-.157	351.205	1643.205	5.283	.306	251.573	1543.573
001	2850.0	16.193	-.170	352.189	1644.189	5.064	.306	251.456	1543.457
001	3135.0	16.412	-.172	352.378	1644.378	4.845	.306	251.340	1543.340
001	3420.0	16.631	-.172	352.415	1644.415	4.627	.306	251.223	1543.223
001	3705.0	16.850	-.172	352.452	1644.453	4.408	.306	251.106	1543.106
001	3990.0	17.069	-.172	352.490	1644.490	4.189	.306	250.989	1542.989
001	4275.0	17.287	-.172	352.527	1644.527	3.970	.306	250.872	1542.872
002	.0	17.506	-.172	352.564	1644.564	3.751	.306	250.756	1542.755
002	122.0	17.600	-.172	352.580	1644.580	7.159	.306	250.706	1542.706
002	244.0	17.694	-.172	352.595	1644.595	7.065	.306	250.656	1542.656
002	366.0	17.725	-.172	352.611	1644.611	6.971	.306	250.606	1542.606
002	488.0	17.631	-.172	352.627	1644.627	6.877	.306	250.556	1542.556
002	610.0	17.537	-.172	352.643	1644.643	6.784	.306	250.506	1542.506
002	732.0	17.444	-.172	352.659	1644.659	6.690	.306	250.456	1542.456
002	854.0	17.350	-.172	352.674	1644.675	6.596	.306	250.407	1542.407
002	976.0	17.256	-.172	352.690	1644.690	6.502	.306	250.357	1542.357
002	1098.0	17.162	-.172	352.706	1644.706	6.409	.306	250.307	1542.307
002	1220.0	17.069	-.172	352.722	1644.722	6.315	.306	250.257	1542.257
002	1342.0	16.975	-.172	352.738	1644.738	6.221	.306	250.207	1542.207
002	1464.0	16.881	-.172	352.754	1644.754	6.127	.306	250.157	1542.157

3. PRESSURE OF PIPELINE

		MAX				MIN			
NO	LENGTH	TIME	FLOW RATE	HEAD	WATER LEVEL	TIME	FLOW RATE	HEAD	WATER LEVEL
	m	sec	m3/m	m	m	sec	m3/m	m	m
002	1586.0	16.787	-.172	352.769	1644.769	6.033	.306	250.107	1542.108
002	1708.0	16.693	-.172	352.785	1644.785	5.940	.306	250.058	1542.058
002	1830.0	16.600	-.172	352.801	1644.801	5.846	.306	250.008	1542.008
002	1952.0	16.506	-.172	352.817	1644.817	5.752	.306	249.958	1541.958
002	2074.0	16.412	-.172	352.825	1644.825	5.658	.306	249.908	1541.908
002	2196.0	16.318	-.172	352.839	1644.839	5.564	.306	249.858	1541.858
002	2318.0	16.224	-.261	346.979	1638.979	5.471	.439	258.180	1550.180


ELEVATION
WATER HAMMER PRESSURE CURVES
NO.P10011
PIPE001002
(m)
1690
1670
1650
1630
1610
1590
1570
1550
1530
1510
1490
1470
1450
1430
1410
1390
1370
1350
1330
1310
1290
MAX. PRESSURE GRADIENT
HYDRAULIC GRADIENT
PIPELINE PROFILE
MIN. PRESSURE GRADIENT
0
800
1600
2400
3200
4000
4800
5600
6400
7200
8000
PIPELINE LENGTH(m)
BASIC LEVEL 1292
Qhadesiyyeh pipe line

W A T E R H A M M E R A N A L Y S I S NO. P10022 PAGE 1

Qhadesiyyeh with air valves

BASIC LEVEL 1292.000 m
DELTA T .06438 sec

【 PIPELINE DATA 】

PIPELINE NO	LENGTH m	MATE-RIAL	DIA. mm	THICK-NESS mm	ELASTIC MODULUS (LONG.)	UPSTREAM PIPE NO.	CONDITION PUMP	SURGE	VALVE	END	FLOW RATE m3/m	LOSS PIPE-LINE	LOSS END VALVE	INTERVAL TIME sec	PIPELINE CONSTANT	DIVI-SION
001	4360.0	FCD3	200	10.0	2.100		1 0	0	0	0	1.500	43.000	.000	6.6954	35.2700	104
002	2640.0	FCD3	200	10.0	2.100	001	0 0	0	1	0	1.500	26.000	.000	4.0541	35.2700	64

