添付資料８　漏水調査

添付資料　　漏水調査

１．　目的

既存給･配水管の漏水状況を把握し、本計画による配水管改善の基礎資料とするとともに、将来PNG側実施機関が対応すべき漏水対策のガイドラインとする。

２．　既存給･配水管での漏水率

事業体職員からの聞き取りと漏水個所の現認により推定した漏水量から、管種別の漏水率を求め、配水管の管種別表面積比および給水管の接続数比から全体漏水量を算出した。

２．１　管種別漏水率（表１）

（１）ローレンガウ

ローレンガウ管種別漏水率

		延長／接続数	管種別漏水率
配水管	鋼管	5,743 m	80%
	PVC管	7,699 m	15%
給水管	鋼管から接続	342 箇所	20%
	PVC管から接続	458 箇所	15%

接続数は、総接続数を配水管種別延長で比例配分した。

A.　配水管（鋼管）

鋼管からの漏水は約1.5 kmの距離の中で露出管部からの漏水個所が6個所現認された。この漏水は、配管の老朽化（敷設後約40年）による腐食が原因で、3 mm程度の孔からの水の噴出である。水理計算からこの噴出量は1個所当たり25 L/時間であり、鋼管部分の水量が1,100 m^3/dであることから現認された部分の漏水率は20%となる。鋼管の総延長距離が約6 kmであり、現地職員からの聞き取りで、埋設部分からも地表に漏水が染み出している個所（大きな漏水）があり、延長距離6 kmの中で露出部と同様な漏水があるものとすると6 kmでの漏水率は80 %と推定される。

B.　配水管（PVC管）

本管の中でPVCを使用している口径50 mm～200 mm、総延長約7.7 kmについても管

敷設時期が1980年以降と新しく、1999年度での修理実績がなく、耐用年限以内であることから15%と推定した。

C. 給水管

給水管からの漏水は1999年1年間の管修理回数が鋼管から接続されている給水管の方が多く100件であり、PVCからの修理回数は10件である。鋼管からの接続される給水管の敷設時期は古く、鋼管の敷設と同じ時期であるから、すでに管寿命が来ているものがほとんどである。現認された漏水個所は表面処理なし鋼管の接続部分からの漏水であり、測定すると1個所当たり約0.8 L/分であった。また、これら古い管の地域住民からの苦情が多く、あと残りの約200個の給水管も全て同程度の漏水が予想される。この事実から、漏水は、全ての古い給水管に対し20%と推定される。また、PVCから接続されている給水管からの漏水は管の敷設が比較的新しく、材料も腐食に強い亜鉛引鋼管を使用している部分が多いことから、20%より低く、15%程度と推定される。

(2) ゴロカ

ゴロカ管種別漏水率

		延長／箇所数	管種別漏水率
配水管	AC管	29,026m	40%
	ダクタイル鉄管	2,475m	15%
	PVC管	27,081m	15%
	鋼管	811m	15%
給水管	AC管から接続	1,879 箇所	15%
	PVC／鋼管から接続	1,804 箇所	15%

接続数は、総接続数を配水管種別延長で比例配分した。

A. 石綿セメント管(AC管)

配水本管の多くの部分がAC管である。この管の敷設は古く1960年初期である。すでに管の耐用年限である25年（地方公営企業法施行令）が経過しているもので、現状圧力ではかろうじて耐えているが、それでも年間39回におよぶ事故/修理がタウンマネージャーに報告されている。修理状態から、漏水部はクラックが生じその隙間からの漏水が多い。隙間は色々の形状をしているが、本調査では最近事故例から1個所0.1 mmの巾で5 cmの長さを過程し、平均動水頭15 mとして計算すると1.8 m^3/hr. となり、40個所全ての漏水量は1,684 m^3/dとなり、AC管全体水量に占める割合は約25%となる。AC管は本管として幹線に使用しており、事故の場合漏水量が多いことから、修理は完全に実施されているものと考えられる。その他全線にわたる小さな漏水としておよそ15%程度の漏水があるものと思われる。よって、AC管からの漏水率は40%と推定した。

B.　ダクタイル鉄管／PVC管／鋼管

ゴロカ市では配管の維持管理に4名の配管工が常に巡回点検・修理に当たっている。そのために、比較的新しい時代に敷設されたPVC管や鋼管からの漏水率は低いと考えられる。管の耐用年内での平均漏水率として15%程度と推定した。

C.　給水管

給水管からの漏水は、敷設年次および聞き取り等から15%と推定した。

2．2　給･配水管の既存漏水率

(1)　配水管の漏水率（表2-1、表3-1）

上記で求めた配水管の管種別漏水率を表面積比で加重平均して、全体配水量に対する配水管からの漏水率を求めた。

配水管の漏水率　＝Σ（[管種別漏水率]×[管表面積比率]）
＝Σ([管種別漏水率]×(π×[管口径]×[管延長])／[管表面積合計])

ローレンガウ：42.7%
ゴロカ：31.4%

(2)　給水管での漏水率の算出（表2-2、表3-2）

配水管管種毎の漏水率を設定し、接続数から加重平均を求め、全体配水量に対する給水管からの漏水率を算出する。

給水管の漏水率　＝Σ（[管種別漏水率]×[接続箇所数比率]）
＝Σ（[管種別漏水率]×（[接続箇所数]）／[接続箇所数合計]）

ローレンガウ：17.1%
ゴロカ：15.0%

(3)　給･配水管の全体漏水率

上記の合計より、全体漏水率を求めた。

ローレンガウ：59.2%
ゴロカ：46.4%

２．本計画実施後の計画漏水率

（１）　本計画で管を更新した場合の管種別漏水率（表 2-3、表 3-3)

①水理解析により口径・延長・標準水圧を設定する。
②新管の漏水率は、計画値として 10%とする。
③既存配水管の漏水率は漏水量算定式（水道技術研究センター「実務者のための漏水調査」）により算出した。

漏水率(L1)＝既存漏水率(L0)×（計画標準水圧(P1)／既存標準水圧(P0)）exp(1.15)
（既存配水管の圧力を改善した場合の圧力増加に伴う漏水量を算出する式）

（２）　配水管の全体漏水率

表面積比の加重平均により配水管の全体漏水率を算出

ローレンガウ：14.2%
ゴロカ：11.3%

（３）　給水管での漏水率（表 2-4、表 3-4)

2003 年次の給水管の接続数を配水管の管種別の延長で比例配分する。給水管を更新した場合の漏水率を 10%と設定し、接続数から加重平均を求め、給水管での漏水率を算出する。

ローレンガウ：10.9%
ゴロカ：13.9%

（４）　全体漏水率

上記より、配水管の漏水率と給水管での漏水率を合計し、全体漏水率とする。

ローレンガウ：25.2%
ゴロカ：25.1%

以上より、本計画での管更新後の漏水率の目標値として 25%とする。

表１　管種別漏水調査結果

表1-1 Lorengau

Points	g	h (m)	V (m/sec)	d (mm)	A(m2)	現認漏水量 箇所当たり漏水量 Q (L/hr.)	現認漏水量 漏水個所数 N	現認漏水量 漏水量 ΣQ(m3/d)	管種別配水量Q (m3/d)	管種別漏水率 現認	管種別漏水率 推定	管種別漏水率 合計
PVC	9.8	10	0	0	0	0	0	0	900	0%	15%	15%
Steel Pipe	9.8	10	58.8	3	7.065E-06	25	6	215	1,100	20%	60%	80%
S.P.(Steel)			1個所当たり		20 L/hr	20	100	48	855	6%	14%	20%
S.P.(PVC)			1個所当たり		20 L/hr	20	10	5	1,145	0%	15%	15%

個所数(N)： Steel Pipeは現認数、S.P.は1999年の修理個所数

S.P.：Service Pipe

表1-2 Goroka

Points	g	h (m)	V (m/sec)	d (mm)	A(m2)	現認漏水量 箇所当たり漏水量 Q (L/hr.)	現認漏水量 漏水個所数 N	現認漏水量 漏水量 ΣQ(m3/d)	管種別配水量Q (m3/d)	管種別漏水率 現認	管種別漏水率 推定	管種別漏水率 合計
ACP		15	99.96		0.000005	1,799	39	1,684	6,750	25%	15%	40%
Others		0	0	0	0	0	0	0	5,750	0%	15%	15%
S.P.(ACP)			1個所当たり		20 L/hr	20	30	14	6,377	0%	15%	15%
S.P.(Others)			1個所当たり		20 L/hr	20	30	14	6,123	0%	15%	15%

個所数（N）：市からの聞き取りによる1999年度での修理回数

ACPの漏水個所：0.1mm巾で5cmのクラック（市からの聞き取り）を想定した

g: 9.8m/sec^2
V=0.6x(2gh)^1/2
Q=AxV

Q: Leakage volume
h: Dynamic head
V: Velocity through the hole

A: Area of the hole
N: No. of the holes

表2 ローレンガウ漏水率

表2-1 既存配水管からの漏水

管種	口径(mm)	延長(m)	標準水圧	管種別漏水率(%)	管表面積(m2)	全体漏水率(%)
鋼管	200	1,338	10	80%	841	14.8%
鋼管	100	868	10	80%	273	4.8%
鋼管	80	2,737	10	80%	688	12.2%
鋼管	50	800	10	80%	126	2.2%
PVC	200	524	10	15%	329	1.1%
PVC	150	1,078	10	15%	508	1.7%
PVC	100	4,699	10	15%	1,476	4.9%
PVC	80	734	10	15%	184	0.6%
PVC	50	664	10	15%	104	0.3%
					加重平均	42.7%

表2-2 給水管からの漏水

	箇所数	漏水率	全体漏水量
鋼管部分	342	20%	8.6%
PVC部分	458	15%	8.6%
		加重平均	17.1%

箇所数：全体接続数を管種毎の延長で比例配分

全体漏水量	59.8%

表2-3 更新後の漏水

管種	口径(mm)	延長(m)	標準水圧(m)	管種別漏水率(%)	管表面積(m2)	全体漏水率(%)
PVC/鋼管(新	200	1,338	15	10%	841	1.7%
PVC/鋼管(新	100	1,875	15	10%	589	1.2%
PVC/鋼管(新	80	3,184	15	10%	800	1.7%
PVC/鋼管(新	50	0	15	10%	0	0.0%
PVC(既存)	200	524	15	24%	329	1.6%
PVC(既存)	150	1,078	15	24%	508	2.5%
PVC(既存)	100	4,699	10	15%	1,476	4.6%
PVC(既存)	80	734	10	15%	184	0.6%
PVC(既存)	50	664	10	15%	104	0.3%
					加重平均	14.2%

更新後漏水率
1)新管　計画値として10%とする。
2)既存管　漏水量算定式（水道技術研究センター「実務者のための漏水調査」）より
漏水率(L1)＝既存漏水率(L0)×（計画標準水圧(P1)／既存標準水圧(P0)）exp(1.15)

表2-4 配水管更新後の給水管からの漏水

	箇所数	漏水率	全体漏水量
PVC(新管)部分	397	10%	5.0%
PVC(既存)部	478	10%	6.0%
		加重平均	10.9%

箇所数：全体接続数を管種毎の延長で比例配分

全体漏水量	25.2%

表3 ゴロカ漏水率

表3-1 既存配水管からの漏水

管種	口径(mm)	延長(m)	標準水圧	管種別漏水率(%)	管表面積(m2)	全体漏水率(%)
石綿管	300	0	15	40%	0	0.0%
石綿管	250	0	15	40%	0	0.0%
石綿管	200	2,376	15	40%	1,493	2.8%
石綿管	150	12,210	15	40%	5,754	10.9%
石綿管	100	14,196	15	40%	4,460	8.4%
石綿管	80	244	15	40%	61	0.1%
DIP	300	2,475	15	40%	2,333	4.4%
PVC	150	348	15	15%	164	0.1%
PVC	100	18,876	15	15%	5,930	4.2%
PVC	80	52	15	15%	13	0.0%
PVC	50	4,316	15	15%	678	0.5%
PVC	25	2,444	15	15%	192	0.1%
PVC	20	1,045	15	15%	66	0.0%
GSP	25	629	15	15%	49	0.0%
GSP	20	182	15	15%	11	0.0%
					加重平均	31.4%

表3-2 給水管からの漏水

	箇所数	漏水率	全体漏水量
ACP部分	1879	15%	7.7%
PVC/鋼管部分	1804	15%	7.3%
		加重平均	15.0%

箇所数：全体接続数を管種毎の延長で比例配分

全体漏水量	46.4%

表3-3 更新後の漏水

管種	口径(mm)	延長(m)	標準水圧(m)	管種別漏水率(%)	管表面積(m2)	全体漏水率(%)
PVC(新管)	300	270	15	10%	254	0.1%
PVC(新管)	250	880	15	10%	691	0.4%
PVC(新管)	200	3,134	15	10%	1,969	1.2%
PVC(新管)	150	2,080	15	10%	980	0.6%
PVC(新管)	100	6,517	15	10%	2,047	1.2%
PVC(新管)	80	6,382	15	10%	1,604	0.9%
DIP(既存)	300	2,475	15	10%	2,333	1.4%
PVC(既存)	150	348	15	15%	164	0.1%
PVC(既存)	100	18,876	15	15%	5,930	5.2%
PVC(既存)	80	52	15	15%	13	0.0%
PVC(既存)	50	4,316	15	15%	678	0.6%
PVC(既存)	25	2,444	15	15%	192	0.2%
PVC(既存)	20	1,045	15	15%	66	0.1%
GSP(既存)	25	629	15	15%	49	0.0%
GSP(既存)	20	182	15	15%	11	0.0%
					加重平均	11.3%

更新後漏水率

1)新管　計画値として10%とする。

2)既存管　漏水量算定式（水道技術研究センター「実務者のための漏水調査」）より

漏水率(L1)＝既存漏水率(L0)×（計画標準水圧(P1)／既存標準水圧(P0)）exp(1.15)

表3-4 配水管更新後の給水管からの漏水

	箇所数	漏水率	全体漏水量
PVC(新管)部分	1611	10%	4.4%
PVC(既存)部分	2331	15%	9.5%
		加重平均	13.9%

箇所数：全体接続数を管種毎の延長で比例配分

全体漏水量	25.1%

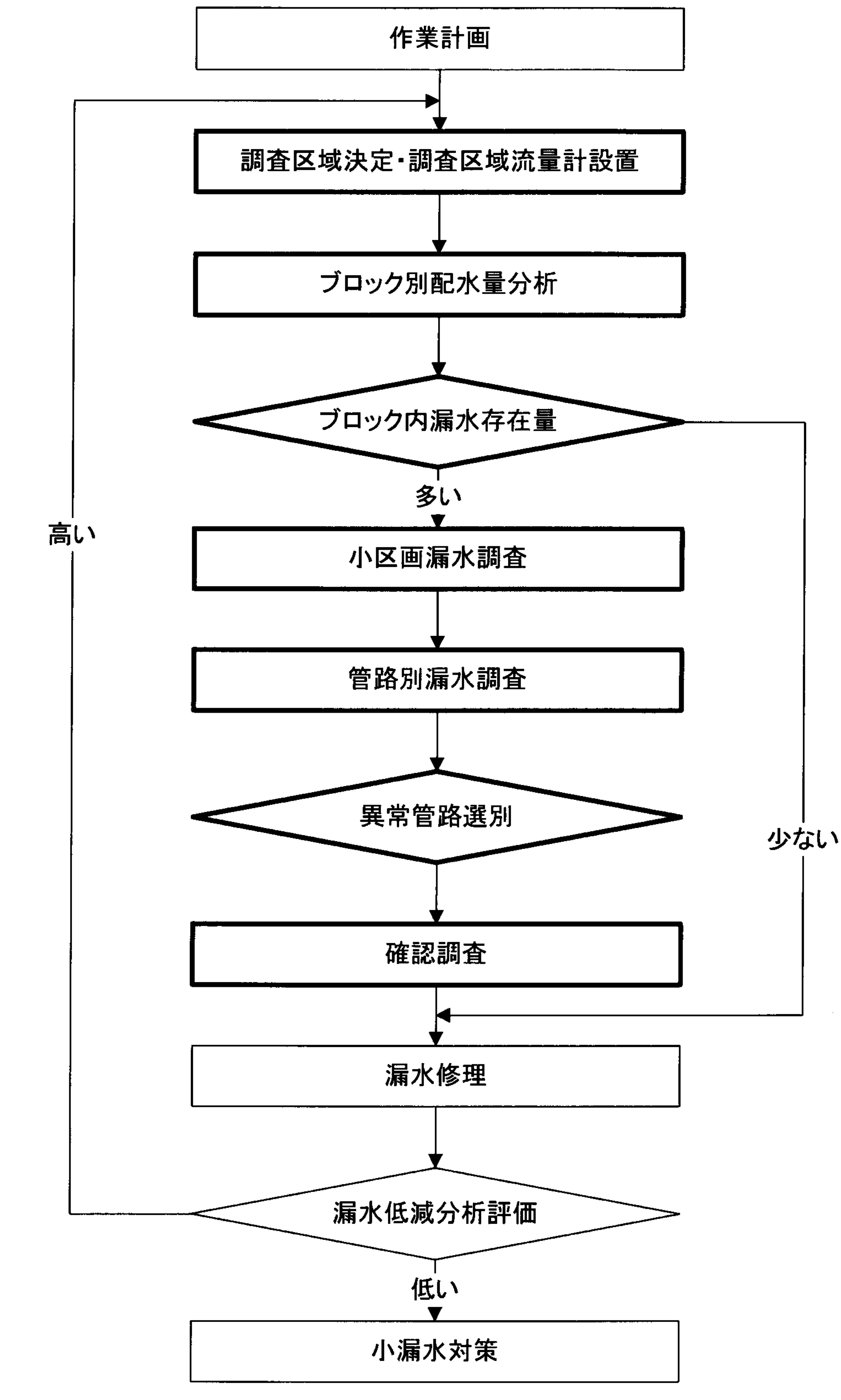
３． 計画実施後の漏水対策

本計画では、配水管の更新によって目標年次における漏水率を 25%にまで低減する計画である。また、本計画実施後も漏水防止計画を継続し、漏水率の低減による有収率の向上を通じて財務基盤の健全化を目指すことが望まれる。

本計画では個別給水の水道メーターおよびゴロカの漏水対策用機材として可搬式流量計（超音波流量計）を調達することとなっている。水道メーターは水道料金制度を健全に運用するために必要であるのに加え、配水量分析に活用することにより漏水量の実態を把握するための基礎データとなる。また、超音波流量計計は、既設流量計作動状況の確認、既設流量計の代替え使用、導水管漏水調査等を始め、水理解析の検証等、水道施設維持管理面で効果的に活用できるものである。

次頁に漏水低減計画のフローチャートと本計画で調達する機材の活用範囲を示す。本計画では、PNG 側で水道メーターの設置およびゴロカでは配水ブロック毎の配水量管理を実施することとなっている。その後、漏水量の大きい重点地区の管路補修等を行い、小量の漏水対策へと進めていく必要がある。

漏水低減計画フローチャート



添付資料９　人口と水需要

人口と水需要

1.人口

(1) 調査対象地域

① 人口と世帯数

地域		2000年		2003年（*1）	
		人口	世帯数	人口	世帯数
Lorengau (*2)		5,298	1,090	5,672	1,167
Goroka (*3)	Town	22,032	3,684	23,587	3,944
	Village	11,428	3,590	12,235	3,843
	Subtotal	33,460	7,274	35,822	7,7,87
Total		38,758	10,958	41,494	11,731

出典

(*1) 2003年の人口推計は、1990年度実施の国勢調査人口を基準として年人口増加率を2.3%とした。

(*2) 2000年7月実施の国勢調査実数

(*3) 2000年8月実施の家屋数調査（本調査団実施）

② 調査地域の水需要者（2000年）

	給水人口	学校		病院	ホテル	レストラン	商店	事務所	その他
		教師	生徒	床数	室数	店数	店数	件数	件数
Lorengau	4,055	76	2,062	110	28	5	10	61	0
Goroka	22,032	317	5,208	369	412	34	190	200	2
合計	26,087	393	7,270	479	440	39	200	261	2

(2) Lorengau

① 地区別調査対象地域の人口と給水人口(2000 年及び 2003年)

年	2000		2003		給水人口	
地区No.	人口 (A)	所帯数 (B)	人口 (C)	所帯数 (D)	2000	2003
1	690	143	739	153	515	551
2	785	161	840	172	650	696
3	940	191	1,006	204	505	541
4	605	125	648	134	455	487
5	748	156	801	167	645	691
6	630	130	674	139	600	642
7	900	184	964	197	685	733
合計	5,298	1,090	5,672	1,167	4,055	4,341
給水普及率					77%	77%

Note :
Source: (A) and (B) , Population census in July 2000
(C): Population growth rate is 2.3% based on population census in 1990
(D) =(C)/((A)/(B))
Population served in 2003 is the same rate as present conditions in year 2000.