【 PUMP DATA 】

NO	Q'TY	TYPE	TYPE OF VALVE CLOSING	V-NO	TOTAL HEAD m	FLOWRATE m3/m	-- MOTOR -- kw	POLE	TYPE	GD2 kg-m2	GD2 (WHEEL) kg-m2	SPEED min-1	EFF. %	START CONDITION k	HEAD m	FLOW RATE m3/m	SPEED	TORQUE
1	1	1	1	0	380.000	1.500	200.0	2	0	5.000	.000	2950	62	1.2589	380.000	1.500	1.000	1.000

【 SURGE TANK DATA 】

NO	TYPE	V-NO	HEAD m	SECTION AREA m2	FRICTION LOSS m	Num. A/V	DIS-TANCE m	PIPE MATERIAL	DIA. mm	THIC-KNESS mm	ELASTIC MODULAS	INTERVAL TIME sec	PIPELINE CONSTANT	DIVI-SION	INITIAL AIR m3	LOSS m
1	6	0	276.200	999.990	.000	3	.0	0	0	.0	.000	.0000	.000	0	.0	.000

【 PIPELINE ROUTE 】

001 002

【 PROFILE OF PIPELINE 】

NO	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m
001	.0	1290.00	2500.0	1475.90	2840.0	1477.90	4360.0	1566.20
	4560.0	1568.50	5020.0	1561.50	6320.0	1567.50	6400.0	1567.20
	6620.0	1565.50	6820.0	1572.00	7000.0	1582.50		

1. CALCULATION INTERVAL 4

2. FLUCTUATION OF WATER LEVEL IN TANK

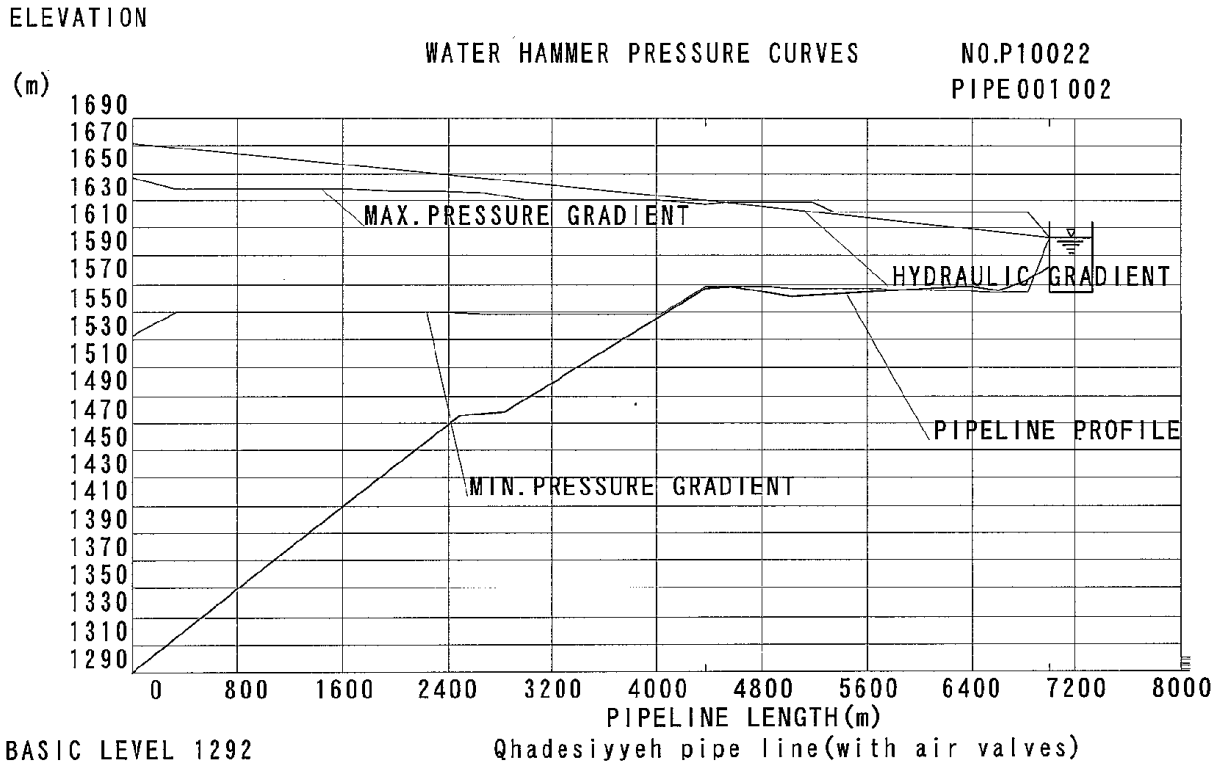
NO	MAX HEAD m	MAX WATER LEVEL m	MIN HEAD m	MIN WATER LEVEL m	FLUCTUATION W.LEVEL m	SECTION AREA m2	DISCHARGE FLOW m3
1	276.200	1568.200	276.200	1568.200	.000	999.9900	.000

3. PRESSURE OF PIPELINE

NO	LENGTH m	MAX TIME sec	MAX FLOW RATE m3/m	MAX HEAD m	MAX WATER LEVEL m	MIN TIME sec	MIN FLOW RATE m3/m	MIN HEAD m	MIN WATER LEVEL m
001	.0	17.640	.000	353.969	1645.969	6.824	.000	240.886	1532.886
001	335.4	17.382	-.110	346.218	1638.218	6.567	.236	257.456	1549.456
001	670.8	17.125	-.110	346.235	1638.235	6.309	.236	257.374	1549.374
001	1006.2	16.867	-.110	346.253	1638.253	6.052	.236	257.293	1549.292
001	1341.5	16.610	-.110	346.271	1638.271	5.794	.236	257.211	1549.211
001	1676.9	16.352	-.108	346.408	1638.408	5.537	.236	257.129	1549.129
001	2012.3	19.185	.130	344.656	1636.656	5.279	.236	257.047	1549.047
001	2347.7	19.442	.130	344.631	1636.631	5.022	.236	256.965	1548.965
001	2683.1	19.635	.103	342.683	1634.683	4.764	.236	256.883	1548.883
001	3018.5	17.382	.022	337.144	1629.144	4.506	.236	256.801	1548.801
001	3353.8	17.640	.020	337.244	1629.244	4.249	.236	256.719	1548.719
001	3689.2	17.897	.022	337.150	1629.150	3.991	.236	256.637	1548.637
001	4024.6	18.155	.022	337.150	1629.150	3.734	.236	256.555	1548.555
002	.0	20.923	.201	335.170	1627.170	3.605	.638	276.200	1568.200
002	165.0	21.116	.234	336.180	1628.180	7.339	.638	275.906	1567.906
002	330.0	21.245	.234	336.140	1628.140	7.210	.638	275.612	1567.612
002	495.0	21.374	.234	336.100	1628.100	7.082	.638	275.318	1567.318
002	660.0	21.502	.234	336.060	1628.060	6.953	.638	275.024	1567.024
002	825.0	21.631	.234	336.021	1628.021	6.824	.638	274.730	1566.730
002	990.0	20.151	.121	329.496	1621.496	6.695	.638	274.436	1566.436
002	1155.0	20.022	.121	329.485	1621.485	6.567	.638	274.142	1566.142
002	1320.0	19.893	.121	329.474	1621.474	6.438	.638	273.848	1565.848
002	1485.0	19.764	.121	329.464	1621.464	6.309	.638	273.553	1565.553

3. PRESSURE OF PIPELINE

		MAX				MIN			
NO	LENGTH	TIME	FLOW RATE	HEAD	WATER LEVEL	TIME	FLOW RATE	HEAD	WATER LEVEL
	m	sec	m3/m	m	m	sec	m3/m	m	m
002	1650.0	19.764	.126	329.121	1621.121	6.180	.638	273.259	1565.260
002	1815.0	19.829	.133	328.964	1620.964	6.052	.638	272.965	1564.965
002	1980.0	19.957	.133	328.950	1620.950	5.923	.638	272.671	1564.671
002	2145.0	20.086	.133	328.937	1620.937	5.794	.638	272.377	1564.377
002	2310.0	20.215	.133	328.924	1620.925	5.665	.638	272.083	1564.083
002	2475.0	20.344	.133	328.912	1620.912	5.537	.638	271.789	1563.789