② 地区需要者 (2000 年8月現在)

ワードNo	家屋様式		学校		病院	ホテル	食堂	商店	事務所	地区
	所帯数	住民数	教師数	生徒数	床数	室数	店数	店数	件数	
1	103	515	16	500					8	East
2	150	650	10	200	100		1		6	East
3	101	505	10	200					5	East
4	91	455							2	East
5	129	645			10	28	3	10	26	West
6	120	600	10	200			1		6	West
7	137	685	30	962					8	West
Total	831	4,055	76	2,062	110	28	5	10	61	

資料:200年8月、本調査団によって実施された需要者実態調査による。

(3) Goroka

① 調査対象地域（都市部）需要者数

No ブロック	家 式屋 様			学 校		病 院	ホ テ ル	食 堂	商 店	事 務 所	そ の 他	地 区 名
	所単 帯数	所複 帯数	宿 舎	教 師	生 徒	床 数	室 数	店 数	店 数	件 数	件 数	
1	13									1		
2	3						220			66		East
3	1							3	14	16		East
4								3	4	3		East
5	1							3	13	16		East
6	20	12						1	5	1		East
7	37	12								1		East
8	9	2						2	6			East
9-520/521	29	27	298	99	1,493	2			1			North
9-522	6								1	2		North
9-523	78	12	126	30	196	1		1	7	7		North
10	48	23				5				8	2	North
11	26	30										North
12	9	18						3	6	16		South West
13	6	12						3	14			West
14	6	12		8	164			1	8			West
15	40	33										West
16	26	12								1		West
17	6	14		4	37					4		West
18	62	58	87	11	88	360				2		West
19	62	37		53	1,200				1	1		South West
20	15	108					108	1		4		South West
21	10	43							10	4		South West
22	22	16							3	1		South West
23	21	6							1			South West
25	7	14								1		West
26	12	7										West
27	11	16										West
28	22											West
29	19											West
30	32						8					East
32	35	10										West
33	45	21										East
34									5			East
35	21											West
36	55		24				39					East
37	19	18	21	28			12			7		West
38	20	10										West
39	29	16										East
40	30											West
41	10	12										West
42	7	18										West
43	21	16										West
50	57	9		5	48				1	1		North
51	21	4										North
52	13											North

53	20	14							11	2		East
54	2	21							1			East
55	10	8						1	4			East
61	77	36							4			South West
62	18	2							4			South West
63	14											South West
64	24		8					1	2			South West
65	3							2	4			South West
66	22								2			South West
67	6											South West
68	52	6						2	1			South West
69	46	5							5			South West
70	81							1	5			South West
71	3	4						2	20			South West
72	36								3			South West
73	32								2			East
74	108	19							1	1		North
76	12	10								5		North
78	38											East
79	14											East
80	29	4							1	1		East
81									3	1		West
82	3	4								5		East
83	6	4						1	3	12		East
84	12											East
86	98								2	1		South West
87	7	4				1						South West
88	74	14		21	500					1		West
89	74											East
90	28			34	1,098				1			East
91	10											East
92	14											East
93	12											East
94	8											East
95	9											East
96	10											East
97	3								1			South West
98	52	10								1		West
99	5											West
101	7											East
102	30	25						1		4		North
104	7	5						1	3			East
105	4	11		12	130					2		West
106	14							1				East
107	3	6							2			South West
115	25	12										South West
116	6			6	24		25					North
117	14	5		6	230							North
124	3	6							5	1		East
Town Total	2,227	893	564	317	5,208	369	412	34	190	200	2	

count survey in August 2000

size	6.7	6.7	2
Population	14,921	5,983	1,128
Total	**22,032**		

② 村落の需要者（調査対象地域外）

Name of village	Year 2000			
	Public Tap	Family per 1tap	Consumers per 1tap	Consumers
Okiufa	87	2	6.7	1,310
Segu	79	1	6.7	467
Faniufa	79	1	6.7	375
Kami	8	19	6.7	1,021
kama, Sipiga	348	1	6.7	3,119
Asaroufa	185	3	6.7	3,127
Kafana, Fimito	50	4	6.7	1,367
Lapegu	10	9	6.7	573
Komiufa	39	3	6.7	876
Total population served	885			**12,235**
Total population				23,214
Rate of population served				48%

Source: Population census in July 2000
Population served: Information from Goroka town office

③ Population forecast in 2003 and water demand

Block No.	Population estimated (2000)	Population forecast (2003)	Estimated water demand								
			2000 (A)								2003
			Domestic water demand (m3/day)	School (m3/day)	Hospital (m3/day)	Hotel (m3/day)	Restaurant (m3/day)	Market/shop (m3/day)	Office (m3/day)	Total (m3/day)	(A)*(1+0.023)^3
1	87	93	15.3	0	0	0	0	0	1	16.3	17.5
2	20	22	3.6	0	0	88	0	0	66	157.6	168.7
3	7	7	1.2	0	0	0	7.5	21	16	45.7	48.9
4	0	0	0	0	0	0	7.5	6	3	16.5	17.7
5	7	7	1.2	0	0	0	7.5	19.5	16	44.2	47.3
6	214	230	38	0	0	0	2.5	7.5	1	49	52.5
7	328	351	57.9	0	0	0	0	0	1	58.9	63.1
8	74	79	13	0	0	0	5	9	0	27	28.9
9-520/521	971	1040	171.6	114.4	1	0	0	1.5	0	288.5	308.9
9-522	40	43	7.1	0	0	0	0	1.5	2	10.6	11.3
9-523	855	915	151	16.7	0.5	0	2.5	10.5	7	188.2	201.5
10	476	509	84	0	2.5	0	0	0	8	94.5	101.2
11	375	402	66.3	0	0	0	0	0	0	66.3	71.0
12	181	194	32	0	0	0	7.5	9	16	64.5	69.1
13	121	129	21.3	0	0	0	7.5	21	0	49.8	53.3
14	121	129	21.3	12.3	0	0	2.5	12	0	48.1	51.5
15	489	524	86.5	0	0	0	0	0	0	86.5	92.6
16	255	273	45	0	0	0	0	0	1	46	49.2
17	134	143	23.6	3	0	0	0	0	4	30.6	32.8
18	978	1047	172.8	7.3	180	0	0	0	2	362.1	387.7
19	663	710	117.2	89.3	0	0	0	1.5	1	209	223.8
20	824	882	145.5	0	0	43.2	2.5	0	4	195.2	209.0
21	355	380	62.7	0	0	0	0	15	4	81.7	87.5
22	255	273	45	0	0	0	0	4.5	1	50.5	54.1
23	181	194	32	0	0	0	0	1.5	0	33.5	35.9
25	141	151	24.9	0	0	0	0	0	1	25.9	27.7
26	127	136	22.4	0	0	0	0	0	0	22.4	24.0
27	181	194	32	0	0	0	0	0	0	32	34.3
28	147	158	26.1	0	0	0	0	0	0	26.1	27.9
29	127	136	22.4	0	0	0	0	0	0	22.4	24.0
30	214	230	38	0	0	3.2	0	0	0	41.2	44.1
32	302	323	53.3	0	0	0	0	0	0	53.3	57.1
33	442	473	78	0	0	0	0	0	0	78	83.5
34	0	0	0	0	0	0	0	7.5	0	7.5	8.0
35	141	151	24.9	0	0	0	0	0	0	24.9	26.7
36	417	446	73.6	0	0	15.6	0	0	0	89.2	95.5
37	290	310	51.2	2.8	0	4.8	0	0	7	65.8	70.4
38	201	215	35.5	0	0	0	0	0	0	35.5	38.0
39	302	323	53.3	0	0	0	0	0	0	53.3	57.1
40	201	215	35.5	0	0	0	0	0	0	35.5	38.0
41	147	158	26.1	0	0	0	0	0	0	26.1	27.9
42	168	179	29.5	0	0	0	0	0	0	29.5	31.6

43	248	265	43.7	0	0	0	0	0	0	43.7	46.8
50	442	473	78	3.9	0	0	0	1.5	1	84.4	90.4
51	168	179	29.5	0	0	0	0	0	0	29.5	31.6
52	87	93	15.3	0	0	0	0	0	0	15.3	16.4
53	228	244	40.3	0	0	0	0	16.5	2	58.8	63.0
54	154	165	27.2	0	0	0	0	1.5	0	28.7	30.7
55	121	129	21.3	0	0	0	2.5	6	0	29.8	31.9
61	757	811	133.8	0	0	0	0	6	0	139.8	149.7
62	134	143	23.6	0	0	0	0	6	0	29.6	31.7
63	94	100	16.5	0	0	0	0	0	0	16.5	17.7
64	177	189	31.2	0	0	0	2.5	3	0	36.7	39.3
65	20	22	3.6	0	0	0	5	6	0	14.6	15.6
66	147	158	26.1	0	0	0	0	3	0	29.1	31.2
67	40	43	7.1	0	0	0	0	0	0	7.1	7.6
68	389	416	68.6	0	0	0	5	1.5	0	75.1	80.4
69	342	366	60.4	0	0	0	0	7.5	0	67.9	72.7
70	543	581	95.9	0	0	0	2.5	7.5	0	105.9	113.4
71	47	50	8.3	0	0	0	5	30	0	43.3	46.4
72	241	258	42.6	0	0	0	0	4.5	0	47.1	50.4
73	214	230	38	0	0	0	0	3	0	41	43.9
74	851	911	150.3	0	0	0	0	1.5	1	152.8	163.6
76	147	158	26.1	0	0	0	0	0	5	31.1	33.3
78	255	273	45	0	0	0	0	0	0	45	48.2
79	94	100	16.5	0	0	0	0	0	0	16.5	17.7
80	221	237	39.1	0	0	0	0	1.5	1	41.6	44.5
81	0	0	0	0	0	0	0	4.5	1	5.5	5.9
82	47	50	8.3	0	0	0	0	0	5	13.3	14.2
83	67	72	11.9	0	0	0	2.5	4.5	12	30.9	33.1
84	80	86	14.2	0	0	0	0	0	0	14.2	15.2
86	657	703	116	0	0	0	0	3	1	120	128.5
87	74	79	13	0	0.5	0	0	0	0	13.5	14.5
88	590	631	104.1	37.1	0	0	0	0	1	142.2	152.2
89	496	531	87.6	0	0	0	0	0	0	87.6	93.8
90	188	201	33.2	80.3	0	0	0	1.5	0	115	123.1
91	67	72	11.9	0	0	0	0	0	0	11.9	12.7
92	94	100	16.5	0	0	0	0	0	0	16.5	17.7
93	80	86	14.2	0	0	0	0	0	0	14.2	15.2
94	54	57	9.4	0	0	0	0	0	0	9.4	10.1
95	60	65	10.7	0	0	0	0	0	0	10.7	11.5
96	67	72	11.9	0	0	0	0	0	0	11.9	12.7
97	20	22	3.6	0	0	0	0	1.5	0	5.1	5.5
98	415	445	73.4	0	0	0	0	0	1	74.4	79.7
99	34	36	5.9	0	0	0	0	0	0	5.9	6.3
101	47	50	8.3	0	0	0	0	0	0	8.3	8.9
102	369	395	65.2	0	0	0	2.5	0	4	71.7	76.8
104	80	86	14.2	0	0	0	2.5	4.5	0	21.2	22.7
105	101	108	17.8	10.3	0	0	0	0	2	30.1	32.2
106	94	100	16.5	0	0	0	2.5	0	0	19	20.3
107	60	65	10.7	0	0	0	0	3	0	13.7	14.7
115	248	265	43.7	0	0	0	0	0	0	43.7	46.8
116	40	43	7.1	2.3	0	10	0	0	0	19.4	20.8
117	127	136	22.4	16.7	0	0	0	0	0	39.1	41.9
124	60	65	10.7	0	0	0	0	7.5	1	19.2	20.6
Town Total	22,032	23,589	3,635	417	185	165	80	285	202	4,969	5320

2. 水需要量

(1) Lorengau

① 2000年の水需要量

Water uses	Unit water demand		Q'ty	Water demand(200		Rate(*1)	Rate
Residential (Town)	165	L/c/d	4,055	669	m3/d	-	62%
Residential (Isrand)			L.S.	100	m3/d	-	9%
Others							
School (Pupil)	70	L/c/d	2,062	144	m3/d	19%	13%
School (Teacher)	165	L/c/d	76	13	m3/d	2%	1%
Hospital	500	L/bed/d	110	55	m3/d	7%	5%
Hotel	400	L/room/d	28	11	m3/d	1%	1%
Restaurant	2,500	L/res./d	5	13	m3/d	2%	1%
Commercial	1,500	L/shop/d	10	15	m3/d	2%	1%
Office	1,000	L/off./d	61	61	m3/d	8%	6%
Subtotal				312	m3/d		29%
Total				**1,081**	**m3/d**	**41%**	

Rate(*1) The figure is shown ratio of others uses comparing with domestic use.

(*2) Day pupil: 30 L/c/d (70%), Boading pupil: 165 L/c/d (30%)

② 2003年水需要量予測

Water uses	Unit water demand (U		Q'ty	Water demand		Rate	Rate
Residential (Town)	165	L/c/d	4,341	716	m3/d	-	62%
Residential (Village)	40	L/c/d		100	m3/d	-	9%
Subtotalotal			4,341	816	m3/d	-	71%
Others	41% % of domestic			331	m3/d	41%	29%
Total				1,147	**m3/d**		100%

(2) Goroka

① 2000年の水需要量

需要者	使用原単位		数量	需要量 (2000)		割合(*1)	割合
Residential (Town)	165	L/c/d	22,032	3,635	m3/d	-	67%
Residential (Village)	40	L/c/d	11,428	457	m3/d	-	8%
Subtotal			33,460	4,092	m3/d	-	75%
Others							
School (Pupil)	70	L/c/d	5,208	365	m3/d	9%	7%
School (Teacher)	165	L/c/d	317	52	m3/d	1%	1%
Hospital	500	L/bed/d	369	185	m3/d	5%	3%
Hotel	400	L/room/d	412	165	m3/d	4%	3%
Restaurant	2,500	L/res./d	32	80	m3/d	2%	1%
Commercial	1,500	L/shop/d	190	285	m3/d	7%	5%
Office	1,000	L/off./d	202	202	m3/d	5%	4%
Subtotal				1,333	m3/d		25%
Total			**73,650**	**5,426**	**m3/d**	**33%**	**100%**

Rate(*1) The figure is shown ratio of others uses comparing with domestic use.