ELEVATION
WATER HAMMER PRESSURE CURVES
NO.P10022
PIPE001002
(m)
1690
1670
1650
1630
1610
1590
1570
1550
1530
1510
1490
1470
1450
1430
1410
1390
1370
1350
1330
1310
1290
MAX. PRESSURE GRADIENT
HYDRAULIC GRADIENT
PIPELINE PROFILE
MIN. PRESSURE GRADIENT
0
800
1600
2400
3200
4000
4800
5600
6400
7200
8000
PIPELINE LENGTH(m)
BASIC LEVEL 1292
Qhadesiyyeh pipe line(with air valves)

W A T E R H A M M E R A N A L Y S I S NO. P1003 PAGE 1

Gharandal(without flywheel)

BASIC LEVEL 1292.000 m
DELTA T .09076 sec

【 PIPELINE DATA 】

PIPELINE NO	LENGTH m	MATE-RIAL	DIA. mm	THICK-NESS mm	ELASTIC MODULUS (LONG.)	CONDITION UPSTREAM PIPE NO.	PUMP	SURGE	VALVE	END	FLOW RATE m3/m	LOSS PIPE-LINE	LOSS END VALVE	INTERVAL TIME sec	PIPELINE CONSTANT	DIVI-SION
001	3710.0	FCD3	150	6.0	1.600		1	0 0	0	0	1	.950	48.000	.000	5.9902	59.6353	66

【 PUMP DATA 】

NO	Q'TY	TYPE	TYPE OF VALVE CLOSING	V-NO	TOTAL HEAD m	FLOWRATE m3/m	MOTOR kw	POLE	TYPE	GD2 kg-m2	GD2 (WHEEL) kg-m2	SPEED min-1	EFF. %	START CONDITION HEAD k	START CONDITION FLOW RATE m	START CONDITION SPEED m3/m	START CONDITION TORQUE
1	1	1	1	0	230.000	.950	80.0	2	0	3.000	.000	2950	56	.8905	230.000	.950	1.000	1.000