(*2) Day pupil: 30 L/c/d (70%), Boading pupil: 165 L/c/d (30%)

② 2003年水需要量予測

Water uses	Unit water demand (U		Q'ty	Water demand		Rate	Rate
Residential (Town)	165	L/c/d	23,589	3,892	m3/d	-	67%
Residential (Village)	40	L/c/d	12,235	489	m3/d	-	8%
Subtotalotal			35,824	4,382	m3/d	-	75%
Others	33% % of domestic			1,427	m3/d	33%	25%
Total				5,809	**m3/d**		100%

5.3 設計水量

(1) Lorengau

① 設計諸元

(a)	浄水場使用量 (TPU)	10 %
(b)	漏水良	25 %
(c)	日最大係数（生活用水）	1.2
(d)	日最大係数(その他の用水)	1.1
(e)	時間最大係数(生活用水)	1.8
(e)	時間最大係数(その他の用水)	1.6

② 設計水量

Unit in m3/d

	需要量	日平均水量	日最大水量	時間最大水量
生活用水 (1)	816	816	980	1,469
その他用水 (2)	331	331	364	529
小計(3)= (1)+(2)	**1,147**	1,147	1,343	1,999
漏水 (4)=(3)x0.25/(1-0.25)	0.25	382	448	666
配水量 (4)= (3)+(4)	-	**1,529**	**1,791**	**111**
TPU (5)=(3)x0.1	0.10	-	134	-
取水量 (6)=(4)+(5)	-	-	**1,925**	-

(2) Goroka

① 設計諸元

(a)	浄水場使用水 (TPU)		10 %
(b)	漏水率		25 %
(c)	日最大係数	生活用水	1.2
(d)	日最大係数	その他用水	1.1
(e)	時間最大係数	生活用水	1.8
(e)	時間最大係数	その他用水	1.6

② 設計水量

Unit in m3/d

	需要量	日平均	日最大水量	時間最大水量
生活用水 (1)	4,382	4,382	5,258	7,887
その他用水(2)	1,427	1,427	1,570	2,284
小計 (3)= (1)+(2)	**5,809**	5,809	6,828	10,171
漏水量 (4)=(3)x0.25/(1-0.25)	0.25	1,936	2,276	3,390
配水量 (5)=(3)+(4)		**7,745**	**9,104**	**565**
TPU (4)=(3)x0.1	0.10	-	683	-
取水量		-	**9,787**	-

添付資料１０　施設設計水量

Design Water Flow

(1) Lorengau

① Design criteria

(a)	Treatment plant use (TPU)		10 %
(b)	Rate of leakage		25 %
(c)	Day peak factor	Domestic	1.2
(d)	Day peak factor	Others	1.1
(e)	Hour peak factor	Domestic	1.8
(e)	Hour peak factor	Others	1.6

② Calculation of design water flow　　　Unit in m3/d

	Basic Data	Daily Ave.	Daily Maximum	Hourly Maximum
Domestic (1)	816	816	980	1,469
Others (2)	331	331	364	529
Subtotal (3)= (1)+(2)	**1,147**	1,147	1,343	1,999
Loss (4)=(3)x0.25/(1-0.25)	0.25	382	448	666
Subtotal (4)= (3)+(4)	–	**1,529**	**1,791**	**111**
TPU (5)=(3)x0.1	0.10	-	134	-
Total (6)=(4)+(5)	-	-	**1,925**	-

(2) Goroka

① Design criteria

(a)	Treatment plant use (TPU)		10 %
(b)	Rate of leakage		25 %
(c)	Day peak factor	Domestic	1.2
(d)	Day peak factor	Others	1.1
(e)	Hour peak factor	Domestic	1.8
(e)	Hour peak factor	Others	1.6

② Calculation of design water flow Unit in m3/d

	Basic Data	Daily Ave.	Daily Maximum	Hourly Maximum
Domestic (1)	4,382	4,382	5,258	7,887
Others (2)	1,427	1,427	1,570	2,284
Subtotal (3)= (1)+(2)	**5,809**	5,809	6,828	10,171
Loss (4)=(3)x0.25/(1-0.25)	0.25	1,936	2,276	3,390
Total (5)=(3)+(4)		**7,745**	**9,104**	**565**
TPU (4)=(3)x0.1	0.10	-	683	-
Total		-	**9,787**	-

添付資料１１　浄水場設計計算

Design Calculation for Water Treatment Plant in Goroka

I. Head Loss Calculation for the Water Treatment Plant

II. Water Flow Calculation for the Water Treatment Plant

III. Calculation of Chemical Dosing Equipment

HYDRAULIC CALCULATIONS

I. Head Loss Calculation for the Water Treatment Plant

Hydraulic Calculations

I. Head Loss Calculation for the Water Treatment Plant

1. Basic Conditions

① Plant flow Q=10, 000 m^3/日

Distribution of the water flow

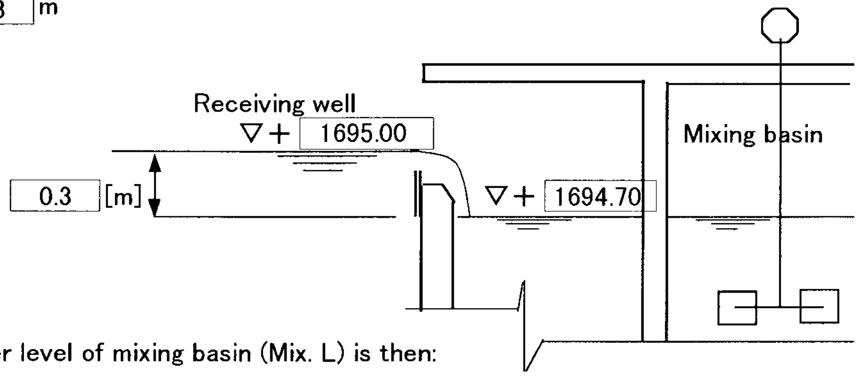
Line No.1 Q_1=	1,700	[m^3/d]	=	0.02	[m^3/s]	(Existing)
Line No.2 Q_2=	4,800	[m^3/d]	=	0.056	[m3/s]	(Existing)
Line No.3 Q_3=	3,500	[m^3/d]	=	0.041	[m^3/s]	(Expansion)

② Basic water levels

New receiving well	WL +	1,695.00	[m]
Existing No.1 sedimentation	WL +	1,685.65	[m]
Existing No.2 sedimentation	WL +	1,685.60	[m]
Existing No.2 filter trough	EL +	1,683.40	[m]

2. From receiving well to eachFacilitie (Line No.1,2and 3)

(1) Head loss of Mixing ba: : Δh_1
(Differential head between Receiving well and Mixing basin)
where: Δh_1= 0.3 m

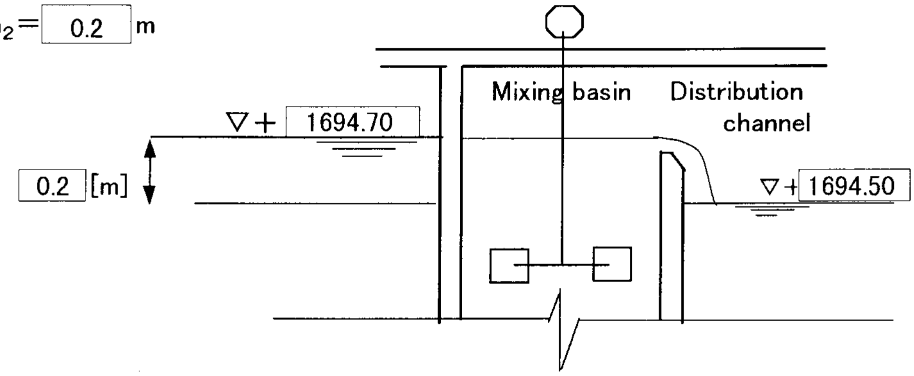


The required water level of mixing basin (Mix. L) is then:

Max.L − Δh_1= 1,695.00 − 0.3 = 1694.700 m

(2) Head loss of the Discharge channel Δh_2
(Differential head between Mixing basin and Distribution channel)

where: Δh_2= 0.2 m



The required water level of distribution channel (Dis.L) is then:

Dis..L − Δh_1 = 1,694.70 − 0.2 = **1694.50** [m]

(3) Head loss of sedimentation basin: Δh_3

(Differential head between Distribution channel and Sedimentation basin)

① No.1 sedimentation

The head loss can be obtained from the Williams and Hazen empirical formula:

$\Delta h_3 = 10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$

where:

C	:	roughness coefficient of the pipe wall	C=	110	(steel pipe)
D	:	internal pipe size	D=	0.2	[m]
L	:	pipe length	L=	145	[m]

therefor:

$= 10.666 \times 110^{-1.85} \times 0.2^{-4.87} \times 0.02^{1.85} \times 145$

= 0.472 [m] → **0.5** [m]

Water level of No. 1 Sedimentation

WL+ 1,685.65 < 1,694.50 − 0.5 = WL+ **1,694.00** [m]

② No.2 sedimentation

The head loss can be obtained from the Williams and Hazen empirical formula:

$\Delta h_3 = 10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$

where:

$= 10.666 \times 110^{-1.85} \times 0.2^{-4.87} \times 0.056^{1.85} \times 150$

= 3.28 [m] → **3.5** [m]

Water level= WL+ 1,685.60 < 1,694.50 − 3.5 =WL+ **1,691.00** [m]

Therefor, the water level with 1,691m is accepted.

③ No.3 sedimentation

The head loss can be obtained from the Williams and Hazen empirical formula:

where:

$\Delta h_3 = 10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$

$= 10.666 \times 110^{-1.85} \times 0.2^{-4.87} \times 0.041^{1.85} \times 10$

= 0.123 [m] → **0.5** [m]

Water level =+ 1,694.50 − 0.5 = WL+ **1,694.00** [m]

where:

L : pipe length

L_1= 145 [m]

L_2= 150 [m]

L_3= 10 [m]

3. Line No. 3 Treatment Plant

(1) Required head loss in the valve with 200mm: Δh_4

$$\Delta h_4 = (fbv + fi + of) \times \frac{V^2}{2g} = (0.30 + 0.30 + 1.00) \times \frac{0.653^2}{2g} = 0.035 \quad [m]$$

→ 0.05 [m]

with:

fbv :	loss coefficient of valves	0.3	
fi :	loss coefficient of pipe inlet	0.30	
fo :	loss coefficient of pipe outlet	1.00	
V :	velocity in the pipe	$\frac{0.041 \times 4}{0.2^2 \times \pi \times 2} = 0.653$	[m/sec]

(2) Required head loss in the flocculation basin: Δh_5

where:

required G-value: 50 1/sec. (10 < G < 75)

$$\Delta h_5 = \frac{G^2 V \mu}{\rho Q g} = \frac{50^2 \times 73.5 \times 10^{-3}}{10^3 \times 0.041 \times 9.8} = 0.46 \quad [m] \rightarrow 0.5 \ [m]$$

with:

V :	Volume of the flocculation basin	73.5	[m^3]	
μ :	Viscosity coefficient of the water	0.001	[kg/m·s]	as 20°C
ρ :	density of the water	1.00	[kg/m^3]	as 20°C
Q :	water flow	0.04	[m^3/S]	

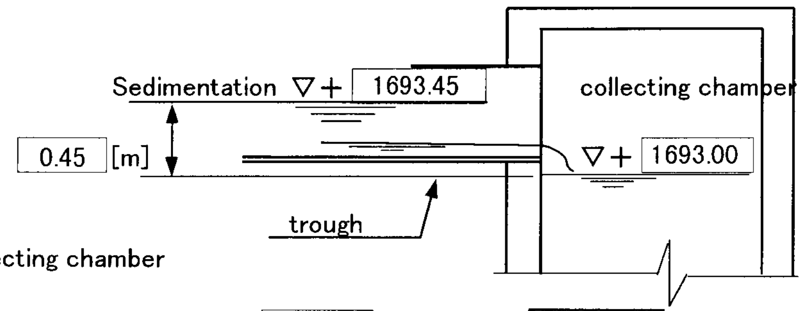
Water level of the sedimentation:

water level $- \Delta h_4 - \Delta h_5 =$ 1694.00 − 0.05 − 0.5 = + 1693.45 [m]

(3) Required head loss in sedimentation basin: Δh_6

where:

$\Delta h_6 =$ 0.45 [m]



water level of the collecting chamber

sedimentation water level · $\Delta h_7 - \Delta h_6 =$ 1693.45 − 0.45 = 1693.000 [m]

(4) Required loss head from collection chamber to filter inlet channel

The head loss can be obtained from the Williams and Hazen empirical formula:

$\Delta h_7 = 10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$

where:

$= 10.666 \times 110^{-1.85} \times 0.2^{-4.87} \times 0.041^{1.85} \times 40$

$= 0.492$ [m] → 0.5 [m]

water level of filter inlet = + 1,693.00 − 0.5 = WL+ 1,692.50 [m]

where:

C : roughness coefficient of the pipe wall   C= 110

D : internal pipe size   D= 0.2 [m]

L : pipe length   L= 40 [m]

(5) Required head loss from filter inlet and filter bed

① Inlet filter valve $\Delta h_{①}$

$$\Delta h_{①} = (fo + fbv) \times \frac{V^2}{2g} = (1.0 + 0.6) \times \frac{0.74^2}{2g}$$

$= 0.045$ → 0.05 [m]

with:

fo : head loss coefficient of the outlet connection   1.0 [-]

fbv : head loss coefficient of the valves   0.6 [-]

$$V : \text{velocity} \frac{4 \times Q_0}{\pi \times D^2} = \frac{4 \times 0.0058}{\pi \times 0.1^2} = 0.74 \text{ [m/s]}$$

② Distribution channel $\Delta h_{②}$

$\Delta h_{②} =$ 0.25 [m]

$\Delta h_8 = \Delta h_{①} + \Delta h_{②} = 0.05 + 0.25 = 0.3$ [m] → 0.5 [m]

HWL of the filter bed

+ 1,692.50 - 0.5 = HWL+ 1,692.00 [m]

③ Filter including initial loss

where:

ha= 2.0 [m]

LWL of the filter bed

+ 1,692.00 - 2.0 = LWL+ 1,690.00 [m]

(6) Required head loss during filtration: Δh_9

① Filter media (sand): Δhs
The filter resistance of the clean filter media is :

$$\Delta hs = \frac{F \mu LvL}{\rho g \phi^2 D^2} \times \frac{(1-\varepsilon)^2}{\varepsilon^3}$$

where:

・empirical coefficeint by Levis formula	F	:	144			
・filtration rate	LV	:	130	[m/d]=	0.0015	[m/s]
・layer depth	L	:	0.7	[m]		
・acceleration gravity	g	:	9.8	[m/s^2]		
・size of the sand	D	:	6.50E−04	[m]		
・rate of media space	ε	:	0.45	[−]		
・media coefficient	ϕ	:	0.8	[−]		
・:viscosity coefficient (at 20℃)	μ	:	1.0E−03	[kg/(m・s)]		
・density	ρ	:	1000	[kg/m^3]		

then:

$$\Delta hs = \frac{144 \times 1.0E{-}03 \times 0.0015 \times 0.7}{1000 \times 9.8 \times 0.8^2 \times 6.50E{-}04^2} \times \frac{(1 - 0.45)^2}{0.45^3}$$

$\Delta hs =$ 0.190 [m]

② supporting gravel Δhg
The filter resistance by the clean filter media is :

$$\Delta hg = \frac{F \mu Lv}{\rho g \phi^2} \times \xi \times \frac{(1-\varepsilon)^2}{\varepsilon^3}$$

・empirical coefficeint by Levis formula	F	:	144			
・filtration rate	LV	:	130	[m/d]=	0.0015	[m/s]
・layer depth	L	:	0.05	[m]		
・acceleration gravity	g	:	9.8	[m/s^2]		
・gravel size (1st)	D_1	:	2.00E−03	[m]		
・gravel size (2nd)	D_2	:	4.00E−03	[m]		
・gravel size (3rd)	D_3	:	6.00E−03	[m]		
・gravel size (4th)	D_4	:	1.30E−02	[m]		
・rate of media space	ε	:	0.4	[−]		
・media coefficient	ϕ	:	0.7	[−]		
・:viscosity coefficient (at 20℃)	μ	:	1.0E−03	[kg/(m・s)]		
・density	ρ	:	1000	[kg/m^3]		

then:

$$\xi = \left[\frac{1}{d_1^2} + \frac{1}{d_2^2} + \frac{1}{d_3^2} + \frac{1}{d_4^2} \right] \times L$$

$$\xi = \left[\frac{1}{2.00E{-}03^2} + \frac{1}{4.00E{-}03^2} + \frac{1}{6.00E{-}03^2} + \frac{1}{1.30E{-}02^2} \right] \times 0.05 = 1.7E{+}04$$

therefore:

$$\Delta hg = \frac{144 \times 1.0E{-}03 \times 0.0015}{1000 \times 9.8 \times 0.7^{2}} \times 1.7E{+}04 \times \frac{(1- 0.4)^2}{0.4^{3}}$$

$\Delta hg =$ 0.004 [m]

③ under collecting device $\Delta hc =$ 5.6 [mm] → 0.006 [m]

④ treated water pipe: Δhp

$$\Delta hp = (fi + fo + fL\frac{L}{D}) \times \frac{V^2}{2g} = (0.5 + 1 + 0.022\frac{3.0}{0.3}) \times \frac{0.08^2}{2g}$$

$=$ 0.001 [m]

with:

fi	: head loss coefficient of the inflow	0.50	[-]
fo	: head loss coefficient of the outflow	1.00	[-]
fL	: head loss coefficient of the friction (0. 020 + 0. 0005 / D)	0.022	[-]
D	: pipe size	0.300	[m]

$$V : \text{velocity } \frac{4 \times Q_0}{\pi \times D^2} = \frac{4 \times 0.0058}{\pi \times 0.3^2} = 0.08 \text{ [m/sec]}$$

Therefore, initial filter resistance of the filter isobtained as follows:

$\Delta h_9 = \Delta hs + \Delta hg + \Delta hc + \Delta hp$

$= 0.190 + 0.004 + 0.006 + 0.001 =$ 0.20 [m]

(7) Required head loss during washing process Δh_9

① filter media (sand) Δhs

$$\Delta hs = \frac{L}{\rho_F}(1-\varepsilon)(\rho_S - \rho_F)$$

where:

・layer depth	L	:	0.7	[m]
・rate of media space	ε	:	0.48	[−]
・specific gravity of the water	ρ_F	:	1000	[kg/m3]
・specific gravity of the sand	ρ_S	:	2630	[kg/m3]

$$\Delta hs = \frac{0.7}{1000}(1- 0.48)(2630 - 1000)$$

$=$ 0.593 [m]

② supporting gravel Δhg

The resistance of the gravel zone is obtained from following formula:

$$\Delta hg = \frac{F\mu u}{\rho g \phi^2} \times \xi \times \frac{(1-\varepsilon)^2}{\varepsilon^3}$$

with:

・empirical coefficient by Levis formula	F	:	144			
・filtration rate	u	:	0.6	[m/分]＝	0.01	[m/s]
・layer depth	L	:	0.05	[m]		
・acceleration gravity	g	:	9.8	[m/s^2]		
・gravel size (1st)	D_1	:	2.00E−03	[m]		
・gravel size (2nd)	D_2	:	4.00E−03	[m]		
・gravel size (3rd)	D_3	:	6.00E−03	[m]		
・gravel size (4th)	D_4	:	1.30E−02	[m]		
・rate of media space	ε	:	0.4	[−]		
・media coefficient	ϕ	:	0.7	[−]		
・viscosity coefficient (at 20℃)	μ	:	1.0E−03	[kg/(m・s)]		
・density	ρ	:	1000	[kg/m^3]		

where:

$$\xi = \left[\frac{1}{d_1^2} + \frac{1}{d_2^2} + \frac{1}{d_3^2} + \frac{1}{d_4^2} \right] \times L$$

$$\xi = \left[\frac{1}{2.00E{-}03^{\,2}} + \frac{1}{4.00E{-}03^{\,2}} + \frac{1}{6.00E{-}03^{\,2}} + \frac{1}{1.30E{-}02^{\,2}} \right] \times 0.05$$

$$= 1.7E{+}04$$

then:

$$\Delta hg = \frac{144 \times 1.0E{-}03 \times 0.01}{1000 \times 9.8 \times 0.7^{2}} \times 1.7E{+}04 \times \frac{(1 - 0.4)^2}{0.4^{3}}$$

$\Delta hg =$ 0.029 [m]

③ under collecting device: $\Delta hc =$ 0.2 [m]

④ treated water pipe Δhp

where:

$$\Delta hp = (fi + fo + fL\frac{L}{D}) \times \frac{V^2}{2g} = (0.1 + 1.0 + 0.022\frac{3.0}{0.3}) \times \frac{0.54^{\,2}}{2g}$$

$= $ 0.020 [m]

with:

fi	:	head loss coefficient of the inflow	0.10	[-]
fo	:	head loss coefficient of the outflow	1.00	[-]
fL	:	head loss coefficient of the friction (0.020 ＋ 0.0005/D)	0.022	[-]
D	:	pipe size	0.300	[m]

$$V : \text{velocity} \quad \frac{4 \times Qb}{\pi \times D^{2}} = \frac{4 \times 0.0384}{\pi \times 0.3^{2}} = 0.54 \ \text{[m/秒]}$$

⑤ treated water valve Δhv

$$\Delta hv = (fi + fo + fbv) \times \frac{V^2}{2g} = (0.1 + 1 + 0.5) \times \frac{0.78^{\,2}}{2g}$$ =0.05m

where:

fi	: head loss coefficient of the inflow	0.1	
fo	: head loss coefficient of the outflow	1	
fbv	: head loss coefficient of the valve	0.5	
D	: valve size	0.25	[m]

V : velocity $\dfrac{4x \quad Qb}{\pi \times D^2} = \dfrac{4 \times 0.038}{\pi \times 0.25^2} = 0.78$ [m/S]

Qb : wash water flow $1.6 \times 2.4 \times 0.6 / 60 = 0.038$ [m^3/sec./bed]

Therefore, required head loss during washing ($\Delta h10$) is:

$\Delta h_{10} = \Delta hs + \Delta hg + \Delta hc + \Delta hp + \Delta hv$

$= 0.593 + 0.029 + 0.200 + 0.020 + 0.050 = 0.892$ [m] → 1.0 [m]

op elevation of the drainage trough in the filter be

$+ 1690.000 - 1.000 = EL+$ 1689.000 [m]

(8) Required overflow head from the treated water channel Δh_{11}

where:

$\Delta h_{11} =$ 0.2 [m]

treated water tank HWL $+ 1690.000 - 0.2 =$ HWL+ 1689.800 [m]

Then effective water depth is 2.5m.

treated water tank LWL $+ 1689.800 - 2.5 =$ LWL+ 1687.300 [m]

(9) Required head loss of pipe between treated water tank and Line No.2 existing filtei Δh_{12}

The head loss is obtained by Hazen-Willamus formula:

$\Delta h_{12} = 10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$

where:

C	:	roughness coefficient of the pipe wall	C= 110	
D	:	inside pipe dia	D= 0.3	[m]
Q	:	flow rate	Q= 0.139	[m^3/sec]
L	:	pipe length	L= 150	[m]

$= 10.666 \times 110^{-1.85} \times 0.3^{-4.87} \times 0.139^{1.85} \times 150$

$= 2.447$ [m] → 2.5 [m]

LWL of treated water tank − top elevation of the drainage trough in No.2 filter bed

$= 1687.30 - 1683.40 = 3.9$ [m] > 2.5 [m]

Where, required head of the back wash water is to be 1.4m.