【 PIPELINE ROUTE 】

001

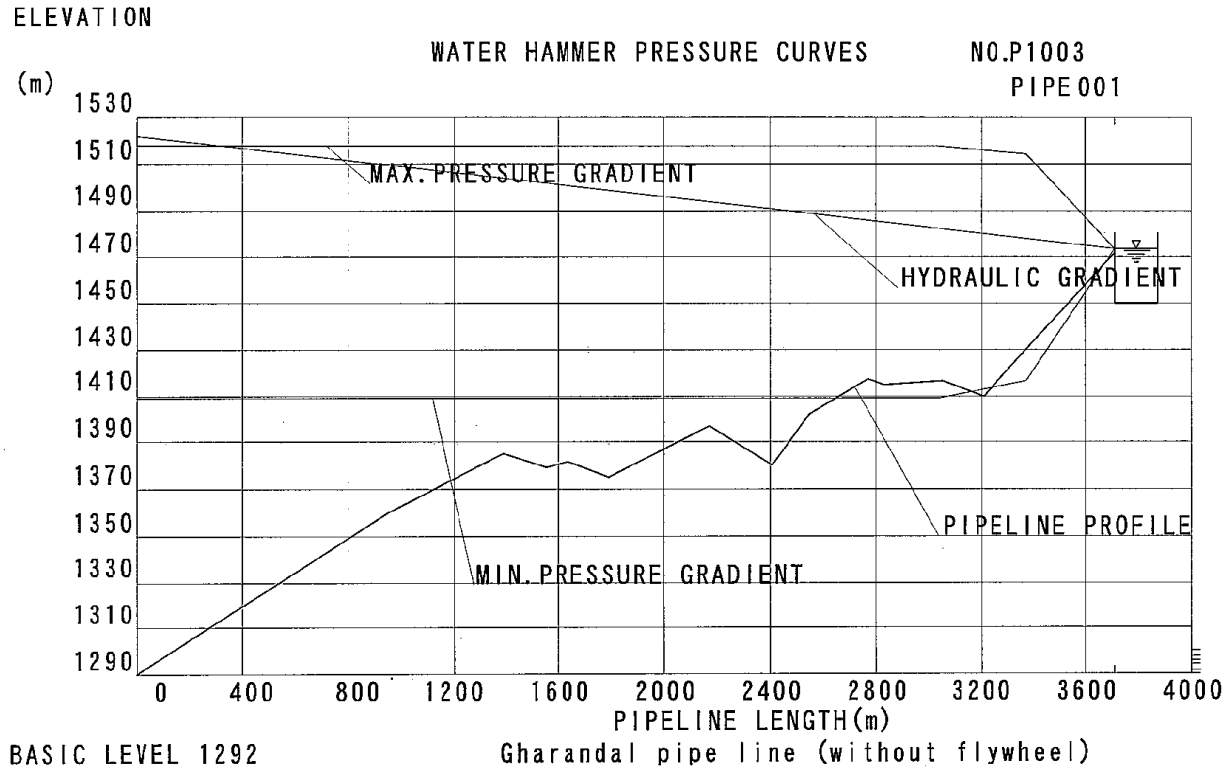
【 PROFILE OF PIPELINE 】

NO	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m
001	.0	1290.00	950.0	1360.00	1390.0	1385.00	1550.0	1379.00
	1630.0	1382.00	1790.0	1375.00	2170.0	1397.30	2410.0	1380.40
	2550.0	1402.40	2770.0	1417.30	2830.0	1415.00	3050.0	1416.00
	3210.0	1410.00	3710.0	1472.00				

1. CALCULATION INTERVAL 4

3. PRESSURE OF PIPELINE

NO	LENGTH m	MAX TIME sec	MAX FLOW RATE m3/m	MAX HEAD m	MAX WATER LEVEL m	MIN TIME sec	MIN FLOW RATE m3/m	MIN HEAD m	MIN WATER LEVEL m
001	.0	11.980	.000	225.269	1517.269	.726	.000	116.693	1408.693
001	337.3	11.708	.000	225.269	1517.269	5.718	.000	116.693	1408.693
001	674.5	11.436	.000	225.269	1517.269	5.446	.000	116.693	1408.693
001	1011.8	11.164	.000	225.269	1517.269	5.173	.000	116.693	1408.693
001	1349.1	10.891	.000	225.269	1517.269	4.901	.000	116.693	1408.693
001	1686.4	10.619	.000	225.269	1517.269	4.629	.000	116.693	1408.693
001	2023.6	10.347	.000	225.269	1517.269	4.357	.000	116.693	1408.693
001	2360.9	10.074	.000	225.269	1517.269	4.084	.000	116.693	1408.693
001	2698.2	9.802	.000	225.269	1517.269	3.812	.000	116.693	1408.693
001	3035.5	9.530	.000	225.269	1517.269	3.540	.000	116.693	1408.693
001	3372.7	9.348	.005	221.987	1513.987	3.358	-.012	124.093	1416.093


ELEVATION
WATER HAMMER PRESSURE CURVES
NO.P1003
PIPE001
(m)
1530
1510
1490
1470
1450
1430
1410
1390
1370
1350
1330
1310
1290
MAX. PRESSURE GRADIENT
HYDRAULIC GRADIENT
PIPELINE PROFILE
MIN. PRESSURE GRADIENT
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
PIPELINE LENGTH(m)
BASIC LEVEL 1292
Gharandal pipe line (without flywheel)

W A T E R H A M M E R A N A L Y S I S NO. P1004 PAGE 1

Gharandal (with flywheel)

BASIC LEVEL 1292.000 m
DELTA T .29951 sec

【 PIPELINE DATA 】

PIPELINE NO	LENGTH m	MATE-RIAL	DIA. mm	THICK-NESS mm	ELASTIC MODULUS (LONG.)	UPSTREAM PIPE NO.	CONDITION - PUMP	SURGE	VALVE	END	FLOW RATE m3/m	LOSS PIPE-LINE	LOSS END VALVE	INTERVAL TIME sec	PIPELINE CONSTANT	DIVI-SION
001	3710.0	FCD3	150	6.0	1.600		1	0 0	0	0	1	.950	48.000	.000	5.9902	59.6353	20