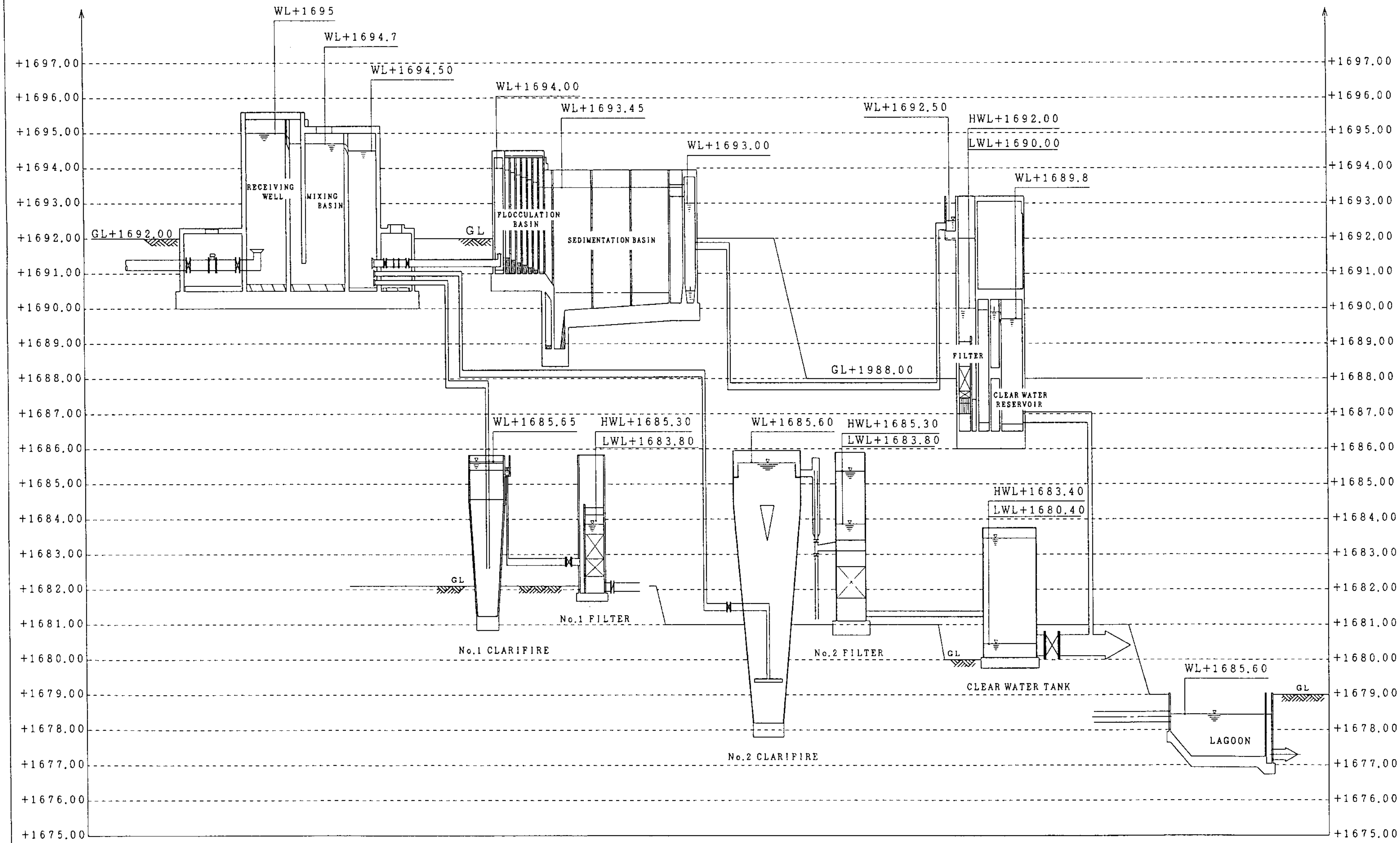

WL+1695
WL+1694.7
WL+1694.50
WL+1694.00
WL+1693.45
WL+1693.00
WL+1692.50
HWL+1692.00
LWL+1690.00
WL+1689.8
GL+1692.00
GL
RECEIVING WELL
MIXING BASIN
FLOCCULATION BASIN
SEDIMENTATION BASIN
FILTER
CLEAR WATER RESERVOIR
GL+1988.00
WL+1685.65
HWL+1685.30
LWL+1683.80
WL+1685.60
HWL+1685.30
LWL+1683.80
HWL+1683.40
LWL+1680.40
No.1 CLARIFIRE
No.1 FILTER
No.2 CLARIFIRE
No.2 FILTER
CLEAR WATER TANK
WL+1685.60
LAGOON
GL
+1697.00
+1696.00
+1695.00
+1694.00
+1693.00
+1692.00
+1691.00
+1690.00
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図 2　　水位高低図

II. Water Flow Calculation for the Water Treatment Plant

II. Water flow Calculation for the Water Treatment Plant

1. Receiving Well

(1) Design conditions

Plant flow (Q)	: 10,000 m3/d = 6.94m3/min.
No. of basin	: 1tank
Detention time (t)	: more than 1.5 min. (based on the guideline of water supply design, Japan)

(2) Required capacity : V_o

When the detention time is 5 minutes, the required capacity of the basin is obtain as follows:

V_0 = Q x t = 6.94 x 5 = 34.7m3

$V_0 = Q \times t$

(3) Determination of the dimension

When width (B) of the basin is 2.8m and depth (H) is 4.3m, length (L) of the basin is:

$$L = \frac{V_0}{B \times H} = \frac{34.7}{2.8 \times 4.3} = 2.88 \rightarrow 2.8 \text{ [m]}$$

(4) Available capacity: V

$$V = B \times L \times H = 2.8 \times 2.8 \times 4.3 = 33.7 \text{ [m}^3\text{]}$$

(5) Confirmation of the available detention time: T

$$T = \frac{V}{Q} = \frac{33.7}{6.94} = 4.9 \text{ [min.]} > 1.5 \text{ [min.]}$$

(6) Design

Shape	rectangular
Dimension	2.8 [mW] × 2.8 [mL] ×4.3 [mH]
No. of basin	1 unit
Detention time	4.9 [min.]

2 Rapid Mixing Basin

(1) Basic conditions

Plant flow (Q)	: 10,000 m3/d = 6.94m3/min.
No. of basin	: 1tank
Detention time (t)	: more than 1 to 5 min. (based on the guideline of water supply design, Japan)

(2)When the detention time is 5 minutes, the required capacity of the basin is obtained as follows:

$$V_0 = Q \times t = 6.94 \times 4 = 27.8 \text{ [m}^3\text{]}$$

(3) Determination of the dimension

When width of the basin will be 2.8m and depth in 4.0m, length of the basin is:

$$L = \frac{V_0}{B \times H} = \frac{27.8}{2.8 \times 4} = 2.48 \rightarrow 2.8 \ [m]$$

(4) Available capacity: V

$$V = B \times L \times H = 2.8 \times 2.8 \times 4 = 31.4 \ [m^3]$$

(5) Available detention time: T

$$T = \frac{V}{Q} = \frac{31.4}{6.94} = 4.5 \ [分]$$

(6) Design

Shape	rectangular
Dimension	2.8 [mW] × 2.8 [mL] ×4.0 [mH]
No. of basin	1 tank

3.Flocculation Basin

(1) Basic conditions

Plant flow (Q)	: 10,000 m3/d = 6.94m3/min. = 0.041 m3/sec.
No. of basin	: 1tank
Detention time (t)	: more than 20 to 40 min. (based on the guideline of water supply design, Japan)

(2) Required capacity: V_o

When the detention time (t) is 30 minutes, the required capacity of the basin is obtained as follows:

$$V_0 = Q \times t = 2.43 \times 30 = 72.9 \ [m^3]$$

(3) Determination of the dimension

When width (B) of the basin is 3.5 m and depth (H) is 2.5m, length of the basin is:

$$L = \frac{V_0}{B \times H} = \frac{72.9 \times 2}{3.5 \times 2.5} = 4.17 \rightarrow 4.2 \ [m]$$

(4) Available capacity: V

$$V = B \times L \times H = 3.5 \times 4.2 \times 2.5 \times 2 = 73.5 \ [m^3]$$

(5) Confirmation of the detention time: T

$$T = \frac{V}{Q} = \frac{73.5}{2.43} = 30.2 \ [min.]$$

(6) Required head loss for G-value

Where, required G-value for flocculation is 50 S^{-1}.

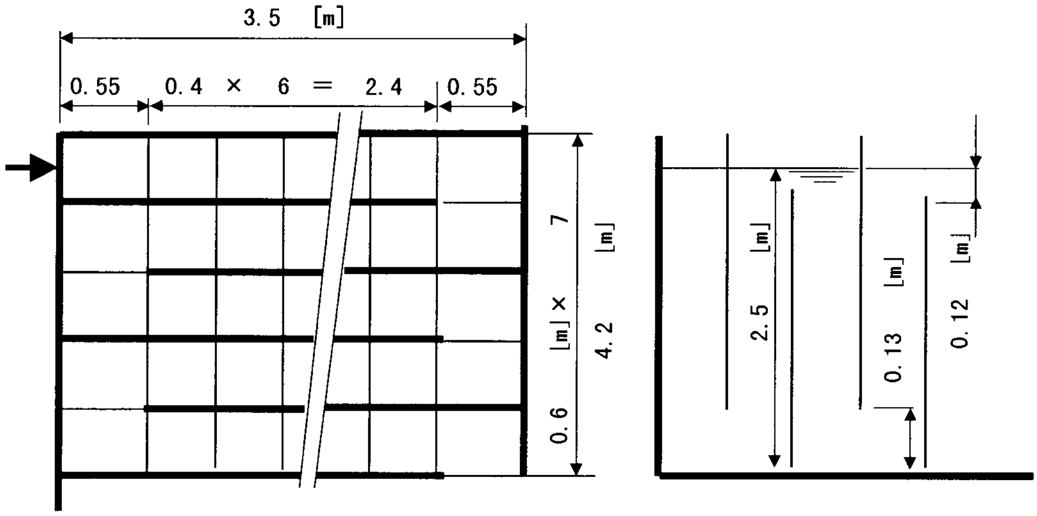
(The available G-value (G) is from 10 to 75 based on Camp empirical formula.)

$$H = \frac{G^2 \cdot V \cdot \mu}{\rho \cdot Q \cdot g} = \frac{50^2 \times 73.5 \times 10^{-3}}{10^3 \times 0.041 \times 10} = 0.5 \quad m$$

μ : Viscosity coefficient 10^{-3} [kg/(m・s)]

g : acceleration gravity 9.8 [m/(sec.^{2})]

(7) Required head loss for the flocculation



① Required head loss through the bottom bend Δh_1

$$\Delta h_1 = f \frac{v_1^2}{2g} \times \text{No. of bend}$$

where:

f : head loss coefficient $f = 3 \sim 4.5$

$$v_1 : \frac{0.041}{2 \times 0.6 \times 0.13} = 0.263$$

(available velocity is [m/sec] $0.3 > v > 0.15$ [m/sec])

then:

$$= 4 \times \frac{0.26^2}{2 \times 10} \times 28 = \boxed{0.392} \text{ [m]}$$

② Required head loss through weir: Δh_2

$$\Delta h_2 = \frac{v_2^2}{2g} \times \text{No. of weir}$$

where:

$$v_2 : \frac{0.041}{2 \times 0.6 \times 0.12} = \boxed{0.285} \text{ [m]}$$

(available velocity is [m/sec] $0.3 > v > 0.15$ [m/sec])

③ Required head loss through open channel: Δh_3

$$\Delta h_3 = \frac{L}{C^2 R} v_3^2$$

where:

R : hydraulic radius

$$\frac{0.55 \times 0.6}{2 \times (0.55 + 0.6)} = 0.143 \quad [m]$$

C : coefficient given by empirical Chezy formula

$$v_3 : \frac{0.041}{2 \times 0.55 \times 0.6} = 0.062 \quad [m/sec.]$$

then:

$$= \frac{0.281^2}{2 \times 9.8} \times 28 = 0.113 \quad [m]$$

Required head loss Δh_2) is calculated as follows :

$$= \frac{2.5 \times 6 \times 7 + 2.4 \times 7}{31^2 \times 0.143} \times 0.061^2 = \boxed{0.003} \ [m]$$

Based on each head loss to be obtained above calculation, total head loss is:

$$\Sigma \Delta h = 0.392 + 0.113 + 0.003 = \boxed{0.508} \ [m] > 0.5 \ [m]$$

(8) Design

Shape	rectangular
Dimension	3.5 [mW] × 4.2 [mL] × 2.5 [mH]
No. of basin	2 [tanks]
Detention time	30.2 [min.]

4. Chemical Sedimentation

(1) Basic conditions

Plant flow Q= 3,500 [m^3/d] = 2.43 [m^3/min.]

No. of basin n= 2 [tanks]

Surface load E= 20 [mm/min.]

(where, the available surface load is from 15 to 30 mm/min. based on the guideline for water supply design, Japan.

Velocity in the basin v= 0.4 [m/min.]

(2) Required settling area

$$A_0 = \frac{Q}{SL \times 10^{-3}} = \frac{2.43}{20 \times 10^{-3}} = 121.5 \quad [m^2]$$

(3) Determination of the dimension

When width of the basin (B) is 3.5 m and settling area (A_0) is 121.5m², length of the basin (L) is:

$$L = \frac{A_0}{B \times n} = \frac{121.5}{3.5 \times 2} = 17.4 \quad [m] \rightarrow \quad 18.9 \quad [m]$$

(4) Available capacity

When the available depth of the basin (H) is 3.5m, the available capacity is:

$$V = B \times L \times H \times n = 3.5 \times 18.9 \times 3.5 \times 2 = 463.05 \quad [m^3]$$

(5) Confirmation of the detention time : T

$$T = \frac{V}{Q} = \frac{463}{2.43} = 191 \quad [min.]$$

(6) Available settling area : A

$$A = B \times L \times n = 3.5 \times 18.9 \times 2.0 = 132.3 \quad [m^2]$$

(7) Confirmation of the surface load : E

$$E = \frac{Q}{A \times 10^{-3}} = \frac{2.43}{132.3 \times 10^{-3}} = 18.4 \quad [mm/min.]$$

(8) Confirmation of the velocity in the basin: VH

$$VH = \frac{Q}{B \times H \times n} = \frac{2.43}{3.5 \times 3.5 \times 2} = 0.099 \quad [m/min.] \leqq 0.4 \ m/min.$$

(9) Design

Shape	rectangular
Dimension	3.5 [mB] × 18.9 [mL] × 3.5 [mH]
No. of basin	2 [tanks]
Detention time	191 [min.]
Surface load	18.4 [mm／min.]

5. Rapid Sand Filter

(1) Basic conditions

Plant flow	Q= 3,500 [m³/d] = 2.43 [m³/min.]	
Filtration rate	LV=120～150 [m/d]	
Filter media	silica sand	layer 0.7 [m]
Washing system	surface and back wash water	
Required velocity:		
surface wash	qa= 0.2 [m³/min./m²]	
Back wash	qb= 0.6 [m³/min./m²]	
Required period		
surface wash	Ta= 6 [min.]	
Back wash	Tb= 6 [min.]	
drain	Td= 20 [min.]	

(2) Required area of filter bed

When filtration rate is 120 m/d, required filter area is:

$$A_0 = \frac{Q}{LV} = \frac{3,500}{120} = 29.2 \quad [m^2]$$

(3) Determination of the dimension of filter bed

Shape	rectangular
No. of bed	n = 8 [beds] (including 1set of stand-by bed)
	n' = 8 [beds]
Dimension	width (B) : 1.6 [m] × length L : 2.4 [m]

(4) Available filter area :A

$A = B \times L = 1.6 \times 2.4 = 3.84$ [m²/bed]

(5) Confirmation of the filtration rate: LV

$$LV = \frac{Q}{A \times n'} = \frac{3,500}{3.84 \times 8} = 114 \quad [m/d]$$

(6) Required surface wash water flow: Qs

$\Sigma Qs = A \times qa \times Ta = 3.84 \times 0.2 \times 6 =$ **4.6** [m^3]

where: Qa: unit washing water flow : 0.2 m^3/min.・m^2

Ta: period of washing (min.)

(7) Total back wash-water flow (Qb)

$\Sigma Qb = A \times qb \times Tb = 3.84 \times 0.6 \times 6 =$ **13.8** [m^3]

where: Qa: unit washing water flow : 0.6 m^3/min.・m^2

Ta: period of washing (min)

(8) Total drainage water before washing: Qd

$Qd = A \times LV \times T_1 = 3.84 \times 114 \times 20 / 24 / 60 =$ **6.1** [m^3]

(9) Remaining water after washing : Qr

$Qr = B' \times L \times H = 2.4 \times 2.4 \times 3 =$ **17.3** [m^3]

(10) Total discharge water flow through washing:

$\Sigma Q = Qs + Qb + Qd + Qr = 4.6 + 13.8 + 6.1 + 17.3 =$ **41.8** [m^3]

(11) Design

Shape	rectangular
Dimension	1.6 [m] × 2.4 [m]
No. of bed	8 [bed] (including 1 bed of stand-by)
Filter area	3.84 [m²/bed]
Filtrate	114 [m/d]
Discharge water for washing	41.8 [m^3/池]

7. Sludge Lagoon

(1) Basic conditions

Plant flow	Q1= 1,700	[m^3/d]	= 1	[m^3/min.]
	Q2= 4,800	[m^3/d]	= 3	[m^3/min.]
	Q3= 3,500	[m^3/d]	= 2	[m^3/min.]
	合計 10,000	[m^3/d]		
No. of filter bed for washing	n= 2	[tank]		
Average turbidity	Tu= 5	[mg/L]		
Alum dosing rate	α= 20	[mg/L]		
concentration of the sludge	Cs= 3	[kg/m3]		
Settling rate	E= 10	[mm/min.]		

(2) Dry sludge volume

W1= 1,700 × (5 ×1.0 + 0 × 20) × 1 ／1000 = 16.5 [kg・DS/d]

W2= 4,800 × (5 ×1.0 + 0 × 20) × 1 ／1000 = 46.5 [kg・DS/d]

W3= 3,500 × (5 ×1.0 + 0 × 20) × 1 ／1000 = 33.9 [kg・DS/d]

(3) Waste water flow

V1= 16.5 ÷ 3 = 7 [m^3/d]

V2= 46.5 ÷ 3 = 18.6 [m^3/d]

V3= 33.9 ÷ 3 = 13.6 [m^3/d]

(4) Required area of solid-liquid separator :A

where, it is treated 4times every day of waste water with max.18.6m3/d. A treated period every time takes 15min.

$$A = \frac{18.6}{4 \times 15 \times 10 \times 10^{-3}} = 31 \quad [m^2]$$

(5) Determination of the dimension

where, width of the basin is 3m, required length (L) is:

$$L = \frac{31}{3} = 11 \quad [m]$$

(6) Surface area of the lagoon : A

A= 3 × 11 = 31.9 [m^2]

(7) Design

Shape	:rectangular
Dimension	:3 [mB] × 11 [mL]
No. of basin	:2 [tanks]
Surface area of the basin	:31.9 [m^2]

III. Calculation of Chemical Dosing Equipment

III Calculation of Chemical Dosing Equipment

1. Basic design conditions

(1) Plant flow:

Line No. 1 treatment plant (existing)	1,700 m^3/d
Line No.2 treatment plant (existing)	4,800 m^3/d
Line No.3 treatment plant (expansion)	3,500 m^3/d
Total plant flow	10,000 m^3/d (6.94 $m^3/min.$)

(2) Water quality

Turbidity as kaolin test:

Max.	Average	Min.
10 mg/l	5mg/l	3mg/l

(3) Chemical

Dosing purpose	Chemical
Coagulation	Solid Alum
pH control	Soda ash
Disinfecting	Hipo-chlorine calcium (65% cl_2)

(4) Dosing rate

The dosing rate has been determined by site experiments as follows:

Unit in mg/l

Chemical	Max.	Average	Min.
Alum	30	20	10
Soda ash	8	5.5	3
Hipo-chlorine	2	1	-

2. Calculation of dosing capacity

(1) Alum

The dosing capacity in kg/d (q_1) is:

$q_1 = Q \times \alpha \times 10^{-3}$

where:

Q: plant flow (m^3/d)

α : dosing rate (mg/l)

then:

Max.	Average	Min.
12.5	8.33	4.16

The dosing capacity in volumetric unit (q_2)is calculated as follows:

$q_2 = Q \times \alpha \times 100/C \times 1/r \times 10^{-3}$

where:

C: solution concentration (10%)

r: specific gravity (1.05 at 10% solution)

therefore:

	Max.	Average	Min.
Unit in l/d	2,857	1,905	952
Unit in l/hr.	119	79.4	39.6

(2) Soda ash

The dosing capacity in kg/d (q_1) is :

$q_1 = Q \times \alpha \times 10^{-3}$

where:

Q: plant flow (m^3/d)

α : dosing rate (mg/l)

then:

Max.	Average	Min.
80	55	30

The dosing capacity in volumetric unit (q_2)is calculated as follows:

$q_2 = Q \times \alpha \times 100/C \times 1/r \times 10^{-3}$

where:

C: solution concentration (5 %)

r: specific gravity (1.05 at 5% solution)

therefore:

	Max.	Average	Min.
Unit in l/d	1,524	1,048	571
Unit in l/hr.	63.5	47.67	23.8

(3) Hipo-chlorine

The dosing capacity in kg/d (q_1) is :

$q_1 = Q \times \alpha \times 10^{-3}$

where:

Q: plant flow (m3/d)

α : dosing rate (mg/l)

then:

Max.	Average	Min.
30.8	15.4	–

The dosing capacity in volumetric unit (q_2)is calculated as follows:

$q_2 = Q \times \alpha \times 100/C \times 1/r \times 10^{-3}$

where:

C: solution concentration (3%)

r: specific gravity (1at 3% solution)

therefore:

	Max.	Average	Min.
Unit in l/d	667	333	–
Unit in l/hr.	27.8	13.9	–

3. Equipment capacity

(1) Alum

① Solution tank capacity

The capacity is calculated using the average dosing capacity and detention for 1 day. The capacity is to be 1,905 liter. The tank made from polyethylene will prepare 2 tanks and each capacity has 2,000 liter. The tank is required the baskets for solid Alum with dimension in 450mm diameter and 500mm depth.

② Dosing pump

The dosing pumps will operate by means of 3 stages-step control with plant flow. The capacity of a pump (q_3: l/min.) will be determined as bellow:

q_3 = 119 l/hr. x 3,500/10,000 x 1/60 = 0.694 l/min.

Quantities of the pump are 4 sets including 1set of stand bay.

③ Storage space

Storage period: 1month

Where:

200 kg/d x 30 days = 6,000 kg

6,000 kg/25 kg/1bag = 240 bags

dimension of a bag: 0.45 x 0.65 x 0.12 (thickness)

loading limit: max. 10 bags

therefore:

(240/10) x 0.45 x 0.65 = 7 (m^2)

(2) Soda ash

① Solution tank capacity

The capacity is calculated using the average dosing capacity and detention for 1 day. The capacity is to be 1,048 liter. The tank made from polyethylene will prepare 2 tanks and each capacity has 2,000 liter. The concentrate of the Soda ash is adjusted the solution with 3 % in the tanks.

② Dosing pump

The dosing pumps will operate by means of 3 stages-step control with plant flow. The capacity of a pump (q_3: l/min.) will be determined as bellow:

q_3 = 63.5 l/hr. x 3,500/10,000 x 1/60 =0.37 l/min.

Quantities of the pump are 4 sets including 1set of stand bay.

③ Storage space

Storage period: 1month

Where:

55 kg/d x 30 days = 1,650 kg

1,650 kg/25 kg/1bag = 66 bags

Dimension of a bag: 0.45 x 0.65 x 0.12 (thickness)

Loading height: 10 bags

therefore:

(66/10) x 0.45 x 0.65 = 2.34 (m2)

(3) Hipo-chlorine

① Solution tank capacity

The capacity is calculated using the average dosing capacity and detention for 1 day. The capacity is to be 667 liter. The tank made from polyethylene will prepare 2 tanks and each capacity has 1,000 liter. The concentrate of the Hypo-chlorine is adjusted solution with 3% in the tanks.

② Dosing pump

The dosing pumps will operate by means of 3 stages-step control with plant flow. The capacity of a pump (q_3: l/min.) will be determined as bellow:

q_3 = 27.8 l/hr. x 3,500/10,000 x 1/60 =0.162 l/min.

Quantities of the pump are 4 sets including 1set of stand bay.

③ Storage space

Storage period: 1month

Where:

15.4 kg/d x 30 days = 462 kg

462 kg/25 kg/1can = 19 cans

dimension of a can: 0.6mΦx 0.7 m(high)

Loading height: 3 cans

therefore:

$(19/3) \times 0.3^2 \times 3.14 = 1.96\ (m^2)$

4. Equipment Specifications (Preliminary Design)

(1) Alum

① Dissolution tank

Type	: cylindrical tank
Capacity	: 2 m^3
Dimension	:Φ1,400mm x 1,545mH
Materials	: polyethylene
No. of set	: 2 set including 1set of stand-by
Accessory	: stirrer with approx. 0.75 kW motor

② Dosing pump

Type	: diaphragm chemical pump
Capacity	: 0.694 l/min.
Motor output	: AC240V, 3fhase, 50Hz, approx. 0.2kW
No. of set	: 4 sets including 1set of stand-by

(2) Soda ash

① Dissolution tank

Type	: cylindrical tank
Capacity	: 2 m^3
Dimension	:Φ1,400mm x 1,545mH
Materials	: polyethylene
No. of set	: 2 set including 1set of stand-by
Accessory	: stirrer with approx. 0.75 kW motor

② Dosing pump

Type	: diaphragm chemical pump
Capacity	: 0.37 l/min.
Motor output	: AC240V, 3fhase, 50Hz, approx. 0.2kW
No. of set	: 4 sets including 1set of stand-by

(3) Soda ash

① Dissolution tank

Type	: cylindrical tank
Capacity	: 1 m^3
Dimension	:Φ1,060mm x 1,250 mH
Materials	: polyethylene
No. of set	: 2 set including 1set of stand-by
Accessory	: stirrer with approx. 0.4 kW motor

② Dosing pump

Type	: diaphragm chemical pump
Capacity	: 0.162 l/min.
Motor output	: AC240V, 3fhase, 50Hz, approx. 0.2kW
No. of set	: 4 sets including 1set of stand-by

5. Production Makers

The design specification is based on the equipment of following production makers

Suidou Kiko Kaisha, Ltd

Ebara corporation

Hitach Plant Engineering & Construction Co., Ltd

添付資料１２　配水管網解析

配水管網解析

2003 年の需要水量（日最大）に基づく時間最大給水量（ピーク時）を配水するための管網の設計を行った。水理解析の条件は以下のようである。

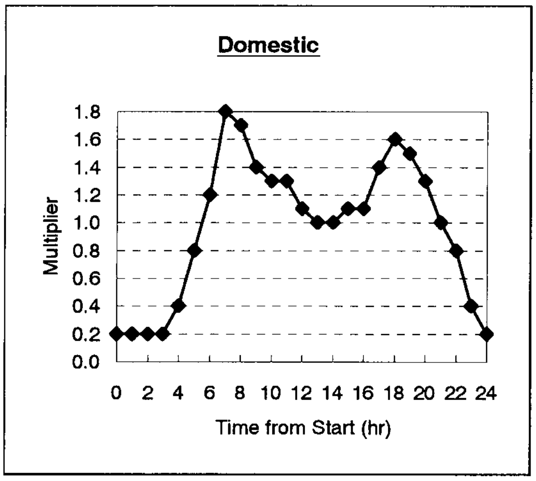
ー流量計算式：Hazen Williams 公式
ー流速係数：C=110
ー最小動水圧：10m
ー最大動水圧：50m
ー最大静水圧：70m

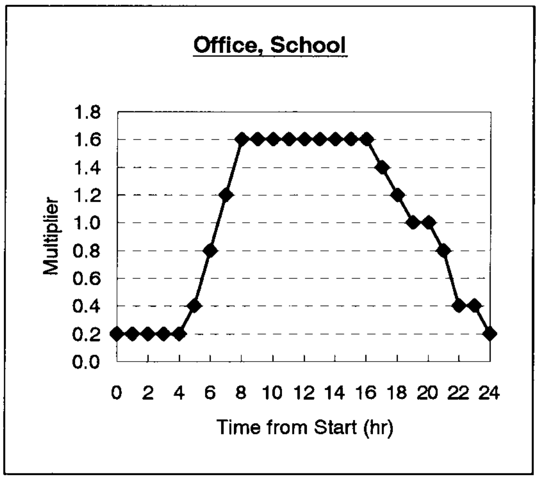
水理解析の結果、所要の水量と水圧を確保する配水管網を構築することができた。なお、最大動水圧が 50m を超えないように管路の要所に圧力調整弁（減圧弁）を設けた。

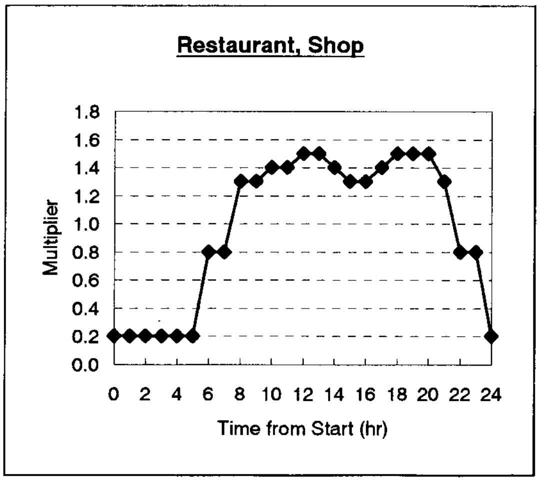
次頁以降に下記内容の管網解析結果を掲げる。
ー水需要パターン（4 種類）
ーローレンガウ　管網図（2003 年の管路番号および接点番号）
ーローレンガウ　ピーク時管網解析結果の接点データ
ーローレンガウ　ピーク時管網解析結果の管路データ
ーゴロカ　管網図（2003 年の管路番号および接点番号）
ーゴロカ　ピーク時管網解析結果の接点データ
ーゴロカ　ピーク時管網解析結果の管路データ

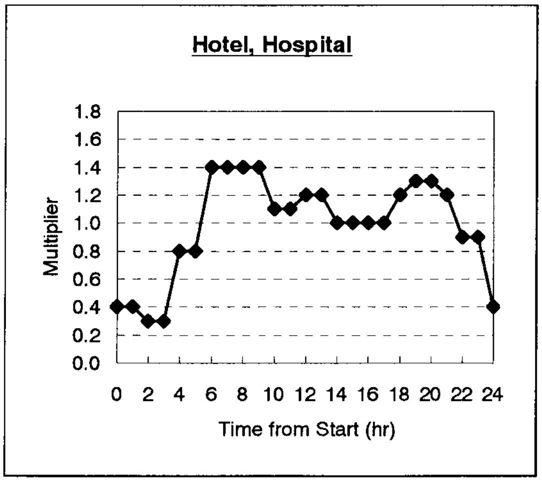
Demand Patterns

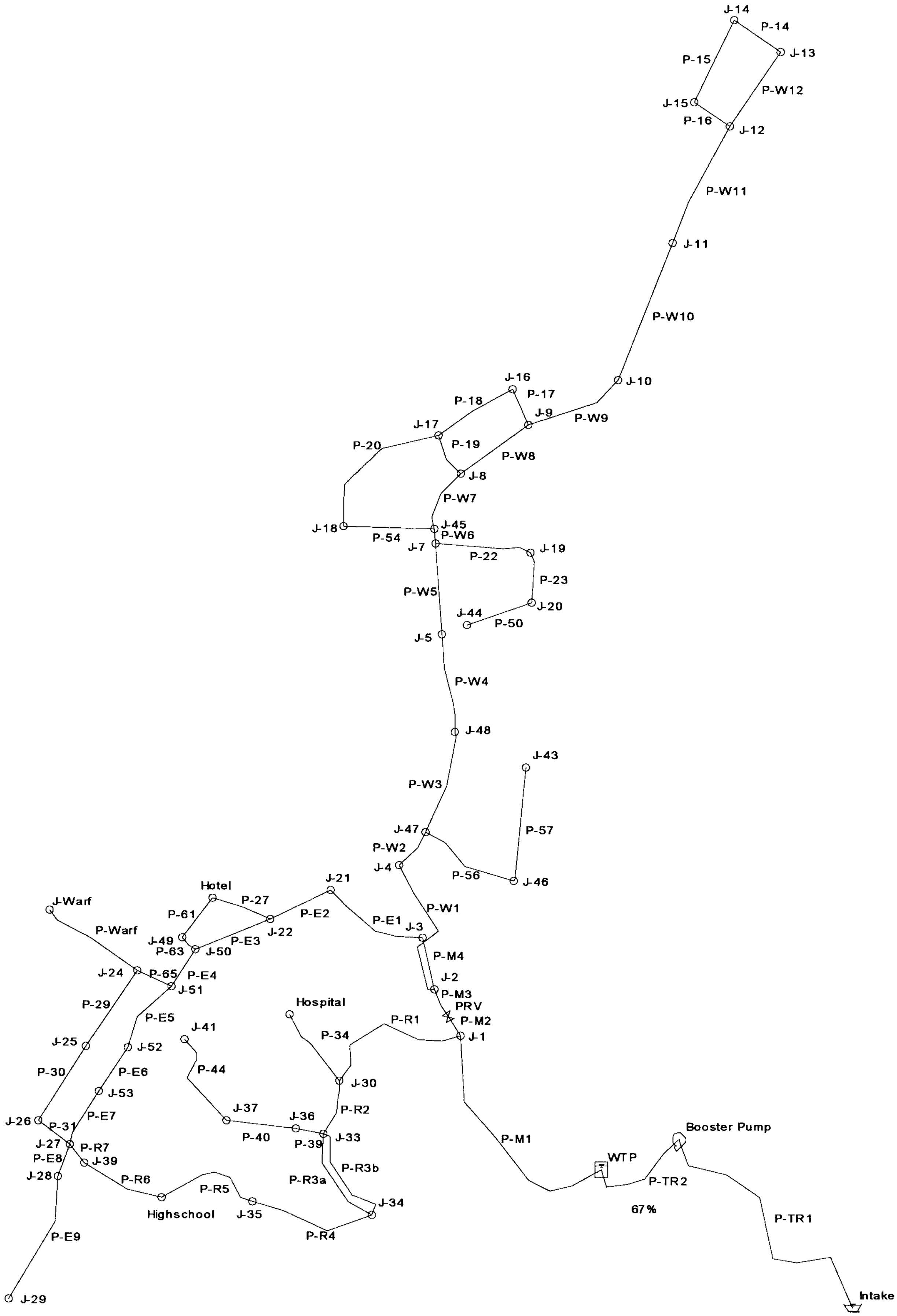
Time from start (hr)	Multiplier			
	Domestic	Office, School	Restaurant, Shop	Hotel, Hospital
0	0.2	0.2	0.2	0.4
1	0.2	0.2	0.2	0.4
2	0.2	0.2	0.2	0.3
3	0.2	0.2	0.2	0.3
4	0.4	0.2	0.2	0.8
5	0.8	0.4	0.2	0.8
6	1.2	0.8	0.8	1.4
7	1.8	1.2	0.8	1.4
8	1.7	1.6	1.3	1.4
9	1.4	1.6	1.3	1.4
10	1.3	1.6	1.4	1.1
11	1.3	1.6	1.4	1.1
12	1.1	1.6	1.5	1.2
13	1.0	1.6	1.5	1.2
14	1.0	1.6	1.4	1.0
15	1.1	1.6	1.3	1.0
16	1.1	1.6	1.3	1.0
17	1.4	1.4	1.4	1.0
18	1.6	1.2	1.5	1.2
19	1.5	1.0	1.5	1.3
20	1.3	1.0	1.5	1.3
21	1.0	0.8	1.3	1.2
22	0.8	0.4	0.8	0.9
23	0.4	0.4	0.8	0.9
24	0.2	0.2	0.2	0.4