【 PUMP DATA 】

NO	Q'TY	TYPE	TYPE OF VALVE CLOSING	V-NO	TOTAL HEAD m	FLOWRATE m3/m	-- MOTOR -- kw	POLE	TYPE	GD2 kg-m2	GD2 (WHEEL) kg-m2	SPEED min-1	EFF. %	START CONDITION k	HEAD m	FLOW RATE m3/m	SPEED	TORQUE
1	1	1	1	0	230.000	.950	80.0	2	0	3.000	7.000	2950	56	.2671	230.000	.950	1.000	1.000

【 PIPELINE ROUTE 】

001

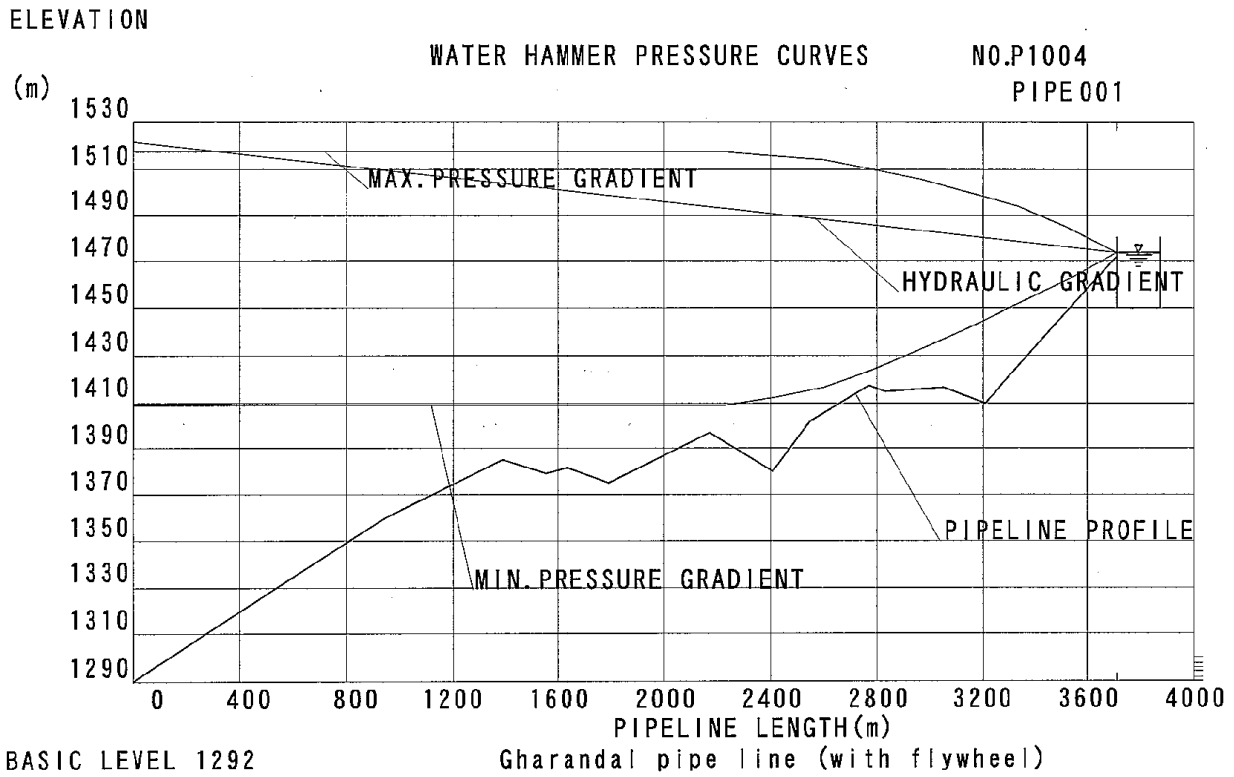
【 PROFILE OF PIPELINE 】

NO	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m	LENGTH m	LEVEL m
001	.0	1290.00	950.0	1360.00	1390.0	1385.00	1550.0	1379.00
	1630.0	1382.00	1790.0	1375.00	2170.0	1397.30	2410.0	1380.40
	2550.0	1402.40	2770.0	1417.30	2830.0	1415.00	3050.0	1416.00
	3210.0	1410.00	3710.0	1472.00				