J-14
P-14
J-13
P-15
P-W12
J-15
P-16
J-12
P-W11
J-11
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J-10
P-17
P-18
J-9
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J-17
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J-8
P-W7
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J-45
P-W6
P-54
J-7
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J-19
P-23
P-W5
J-44
J-20
P-50
J-5
P-W4
J-48
J-43
P-W3
P-57
J-47
P-W2
J-4
P-56
J-46
Hotel
J-21
J-Warf
P-27
P-61
P-E2
P-W1
P-Warf
P-E1
J-3
J-22
J-49
P-E3
P-63
J-50
P-M4
J-24
P-65
P-E4
J-2
J-51
P-M3
Hospital
PRV
P-29
P-E5
P-R1
P-M2
J-41
P-34
J-1
J-25
J-52
P-44
P-30
P-E6
J-30
J-53
J-37
P-R2
P-E7
J-36
J-26
P-31
P-40
J-33
P-M1
Booster Pump
J-27
P-R7
P-39
WTP
P-E8
J-39
P-R3b
J-28
P-R6
P-R3a
P-TR2
P-R5
J-34
67%
Highschool
J-35
P-R4
P-TR1
P-E9
J-29
Intake

Networks Calculation at Peak Hour (LORENGAU, Year 2003)

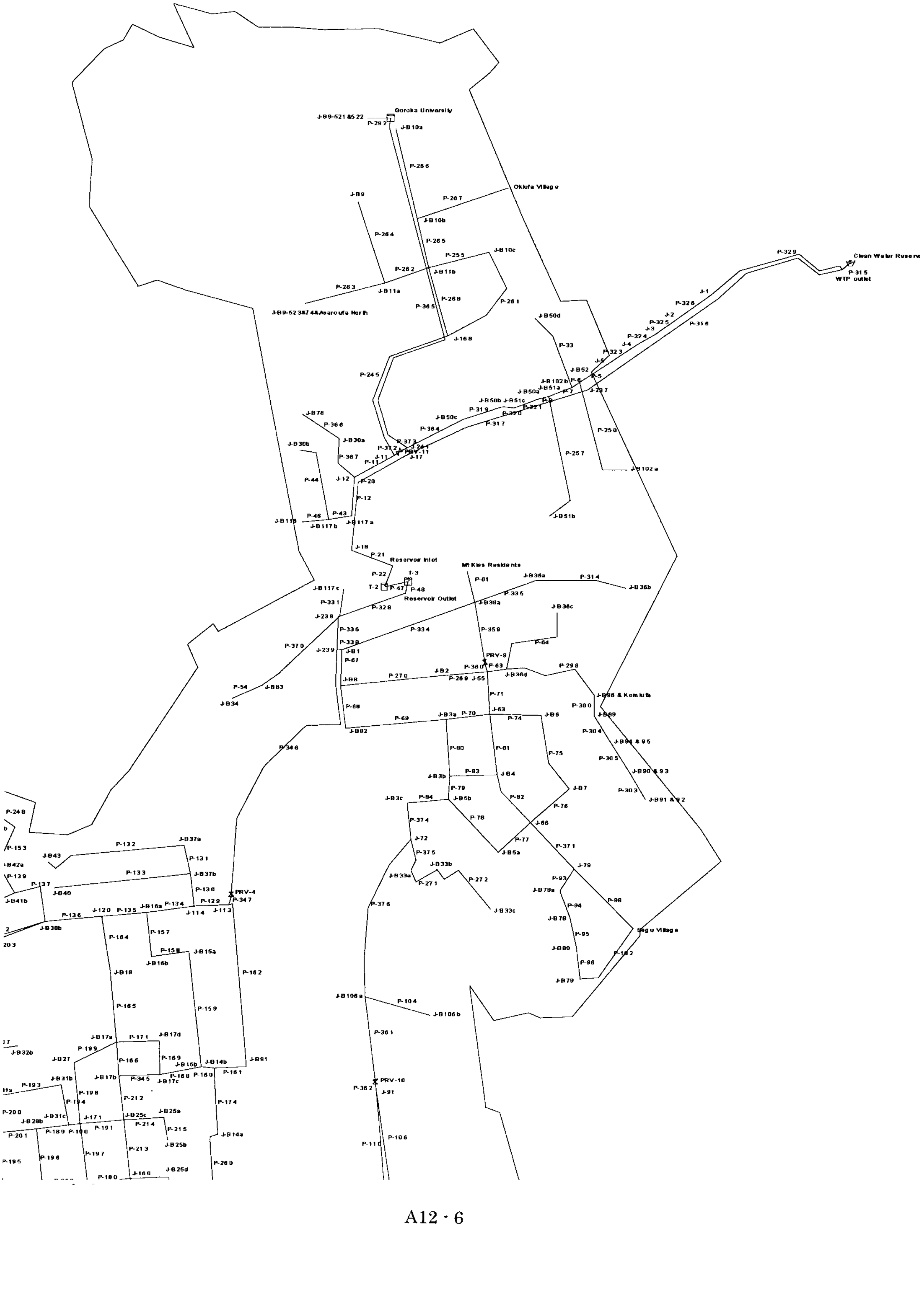
Junction Report

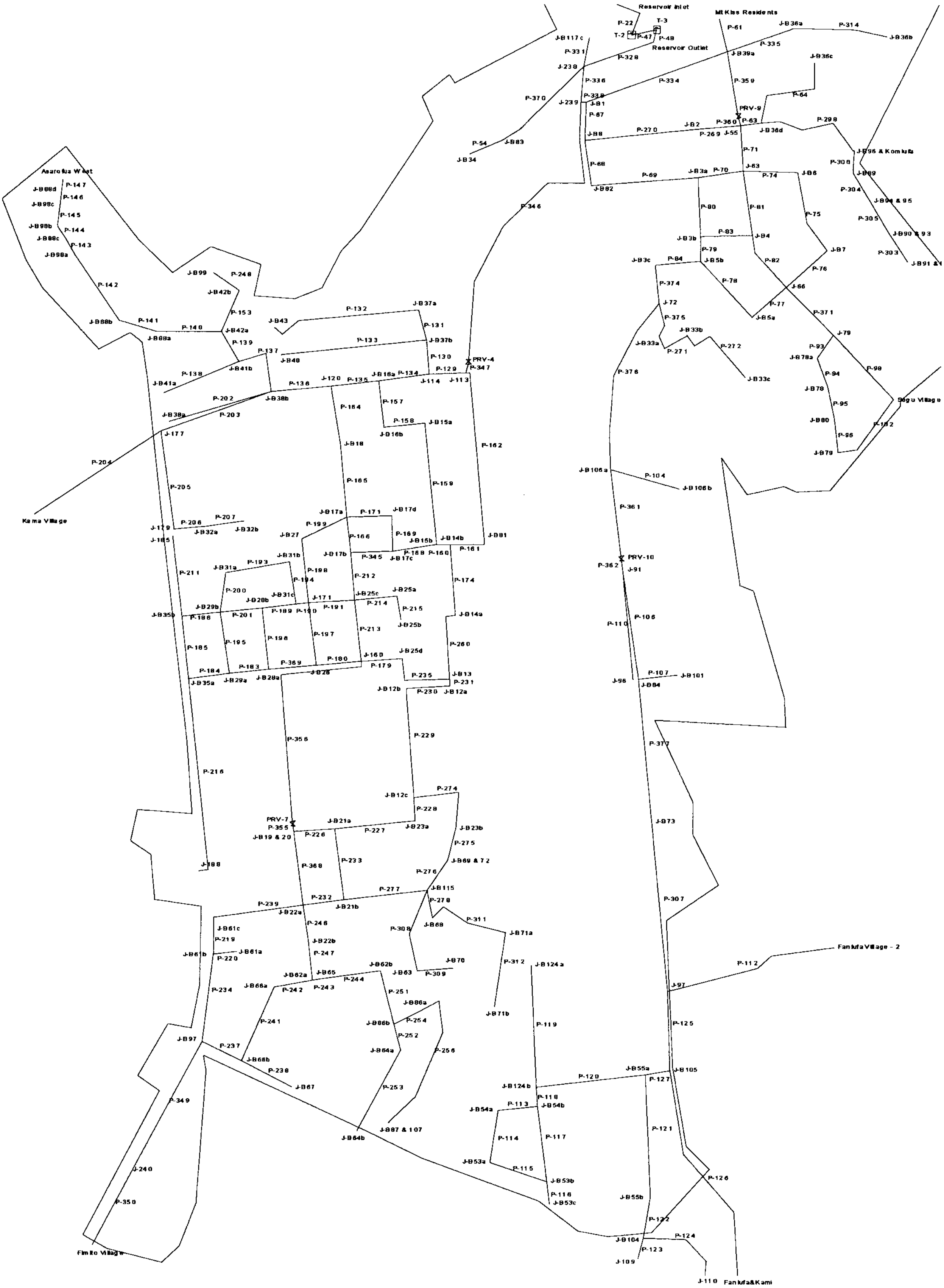
Node	Hydraulic Grade (+m)	Elevation (+m)	Pressure Head (m)	Base Demand (l/s)	Peak Hour Demand (l/s)	Zone
J-1	65.51	55.00	10.51	0.20	0.28	Ward-5
J-2	49.74	16.00	33.74	0.30	0.46	Ward-5
J-4	49.03	3.00	46.03	0.32	0.50	Ward-4
J-5	46.29	6.00	40.29	0.46	0.69	Ward-3
J-7	45.29	5.00	40.29	0.47	0.66	Ward-3
J-8	43.08	3.00	40.08	0.49	0.74	Ward-2
J-9	42.40	3.00	39.40	0.45	0.66	Ward-2
J-10	41.16	3.00	38.16	0.41	0.60	Ward-1
J-11	39.88	3.00	36.88	0.41	0.60	Ward-1
J-12	39.13	3.00	36.13	0.42	0.61	Ward-1
J-13	39.07	3.00	36.07	0.42	0.61	Ward-1
J-14	39.06	3.00	36.06	0.41	0.60	Ward-1
J-15	39.08	3.00	36.08	0.42	0.61	Ward-1
J-16	42.47	3.00	39.47	0.41	0.63	Ward-2
J-17	42.82	3.00	39.82	0.43	0.66	Ward-2
J-18	43.59	3.00	40.59	0.43	0.66	Ward-2
J-19	45.00	11.00	34.00	0.36	0.57	Ward-3
J-20	44.93	22.00	22.93	0.36	0.57	Ward-3
J-21	46.50	3.00	43.50	0.32	0.50	Ward-5
J-22	45.42	3.00	42.42	0.62	0.78	Ward-5
Hotel	45.13	3.00	42.13	0.44	0.55	Ward-5
J-24	44.80	3.00	41.80	0.43	0.65	Ward-6
J-25	44.79	3.00	41.79	0.34	0.54	Ward-6
J-26	44.83	3.00	41.83	0.53	0.74	Ward-7
J-27	44.96	3.00	41.96	0.30	0.46	Ward-7
J-28	44.83	3.00	41.83	0.43	0.59	Ward-7
J-29	44.56	3.00	41.56	0.82	1.36	Ward-7
J-30	65.13	40.00	25.13	0.32	0.50	Ward-5
Hospital	64.77	23.00	41.77	0.73	0.97	Ward-5
J-33	64.72	45.00	19.72	0.18	0.26	Ward-7
J-34	63.87	55.00	8.87	0.23	0.35	Ward-7
J-35	59.96	43.00	16.96	0.18	0.26	Ward-7
J-36	64.60	40.00	24.60	0.18	0.26	Ward-7
J-37	64.27	20.00	44.27	0.35	0.57	Ward-6
Highschool	50.82	20.00	30.82	0.68	0.89	Ward-7
J-39	46.23	10.00	36.23	0.17	0.25	Ward-7
J-41	64.17	20.00	44.17	0.28	0.44	Ward-6
J-Warf	44.80	3.00	41.80	0.05	0.05	Ward-6
J-43	45.21	18.00	27.21	0.27	0.45	Ward-4
J-44	44.91	20.00	24.91	0.36	0.57	Ward-3
J-45	44.60	3.00	41.60	0.42	0.64	Ward-2
J-46	46.08	15.00	31.08	0.27	0.45	Ward-4
J-47	48.97	3.00	45.97	0.32	0.50	Ward-4
J-48	47.53	3.00	44.53	0.35	0.53	Ward-4
J-49	45.06	3.00	42.06	0.25	0.32	Ward-5
J-50	45.06	4.50	40.56	0.48	0.63	Ward-5
J-51	44.89	5.00	39.89	0.48	0.69	Ward-6
J-52	44.88	5.00	39.88	0.45	0.67	Ward-6
J-53	44.89	5.00	39.89	0.50	0.70	Ward-7
J-3	48.66	15.00	33.66	0.32	0.50	Ward-5

Networks Calculation at Peak Hour (LORENGAU, Year 2003)

Pipe Report

Pipe	Start	End	Length (m)	Dia. (mm)	Material	C	Q (l/s)	V (m/s)	I (m/km)	Headloss (m)	Start Hydraulic Grade (m)	End Hydraulic Grade (m)
P-M1	WTP	J-1	703	200	PVC	110	28.30	0.90	6.14	4.31	69.82	65.51
P-R1	J-1	J-30	485	200	PVC	110	9.29	0.30	0.78	0.38	65.51	65.13
P-M2	J-1	PRV	50	200	PVC	110	18.73	0.60	2.86	0.14	65.51	65.36
P-M4	J-2	J-3	139	100	PVC	110	5.18	0.66	7.75	1.08	49.74	48.66
P-W2	J-4	J-47	44	200	PVC	110	12.59	0.40	1.37	0.06	49.03	48.97
P-W1	J-4	J-2	480	200	PVC	110	-13.09	0.42	1.47	0.71	49.03	49.74
P-22	J-7	J-19	290	100	PVC	110	1.70	0.22	0.99	0.29	45.29	45.00
P-W6	J-7	J-45	44	100	PVC	110	7.60	0.97	15.77	0.69	45.29	44.60
P-W5	J-7	J-5	276	150	PVC	110	-9.97	0.56	3.62	1.00	45.29	46.29
P-W8	J-8	J-9	251	100	PVC	110	2.94	0.37	2.72	0.68	43.08	42.40
P-W9	J-9	J-10	310	100	PVC	110	3.62	0.46	4.00	1.24	42.40	41.16
P-17	J-9	J-16	118	100	PVC	110	-1.34	0.17	0.64	0.07	42.40	42.47
P-W10	J-10	J-11	4[illegible]7	100	PVC	110	3.02	0.38	2.86	1.28	41.16	39.88
P-W11	J-11	J-12	392	100	PVC	110	2.42	0.31	1.90	0.75	39.88	39.13
P-W12	J-12	J-13	272	100	PVC	110	0.80	0.10	0.24	0.07	39.13	39.07
P-14	J-13	J-14	171	100	PVC	110	0.19	0.02	0.02	0.00	39.07	39.06
P-15	J-14	J-15	275	100	PVC	110	-0.41	0.05	0.07	0.02	39.06	39.08
P-16	J-15	J-12	130	100	PVC	110	-1.02	0.13	0.38	0.05	39.08	39.13
P-18	J-16	J-17	263	100	PVC	110	-1.97	0.25	1.30	0.34	42.47	42.82
P-19	J-17	J-8	136	80	PVC	110	-1.37	0.27	1.96	0.27	42.82	43.08
P-20	J-17	J-18	457	80	PVC	110	-1.26	0.25	1.68	0.77	42.82	43.59
P-54	J-18	J-45	277	80	PVC	110	-1.92	0.38	3.66	1.01	43.59	44.60
P-23	J-19	J-20	155	100	PVC	110	1.14	0.14	0.47	0.07	45.00	44.93
P-50	J-20	J-44	206	100	PVC	110	0.57	0.07	0.13	0.03	44.93	44.91
P-E2	J-21	J-22	208	100	PVC	110	4.18	0.53	5.23	1.09	46.50	45.42
P-E1	J-21	J-3	335	100	PVC	110	-4.68	0.60	6.43	2.15	46.50	48.66
P-27	J-22	Hotel	188	80	PVC	110	1.19	0.24	1.51	0.28	45.42	45.13
P-61	Hotel	J-49	146	80	PVC	110	0.64	0.13	0.48	0.07	45.13	45.06
P-29	J-24	J-25	265	80	PVC	110	0.19	0.04	0.05	0.01	44.80	44.79
P-Warf	J-24	J-Warf	331	80	PVC	110	0.05	0.01	0.00	0.00	44.80	44.80
P-30	J-25	J-26	250	80	PVC	110	-0.35	0.07	0.16	0.04	44.79	44.83
P-31	J-26	J-27	103	80	PVC	110	-1.09	0.22	1.28	0.13	44.83	44.96
P-E8	J-27	J-28	104	100	PVC	110	1.95	0.25	1.28	0.13	44.96	44.83
P-R7	J-27	J-39	70	80	PVC	110	-4.55	0.91	18.09	1.27	44.96	46.23
P-E9	J-28	J-29	402	100	PVC	110	1.36	0.17	0.66	0.26	44.83	44.56
P-34	J-30	Hospital	346	80	PVC	110	0.97	0.19	1.04	0.36	65.13	64.77
P-R2	J-30	J-33	178	150	PVC	110	7.83	0.44	2.31	0.41	65.13	64.72
P-R3a	J-33	J-34	274	100	PVC	110	3.15	0.40	3.09	0.85	64.72	63.87
P-39	J-33	J-36	68	80	PVC	110	1.27	0.25	1.70	0.12	64.72	64.60
P-R3b	J-33	J-34	274	100	PVC	110	3.15	0.40	3.09	0.85	64.72	63.87
P-R4	J-34	J-35	390	100	PVC	110	5.95	0.76	10.02	3.91	63.87	59.96
P-R5	J-35	School	334	80	PVC	110	5.69	1.13	27.36	9.14	59.96	50.82
P-44	J-37	J-41	400	80	PVC	110	0.44	0.09	0.24	0.10	64.27	64.17
P-40	J-37	J-36	300	80	PVC	110	-1.01	0.20	1.11	0.33	64.27	64.60
P-R6	School	J-39	230	80	PVC	110	4.80	0.95	19.97	4.59	50.82	46.23
P-TR2	Pump	WTP	350	200	PVC	110	26.76	0.85	5.54	1.94	71.76	69.82
P-TR1	Intake	Pump	950	200	PVC	110	26.76	0.85	5.54	5.26	35.00	29.74
P-57	J-43	J-46	345	50	PVC	110	-0.45	0.23	2.51	0.87	45.21	46.08
P-W7	J-45	J-8	205	100	PVC	110	5.05	0.64	7.39	1.52	44.60	43.08
P-W3	J-47	J-48	322	150	PVC	110	11.19	0.63	4.48	1.44	48.97	47.53
P-56	J-47	J-46	319	50	PVC	110	0.91	0.46	9.05	2.89	48.97	46.08
P-W4	J-48	J-5	302	150	PVC	110	10.66	0.60	4.09	1.24	47.53	46.29
P-63	J-49	J-50	58	80	PVC	110	0.32	0.06	0.13	0.01	45.06	45.06
~~P-65~~ E4	J-50	J-51	139	100	PVC	110	1.91	0.24	1.22	0.17	45.06	44.89
P-E3	J-50	J-22	224	100	PVC	110	-2.22	0.28	1.62	0.36	45.06	45.42
P-~~E4~~ 65	J-51	J-24	95	80	PVC	110	0.89	0.18	0.88	0.08	44.89	44.80
P-E5	J-51	J-52	210	100	PVC	110	0.32	0.04	0.05	0.01	44.89	44.88
P-E6	J-52	J-53	160	100	PVC	110	-0.35	0.04	0.05	0.01	44.88	44.89
P-E7	J-53	J-27	186	100	PVC	110	-1.05	0.13	0.40	0.07	44.89	44.96
P-M3	PRV	J-2	100	200	PVC	110	18.73	0.60	2.86	0.29	50.02	49.74





Reservoir Inlet
T-3
T-2
Reservoir Outlet
Mt Kiss Residents
PRV-9
PRV-4
PRV-10
PRV-7
Asarotua West
Kama Village
Fanlufa Village - 2
Fanlufa&Kami
Fimito Village

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Junction Report

Node	Hydraulic Grade (+m)	Elevation (+m)	Pressure Head (m)	Base Demand (l/s)	Peak Hour Demand (l/s)	Zone
J-1	1,676.11	1,649.00	27.11	0.15	0.27	North
J-2	1,675.11	1,645.00	30.11	0.15	0.27	North
J-3	1,674.51	1,640.00	34.51	0.15	0.27	North
J-4	1,674.04	1,637.00	37.04	0.15	0.27	North
J-5	1,673.25	1,655.00	18.25	0.15	0.27	North
J-B102b	1,672.61	1,636.00	36.61	0.14	0.23	North
J-B52	1,672.42	1,634.00	38.42	0.28	0.45	North
J-B51a	1,671.97	1,647.00	24.97	0.17	0.27	North
J-B50a	1,671.80	1,645.00	26.80	0.35	0.56	North
J-B51c	1,671.36	1,642.00	29.36	0.19	0.30	North
J-12	1,654.26	1,615.00	39.26	0.00	0.00	North
J-B117a	1,654.14	1,615.00	39.14	0.28	0.38	North
J-11	1,654.68	1,631.00	23.68	0.00	0.00	North
Reservoir Inlet	1,663.55	1,650.00	13.55	0.00	0.00	West
J-B50b	1,671.19	1,641.00	30.19	0.35	0.56	North
J-B50c	1,668.53	1,639.00	29.53	0.39	0.62	North
J-17	1,667.61	1,631.00	36.61	0.00	0.00	North
J-18	1,664.63	1,615.00	49.63	0.00	0.00	North
J-B102a	1,671.59	1,650.00	21.59	1.18	1.82	North
J-B50d	1,672.30	1,615.00	57.30	0.46	0.69	North
J-B51b	1,671.93	1,650.00	21.93	0.19	0.30	North
J-B76	1,654.14	1,610.00	44.14	0.56	0.86	North
J-B117b	1,654.08	1,605.00	49.08	0.33	0.47	North
J-B30b	1,654.05	1,605.00	49.05	0.37	0.59	North
J-B116	1,654.08	1,605.00	49.08	0.35	0.49	North
Reservoir Outlet	1,661.58	1,650.00	11.58	0.00	0.00	East
J-B83	1,656.90	1,615.00	41.90	0.55	0.70	East
J-B34	1,656.88	1,616.00	40.88	0.13	0.11	East
J-B1	1,657.49	1,624.00	33.49	0.29	0.46	East
J-B36b	1,653.80	1,640.00	13.80	0.65	0.97	East
J-B39a	1,654.03	1,625.00	29.03	0.80	1.28	East
Mt Kiss Residents	1,654.03	1,645.00	9.03	0.18	0.29	East
J-55	1,644.25	1,609.00	35.25	0.00	0.00	East
J-B36d	1,643.02	1,605.00	38.02	0.02	0.04	East
J-B36c	1,642.80	1,620.00	22.80	0.55	0.87	East
J-B91 & 92	1,635.94	1,580.00	55.94	0.54	0.86	East
J-B8	1,656.91	1,620.00	36.91	0.48	0.59	East
J-B82	1,656.85	1,614.40	42.45	0.24	0.35	East
J-B3a	1,656.82	1,609.00	47.82	0.30	0.30	East
J-63	1,642.39	1,605.00	37.39	0.00	0.00	East
J-B6	1,641.24	1,605.00	36.24	0.89	1.29	East
J-B7	1,640.61	1,600.00	40.61	1.08	1.72	East
J-66	1,638.56	1,600.00	38.56	0.00	0.00	East
J-B5a	1,638.54	1,600.00	38.54	0.37	0.36	East
J-B5b	1,632.43	1,602.00	30.43	0.37	0.36	East
J-B3b	1,634.88	1,604.10	30.78	0.30	0.30	East
J-B4	1,640.35	1,604.00	36.35	0.28	0.25	East
J-B3c	1,628.12	1,605.00	23.12	0.17	0.15	East
J-72	1,624.45	1,602.00	22.45	0.00	0.00	East
J-B33a	1,624.30	1,585.00	39.30	0.14	0.20	East
J-B33c	1,624.07	1,575.00	49.07	0.65	1.05	East
J-79	1,637.48	1,593.00	44.48	0.00	0.00	East
J-B78a	1,637.05	1,594.00	43.05	0.40	0.64	East
J-B78	1,636.77	1,592.00	44.77	0.44	0.71	East
J-B80	1,636.65	1,590.00	46.65	0.76	1.19	East

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Junction Report

Node	Hydraulic Grade (+m)	Elevation (+m)	Pressure Head (m)	Base Demand (l/s)	Peak Hour Demand (l/s)	Zone
J-B79	1,636.65	1,590.00	46.65	0.31	0.49	East
Segu Village	1,636.71	1,590.00	46.71	1.90	2.91	East
J-B106a	1,612.76	1,590.00	22.76	0.14	0.22	West
J-B106b	1,594.11	1,580.00	14.11	0.21	0.31	West
J-91	1,599.39	1,585.00	14.39	0.00	0.00	West
J-B84	1,592.85	1,578.00	14.85	0.27	0.43	West
J-B101	1,592.85	1,570.00	22.85	0.16	0.26	West
J-96	1,599.39	1,578.00	21.39	0.00	0.00	West
J-97	1,578.78	1,558.00	20.78	0.00	0.00	South East
Faniufa Village - 2	1,574.91	1,558.00	16.91	0.50	0.90	South East
J-B54b	1,575.28	1,553.00	22.28	0.24	0.38	South East
J-B54a	1,575.24	1,553.00	22.24	0.29	0.45	South East
J-B53a	1,575.23	1,550.00	25.23	0.53	0.72	South East
J-B53b	1,575.23	1,548.00	27.23	0.33	0.43	South East
J-B53c	1,575.23	1,548.00	27.23	0.20	0.32	South East
J-B124b	1,575.36	1,554.00	21.36	0.08	0.12	South East
J-B124a	1,575.35	1,561.00	14.35	0.27	0.33	South East
J-B55a	1,576.03	1,554.00	22.03	0.27	0.38	South East
J-B55b	1,575.93	1,550.00	25.93	0.28	0.39	South East
J-B104	1,575.92	1,548.00	27.92	0.39	0.53	South East
J-109	1,575.92	1,548.00	27.92	0.00	0.00	South East
J-110	1,575.92	1,545.00	30.92	0.00	0.00	South East
J-B105	1,576.32	1,554.00	22.32	0.55	0.78	South East
Faniufa&Kami	1,557.20	1,545.00	12.20	1.22	1.87	South East
J-113	1,629.53	1,600.00	29.53	0.00	0.00	West
J-114	1,625.01	1,597.00	28.01	0.00	0.00	West
J-B37b	1,624.57	1,595.00	29.57	0.58	0.88	West
J-B37a	1,624.45	1,598.00	26.45	0.60	0.91	West
J-B43	1,624.22	1,580.00	44.22	0.81	1.30	West
J-B40	1,624.42	1,585.00	39.42	0.65	1.04	West
J-B16a	1,619.13	1,591.00	28.13	0.26	0.42	West
J-120	1,614.15	1,587.00	27.15	0.00	0.00	West
J-B38b	1,611.95	1,585.00	26.95	0.12	0.19	West
J-B41b	1,607.47	1,577.00	30.47	0.12	0.20	West
J-B41a	1,607.44	1,575.00	32.44	0.36	0.57	West
J-B42a	1,605.40	1,577.00	28.40	0.15	0.24	West
J-B88a	1,602.35	1,574.00	28.35	0.60	0.88	West
J-B88b	1,600.85	1,571.00	29.85	0.60	0.88	West
J-B98a	1,598.43	1,570.00	28.43	0.42	0.68	West
J-B88c	1,597.96	1,570.00	27.96	0.69	1.04	West
J-B98b	1,597.71	1,570.00	27.71	0.47	0.75	West
J-B98c	1,597.41	1,571.00	26.41	0.48	0.76	West
J-B88d	1,597.30	1,572.00	25.30	0.69	1.04	West
Asarofua West	1,597.25	1,572.00	25.25	1.54	2.37	West
J-B42b	1,604.59	1,580.00	24.59	0.40	0.64	West
J-B99	1,604.56	1,580.00	24.56	0.11	0.17	West
J-B16b	1,618.70	1,591.00	27.70	0.59	0.94	West
J-B15a	1,618.49	1,596.00	22.49	0.80	1.28	West
J-B15b	1,618.31	1,587.00	31.31	0.80	1.28	West
J-B14b	1,629.26	1,587.00	42.26	0.34	0.42	West

Networks Calculation at Peak Hour (GOROKA, Year 2003)
Junction Report

Node	Hydraulic Grade (+m)	Elevation (+m)	Pressure Head (m)	Base Demand (l/s)	Peak Hour Demand (l/s)	Zone
J-B81	1,629.30	1,588.00	41.30	0.16	0.15	West
J-B18	1,610.66	1,585.00	25.66	6.40	9.26	West
J-B17a	1,607.50	1,585.00	22.50	0.11	0.17	West
J-B17b	1,606.42	1,586.00	20.42	0.20	0.28	West
J-B17c	1,606.55	1,587.00	19.55	0.12	0.18	West
J-B17d	1,606.93	1,589.00	17.93	0.13	0.20	West
J-B14a	1,629.22	1,588.00	41.22	0.51	0.67	West
J-B13	1,602.63	1,583.00	19.63	0.88	1.05	West
J-B25d	1,602.82	1,583.00	19.82	0.13	0.21	West
J-160	1,602.97	1,580.00	22.97	0.00	0.00	West
J-B26	1,604.39	1,579.00	25.39	0.41	0.66	West
J-B28a	1,604.33	1,573.00	31.33	0.27	0.43	West
J-B29a	1,604.27	1,570.00	34.27	0.21	0.34	West
J-B35a	1,604.22	1,568.00	36.22	0.27	0.43	West
J-B35b	1,604.22	1,570.00	34.22	0.20	0.32	West
J-B29b	1,604.28	1,573.00	31.28	0.20	0.32	West
J-B28b	1,604.34	1,574.00	30.34	0.21	0.34	West
J-B31c	1,604.45	1,583.00	21.45	0.20	0.32	West
J-171	1,604.58	1,583.00	21.58	0.00	0.00	West
J-B25c	1,604.91	1,583.00	21.91	0.08	0.12	West
J-B31a	1,604.30	1,575.00	29.30	0.20	0.32	West
J-B31b	1,604.37	1,589.00	15.37	0.20	0.32	West
J-B27	1,606.02	1,580.00	26.02	0.59	0.94	West
J-B38a	1,611.73	1,577.00	34.73	0.53	0.85	West
J-177	1,604.25	1,577.00	27.25	0.00	0.00	West
Kama Village	1,596.95	1,565.00	31.95	5.52	8.46	West
J-179	1,604.04	1,575.00	29.04	0.00	0.00	West
J-B32a	1,603.97	1,575.00	28.97	0.46	0.73	West
J-B32b	1,603.95	1,575.00	28.95	0.52	0.84	West
J-185	1,604.16	1,575.00	29.16	0.50	0.90	West
J-B25a	1,604.88	1,585.00	19.88	0.14	0.22	West
J-B25b	1,604.88	1,585.00	19.88	0.13	0.21	West
J-188	1,604.07	1,557.00	47.07	0.50	0.90	South West
J-B61c	1,583.20	1,560.00	23.20	0.80	1.28	South West
J-B61b	1,582.01	1,559.00	23.01	0.88	1.34	South West
J-B61a	1,581.89	1,559.00	22.89	0.90	1.43	South West
J-B22a	1,585.44	1,564.00	21.44	0.43	0.66	South West
J-B19 & 20	1,594.78	1,568.00	26.78	7.24	10.61	South West
J-B21a	1,589.32	1,568.00	21.32	0.69	1.00	South West
J-B23a	1,587.10	1,571.00	16.10	0.34	0.53	South West
J-B12c	1,586.56	1,572.00	14.56	0.50	0.66	South West
J-B12b	1,602.60	1,582.00	20.60	0.50	0.66	West
J-B12a	1,602.62	1,583.00	19.62	0.13	0.16	West
J-B21b	1,586.69	1,563.00	23.69	0.79	1.15	South West
J-B97	1,581.47	1,551.00	30.47	0.09	0.13	South West
Fimito Village	1,576.60	1,540.00	36.60	0.80	1.44	South West
J-B66b	1,582.18	1,551.00	31.18	0.29	0.43	South West
J-B67	1,582.17	1,551.00	31.17	0.13	0.21	South West
J-B66a	1,582.28	1,557.00	25.28	0.24	0.38	South West
J-B62a	1,582.39	1,559.00	23.39	0.26	0.37	South West

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Junction Report

Node	Hydraulic Grade (+m)	Elevation (+m)	Pressure Head (m)	Base Demand (l/s)	Peak Hour Demand (l/s)	Zone
J-B65	1,582.16	1,559.00	23.16	0.25	0.26	South West
J-B62b	1,580.79	1,556.00	24.79	0.29	0.43	South West
J-B22b	1,583.79	1,561.00	22.79	0.50	0.76	South West
J-B86b	1,579.69	1,552.00	27.69	1.05	1.69	South West
J-B64a	1,579.67	1,552.00	27.67	0.40	0.57	South West
J-B64b	1,579.65	1,550.00	29.65	0.27	0.43	South West
J-B86a	1,579.54	1,550.00	29.54	1.16	1.80	South West
J-B87 & 107	1,579.45	1,540.00	39.45	0.50	0.76	South West
J-168	1,648.30	1,605.00	43.30	0.00	0.00	North
J-B10c	1,645.60	1,615.00	30.60	0.63	0.97	North
J-B11b	1,645.64	1,615.00	30.64	0.60	0.96	North
J-B11a	1,640.35	1,613.00	27.35	0.62	1.00	North
J-B9-523&74&Asarouf	1,635.04	1,600.00	35.04	6.61	9.63	North
J-B9	1,639.11	1,617.00	22.11	1.56	2.39	North
J-B10b	1,644.24	1,620.00	24.24	0.60	0.93	North
J-B10a	1,644.06	1,625.00	19.06	0.50	0.80	North
Okiufa Village	1,642.80	1,625.00	17.80	2.86	4.38	North
J-B2	1,655.99	1,615.00	40.99	2.67	3.33	East
J-B33b	1,624.16	1,575.00	49.16	0.65	1.05	East
J-B23b	1,585.05	1,570.00	15.05	0.27	0.43	South West
J-B69 & 72	1,584.51	1,568.00	16.51	2.11	3.22	South West
J-B115	1,584.44	1,566.00	18.44	0.81	1.30	South West
J-B68	1,584.26	1,555.00	29.26	1.37	2.11	South West
J-B71b	1,571.62	1,550.00	21.62	0.41	0.41	South West
J-B117c	1,658.88	1,615.00	43.88	0.08	0.13	East
J-B9-521&522	1,661.60	1,660.00	1.60	5.53	7.77	North
WTP outlet	1,679.53	1,660.00	19.53	0.00	0.00	West
J-B96 & Komiufa	1,637.63	1,580.00	57.63	1.00	1.55	East
J-B89	1,636.87	1,580.00	56.87	1.62	2.60	East
J-B90 & 93	1,635.96	1,580.00	55.96	2.27	3.00	East
J-B94 & 95	1,636.36	1,580.00	56.36	0.37	0.59	East
J-B73	1,585.47	1,568.00	17.47	0.76	1.18	South East
J-B63	1,583.67	1,550.00	33.67	0.31	0.49	West
J-B70	1,583.41	1,550.00	33.41	1.94	2.98	West
J-B71a	1,582.86	1,550.00	32.86	0.35	0.36	West
J-B36a	1,653.89	1,625.00	28.89	0.40	0.64	East
J-237	1,672.26	1,636.00	36.26	0.00	0.00	West
J-238	1,658.90	1,615.00	43.90	0.00	0.00	East
J-239	1,657.63	1,624.00	33.63	0.00	0.00	West
J-240	1,580.65	1,540.00	40.65	0.00	0.00	West
J-241	1,664.81	1,631.00	33.81	0.00	0.00	West
J-B30a	1,654.17	1,610.00	44.17	0.39	0.61	West