1. CALCULATION INTERVAL 4

3. PRESSURE OF PIPELINE

		MAX				MIN			
NO	LENGTH m	TIME sec	FLOW RATE m3/m	HEAD m	WATER LEVEL m	TIME sec	FLOW RATE m3/m	HEAD m	WATER LEVEL m
001	.0	11.980	.000	225.269	1517.269	2.396	.000	116.693	1408.693
001	185.5	11.831	.000	225.269	1517.269	5.840	.000	116.693	1408.693
001	371.0	11.681	.000	225.269	1517.269	5.691	.000	116.693	1408.693
001	556.5	11.531	.000	225.269	1517.269	5.541	.000	116.693	1408.693
001	742.0	11.381	.000	225.269	1517.269	5.391	.000	116.693	1408.693
001	927.5	11.232	.000	225.269	1517.269	5.241	.000	116.693	1408.693
001	1113.0	11.082	.000	225.269	1517.269	5.092	.000	116.693	1408.693
001	1298.5	10.932	.000	225.269	1517.269	4.942	.000	116.693	1408.693
001	1484.0	10.782	.000	225.269	1517.269	4.792	.000	116.693	1408.693
001	1669.5	10.633	.000	225.269	1517.269	4.642	.000	116.693	1408.693
001	1855.0	10.483	.000	225.269	1517.269	4.493	.000	116.693	1408.693
001	2040.5	10.333	.000	225.269	1517.269	4.343	.000	116.693	1408.693
001	2226.0	10.183	.000	225.269	1517.269	4.193	.000	116.693	1408.693
001	2411.5	10.034	-.013	223.717	1515.717	4.043	.030	120.188	1412.188
001	2597.0	10.183	.003	221.782	1513.781	4.193	-.007	124.540	1416.540
001	2782.5	10.034	-.030	217.860	1509.860	4.043	.058	132.157	1424.157
001	2968.0	10.183	.003	213.839	1505.839	4.193	-.006	139.954	1431.954
001	3153.5	10.034	-.048	207.828	1499.828	4.043	.075	149.298	1441.298
001	3339.0	10.183	.005	201.409	1493.408	4.193	-.007	159.269	1451.269
001	3524.5	10.034	-.075	192.159	1484.159	4.043	.088	170.181	1462.181


ELEVATION
WATER HAMMER PRESSURE CURVES
NO.P1004
PIPE001
(m)
1530
1510
1490
1470
1450
1430
1410
1390
1370
1350
1330
1310
1290
MAX. PRESSURE GRADIENT
HYDRAULIC GRADIENT
PIPELINE PROFILE
MIN. PRESSURE GRADIENT
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
PIPELINE LENGTH(m)
BASIC LEVEL 1292
Gharandal pipe line (with flywheel)

ウオータハンマ防止装置

1 Parmakianの簡易計算図表より検証をした。

電算機により以下の図の作成をした。

- 配管縦断及び動水勾配線の作成
- 最低圧力勾配線の作成
- 概略再最高圧力勾配線図の作成
- 上記の図表より負圧地点をチェックする
- 電動機の出力からポンプの慣性時係数の算出
- フライホイールの大きさの算定をする

以上添付図の電算機による表計算結果を参照

2 フライホイールの大きさ決定

フライホイールの外径、D_2は以下の式よりもとめる。

$V=(\Pi \times D_2 \times N)/60$

ここに、

V:周速（m/sec.）60m/secとする

N:回転速度（min-1）$2950m^{-1}$(ポンプ回転数)

$60=(3.14xD_2x2950)/60$

$D_2=$ 0.39 m

フライホイールの自重W(kgf)は以下の式から求める

$GD_2=(Wx(D_1^2+D_2^2))/2$

ここに、

GD_2:7kgf・m^2（表解析から電算機の簡易計算により求められたフライホイールの慣性効果）

D_1:フライホイールの内径（m）0.05とする

W:フライホイールの自重（ｋｇｆ）

$7=Wx0.08125$

W= 86.15 kgf

フライホイールの厚さBは以下の式より求める

$W=\Pi x (D_2^2-D_1^2) xBXG$

ここに、

W:フライホイールの自重86.15（ｋｇｆ）

D1:フライホイールの内径（m）0.05とする

Π:円周率3.14

G:単位退席当たりの重量＝７８００ｋｇｆ/m^3

$86.15=(3.14x0.1575x7800xB)/4$

B= 0.089 m

以上の数値よりフライホイールの外形はおよそ40cm直径、厚さ10ｃｍとなる。