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Pipe Report

Pipe	Start	End	Length (m)	Dia. (mm)	Material	C	Q (l/s)	V (m/s)	I (m/km)	Headloss (m)	Start Hydraulic Grade (m)	End Hydraulic Grade (m)
P-329	J-1	WTP outlet	392.28	200	PVC	110	-34.22	1.09	8.72	3.42	1676.11	1679.53
P-326	J-2	J-1	116.13	200	PVC	110	-33.95	1.08	8.60	1.00	1675.11	1676.11
P-325	J-3	J-2	71.32	200	PVC	110	-33.68	1.07	8.47	0.60	1674.51	1675.11
P-324	J-4	J-3	55.47	200	PVC	110	-33.41	1.06	8.34	0.46	1674.04	1674.51
P-5	J-5	J-B102b	79.25	200	PVC(new)	110	32.87	1.05	8.10	0.64	1673.25	1672.61
P-323	J-5	J-4	96.93	200	PVC	110	-33.14	1.05	8.22	0.80	1673.25	1674.04
P-6	J-B102b	J-B52	26.52	200	PVC(new)	110	30.82	0.98	7.18	0.19	1672.61	1672.42
P-258	J-B102b	J-B102a	304.8	80	PVC(new)	110	1.82	0.36	3.33	1.02	1672.61	1671.59
P-7	J-B52	J-B51a	66.14	200	PVC(new)	110	29.68	0.94	6.70	0.44	1672.42	1671.97
P-8	J-B51a	J-B50a	27.13	200	PVC(new)	110	29.10	0.93	6.46	0.18	1671.97	1671.80
P-257	J-B51a	J-B51b	350.52	80	PVC(new)	110	0.30	0.06	0.12	0.04	1671.97	1671.93
P-321	J-B50a	J-B51c	69.49	200	PVC	110	28.54	0.91	6.24	0.43	1671.80	1671.36
P-320	J-B51c	J-B50b	28.96	200	PVC	110	28.24	0.90	6.12	0.18	1671.36	1671.19
P-12	J-12	J-B117a	103.33	100	PVC(new)	110	1.93	0.25	1.24	0.13	1654.26	1654.14
P-43	J-B117a	J-B117b	61.87	100	PVC	110	1.54	0.20	0.83	0.05	1654.14	1654.08
P-11	J-11	J-12	117.96	100	PVC(new)	110	3.40	0.43	3.56	0.42	1654.68	1654.26
P-245	J-11	J-168	442.87	150	PVC(new)	110	21.06	1.19	14.43	6.39	1654.68	1648.30
P-372	J-11	PRV-11-Out	17.68	150	PVC	110	-24.46	1.38	19.03	0.34	1654.68	1655.02
P-22	Reservoir Inlet	T-2	58.52	280	DIP	110	85.06	1.38	9.13	0.53	1663.55	1663.02
P-319	J-B50c	J-B50b	111.25	150	PVC	110	-27.68	1.57	23.92	2.66	1668.53	1671.19
P-364	J-B50c	J-241	162.15	150	PVC	110	27.06	1.53	22.94	3.72	1668.53	1664.81
P-20	J-17	J-18	327.05	280	DIP	110	85.06	1.38	9.13	2.99	1667.61	1664.63
P-21	J-18	Reservoir Inlet	117.96	280	DIP	110	85.06	1.38	9.13	1.08	1664.63	1663.55
P-47	T-2	T-3	64.31	280	PVC(new)	110	113.01	1.84	15.45	0.99	1663.02	1662.02
P-48	T-3	Reservoir Outlet	30.78	300	PVC(new)	110	130.80	1.85	14.47	0.45	1662.02	1661.58
P-33	J-B50d	J-B52	211.84	80	PVC(new)	110	-0.69	0.14	0.56	0.12	1672.30	1672.42
P-366	J-B76	J-B30a	117.04	100	PVC	110	-0.86	0.11	0.28	0.03	1654.14	1654.17
P-44	J-B117b	J-B30b	221.59	100	PVC	110	0.59	0.07	0.14	0.03	1654.08	1654.05
P-46	J-B117b	J-B116	71.02	100	PVC	110	0.49	0.06	0.10	0.01	1654.08	1654.08
P-328	Reservoir Outlet	J-238	185.01	300	DIP	110	130.80	1.85	14.47	2.68	1661.58	1658.90
P-54	J-B83	J-B34	86.26	50	PVC(new)	110	0.11	0.06	0.18	0.02	1656.90	1656.88
P-67	J-B1	J-B8	94.18	100	PVC(new)	110	4.57	0.58	6.14	0.58	1657.49	1656.91
P-334	J-B1	J-B39a	372.77	200	PVC(new)	110	35.37	1.13	9.27	3.46	1657.49	1654.03
P-338	J-B1	J-239	11.89	200	PVC	110	-40.40	1.29	11.86	0.14	1657.49	1657.63
P-61	J-B39a	Mt Kiss Residents	85.04	100	PVC(new)	110	0.29	0.04	0.04	0.00	1654.03	1654.03
P-335	J-B39a	J-B36a	163.37	100	PVC	110	1.61	0.20	0.89	0.15	1654.03	1653.89
P-359	J-B39a	PRV-9-In	159.41	150	PVC(new)	110	32.19	1.82	31.62	5.04	1654.03	1648.99
P-63	J-55	J-B36d	51.82	100	PVC(new)	110	9.50	1.21	23.83	1.23	1644.25	1643.02
P-269	J-55	J-B2	117.96	100	PVC	110	0.00	0.00	0.00	0.00	1644.25	1655.99
P-71	J-55	J-63	112.47	150	PVC(new)	110	22.69	1.28	16.56	1.86	1644.25	1642.39
P-64	J-B36d	J-B36c	255.12	80	PVC	110	0.87	0.17	0.85	0.22	1643.02	1642.80
P-298	J-B36d	J-B96 & Komiufa	271.88	100	PVC(new)	110	8.59	1.09	19.79	5.38	1643.02	1637.63
P-68	J-B8	J-B82	112.47	80	PVC(new)	110	0.65	0.13	0.50	0.06	1656.91	1656.85
P-69	J-B82	J-B3a	265.48	80	PVC(new)	110	0.30	0.06	0.12	0.03	1656.85	1656.82
P-70	J-B3a	J-63	114.91	80	PVC(new)	110	0.00	0.00	0.00	0.00	1656.82	1642.39
P-74	J-63	J-B6	135.64	80	PVC(new)	110	3.01	0.60	8.43	1.14	1642.39	1641.24
P-81	J-63	J-B4	160.32	150	PVC(new)	110	19.68	1.11	12.72	2.04	1642.39	1640.35
P-75	J-B6	J-B7	213.06	80	PVC(new)	110	1.72	0.34	3.00	0.64	1641.24	1640.61
P-76	J-B7	J-66	136.25	80	PVC(new)	110	0.00	0.00	0.00	0.00	1640.61	1638.56
P-77	J-66	J-B5a	113.08	80	PVC(new)	110	0.36	0.07	0.17	0.02	1638.56	1638.54
P-371	J-66	J-79	168.86	100	PVC(new)	140	5.95	0.76	6.41	1.08	1638.56	1637.48
P-78	J-B5a	J-B5b	191.72	80	PVC(new)	110	0.00	0.00	0.00	0.00	1638.54	1632.43
P-79	J-B5b	J-B3b	59.13	100	PVC(new)	110	-12.81	1.63	41.43	2.45	1632.43	1634.88

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Pipe Report

Pipe	Start	End	Length (m)	Dia. (mm)	Material	C	Q (l/s)	V (m/s)	I (m/km)	Headloss (m)	Start Hydraulic Grade (m)	End Hydraulic Grade (m)
P-84	J-B5b	J-B3c	109.73	100	PVC(new)	110	12.45	1.58	39.28	4.31	1632.43	1628.12
P-80	J-B3b	J-B3a	148.44	80	PVC(new)	110	0.00	0.00	0.00	0.00	1634.88	1656.82
P-83	J-B3b	J-B4	126.49	100	PVC(new)	110	-13.12	1.67	43.27	5.47	1634.88	1640.35
P-82	J-B4	J-66	159.72	100	PVC(new)	110	6.31	0.80	11.17	1.78	1640.35	1638.56
P-374	J-B3c	J-72	95.4	100	PVC	110	12.30	1.57	38.43	3.67	1628.12	1624.45
P-375	J-72	J-B33a	86.87	100	PVC	110	2.30	0.29	1.73	0.15	1624.45	1624.30
P-376	J-72	J-B106a	446.53	100	PVC	110	10.00	1.27	26.19	11.69	1624.45	1612.76
P-271	J-B33a	J-B33b	96.93	100	PVC(new)	110	2.10	0.27	1.46	0.14	1624.30	1624.16
P-93	J-79	J-B78a	68.88	80	PVC(new)	110	2.56	0.51	6.24	0.43	1637.48	1637.05
P-98	J-79	Segu Village	219.46	100	PVC(new)	110	3.39	0.43	3.54	0.78	1637.48	1636.71
P-94	J-B78a	J-B78	76.5	80	PVC(new)	110	1.92	0.38	3.66	0.28	1637.05	1636.77
P-95	J-B78	J-B80	78.94	80	PVC(new)	110	1.21	0.24	1.56	0.12	1636.77	1636.65
P-96	J-B80	J-B79	82.91	80	PVC(new)	110	0.02	0.00	0.00	0.00	1636.65	1636.65
P-102	J-B79	Segu Village	204.22	80	PVC(new)	110	-0.48	0.09	0.28	0.06	1636.65	1636.71
P-104	J-B106a	J-B106b	175.56	20	PVC	110	0.31	0.98	106.18	18.64	1612.76	1594.11
P-361	J-B106a	PRV-10-In	224.03	100	PVC	110	9.47	1.21	23.69	5.31	1612.76	1607.45
P-106	J-91	J-B84	275.84	100	PVC	110	9.47	1.21	23.69	6.53	1599.39	1592.85
P-110	J-91	J-96	275.23	100	PVC	110	0.00	0.00	0.00	0.00	1599.39	1599.39
P-107	J-B84	J-B101	96.62	100	PVC	110	0.26	0.03	0.03	0.00	1592.85	1592.85
P-377	J-B84	J-B73	358.14	100	PVC	110	8.78	1.12	20.61	7.38	1592.85	1585.47
P-112	J-97	Faniufa Village - 2	434.64	50	PVC	110	0.90	0.46	8.90	3.87	1578.78	1574.91
P-125	J-97	J-B105	196.29	100	PVC	110	6.71	0.85	12.51	2.46	1578.78	1576.32
P-113	J-B54b	J-B54a	96.62	100	PVC	110	1.04	0.13	0.40	0.04	1575.28	1575.24
P-118	J-B54b	J-B124b	46.94	100	PVC	110	-2.30	0.29	1.73	0.08	1575.28	1575.36
P-114	J-B54a	J-B53a	130.45	100	PVC	110	0.59	0.08	0.14	0.02	1575.24	1575.23
P-115	J-B53a	J-B53b	150.88	100	PVC	110	-0.13	0.02	0.01	0.00	1575.23	1575.23
P-116	J-B53b	J-B53c	53.64	100	PVC	110	0.32	0.04	0.05	0.00	1575.23	1575.23
P-117	J-B53b	J-B54b	187.76	100	PVC	110	-0.88	0.11	0.29	0.06	1575.23	1575.28
P-119	J-B124b	J-B124a	304.5	100	PVC	110	0.33	0.04	0.05	0.01	1575.36	1575.35
P-120	J-B124b	J-B55a	274.62	100	PVC	110	-2.75	0.35	2.41	0.66	1575.36	1576.03
P-121	J-B55a	J-B55b	301.75	100	PVC	110	0.92	0.12	0.32	0.10	1576.03	1575.93
P-127	J-B55a	J-B105	59.44	100	PVC	110	-4.05	0.52	4.93	0.29	1576.03	1576.32
P-122	J-B55b	J-B104	103.94	100	PVC	110	0.53	0.07	0.11	0.01	1575.93	1575.92
P-123	J-B104	J-109	51.21	100	PVC	110	0.00	0.00	0.00	0.00	1575.92	1575.92
P-124	J-B104	J-110	212.45	50	PVC	110	0.00	0.00	0.00	0.00	1575.92	1575.92
P-126	J-B105	Faniufa&Kami	553.82	50	PVC	110	1.87	0.95	34.52	19.12	1576.32	1557.20
P-129	J-113	J-114	89.92	200	PVC(new)	110	88.22	2.81	50.30	4.52	1629.53	1625.01
P-130	J-114	J-B37b	86.26	100	PVC(new)	110	4.14	0.53	5.12	0.44	1625.01	1624.57
P-134	J-114	J-B16a	127.71	200	PVC(new)	110	84.09	2.68	46.02	5.88	1625.01	1619.13
P-131	J-B37b	J-B37a	75.29	100	PVC(new)	110	2.21	0.28	1.60	0.12	1624.57	1624.45
P-133	J-B37b	J-B40	363.63	100	PVC	110	1.04	0.13	0.40	0.15	1624.57	1624.42
P-132	J-B37a	J-B43	381.61	100	PVC	110	1.30	0.17	0.60	0.23	1624.45	1624.22
P-135	J-B16a	J-120	118.26	200	PVC(new)	110	80.17	2.55	42.14	4.98	1619.13	1614.15
P-157	J-B16a	J-B16b	115.82	100	PVC	110	3.50	0.45	3.75	0.43	1619.13	1618.70
P-136	J-120	J-B38b	149.66	150	PVC(new)	110	21.28	1.20	14.71	2.20	1614.15	1611.95
P-164	J-120	J-B18	146.61	200	PVC(new)	110	58.89	1.87	23.81	3.49	1614.15	1610.66
P-137	J-B38b	J-B41b	164.59	100	PVC(new)	110	10.21	1.30	27.23	4.48	1611.95	1607.47
P-202	J-B38b	J-B38a	265.79	80	PVC(new)	110	0.85	0.17	0.81	0.22	1611.95	1611.73
P-203	J-B38b	J-177	292.3	100	PVC	110	10.03	1.28	26.33	7.70	1611.95	1604.25
P-138	J-B41b	J-B41a	205.13	100	PVC	110	0.57	0.07	0.13	0.03	1607.47	1607.44
P-139	J-B41b	J-B42a	87.48	100	PVC(new)	110	9.44	1.20	23.57	2.06	1607.47	1605.40
P-140	J-B42a	J-B88a	161.24	100	PVC(new)	110	8.39	1.07	18.94	3.05	1605.40	1602.35
P-153	J-B42a	J-B42b	109.73	50	PVC	110	0.81	0.41	7.39	0.81	1605.40	1604.59
P-141	J-B88a	J-B88b	97.54	100	PVC	110	7.51	0.96	15.43	1.50	1602.35	1600.85
P-142	J-B88b	J-B98a	197.51	100	PVC	110	6.63	0.84	12.25	2.42	1600.85	1598.43
P-143	J-B98a	J-B88c	46.33	100	PVC	110	5.96	0.76	10.05	0.47	1598.43	1597.96
P-144	J-B88c	J-B98b	35.36	100	PVC	110	4.92	0.63	7.05	0.25	1597.96	1597.71

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Pipe Report

Pipe	Start	End	Length (m)	Dia. (mm)	Material	C	Q (l/s)	V (m/s)	I (m/km)	Headloss (m)	Start Hydraulic Grade (m)	End Hydraulic Grade (m)
P-145	J-B98b	J-B98c	57	100	PVC	110	4.17	0.53	5.19	0.30	1597.71	1597.41
P-146	J-B98c	J-B88d	32.92	100	PVC	110	3.41	0.43	3.58	0.12	1597.41	1597.30
P-147	J-B88d	Asarofua West	25.91	100	PVC	110	2.37	0.30	1.83	0.05	1597.30	1597.25
P-248	J-B42b	J-B99	77.72	50	PVC	110	0.17	0.09	0.43	0.03	1604.59	1604.56
P-158	J-B16b	J-B15a	100.89	100	PVC	110	2.56	0.33	2.11	0.21	1618.70	1618.49
P-159	J-B15a	J-B15b	303.58	100	PVC	110	1.28	0.16	0.58	0.18	1618.49	1618.31
P-160	J-B15b	J-B14b	32.61	100	PVC(new)	110	0.00	0.00	0.00	0.00	1618.31	1629.26
P-168	J-B15b	J-B17c	109.73	100	PVC(new)	110	0.00	0.00	0.00	0.00	1618.31	1606.55
P-161	J-B14b	J-B81	103.02	100	PVC(new)	110	-1.09	0.14	0.43	0.04	1629.26	1629.30
P-174	J-B14b	J-B14a	175.26	100	PVC(new)	110	0.67	0.09	0.18	0.03	1629.26	1629.22
P-162	J-B81	J-113	425.5	100	PVC(new)	110	-1.24	0.16	0.55	0.23	1629.30	1629.53
P-165	J-B18	J-B17a	182.27	200	PVC(new)	110	49.63	1.58	17.35	3.16	1610.66	1607.50
P-166	J-B17a	J-B17b	89.61	200	PVC(new)	110	40.64	1.29	11.99	1.07	1607.50	1606.42
P-212	J-B17b	J-B25c	117.65	200	PVC(new)	110	42.25	1.34	12.88	1.52	1606.42	1604.91
P-345	J-B17b	J-B17c	106.98	100	PVC	110	-1.90	0.24	1.21	0.13	1606.42	1606.55
P-169	J-B17c	J-B17d	88.09	80	PVC(new)	110	-2.08	0.41	4.26	0.38	1606.55	1606.93
P-171	J-B17d	J-B17a	112.47	80	PVC(new)	110	-2.28	0.45	5.06	0.57	1606.93	1607.50
P-315	Clean Water Reservoir	WTP outlet	27.43	280	PVC	110	119.28	1.94	17.07	0.47	1680.00	1679.53
P-260	J-B14a	J-B13	177.7	100	PVC(new)	110	0.00	0.00	0.00	0.00	1629.22	1602.63
P-179	J-B25d	J-160	102.72	100	PVC(new)	110	-2.08	0.26	1.43	0.15	1602.82	1602.97
P-235	J-B25d	J-B13	166.73	100	PVC	110	1.87	0.24	1.18	0.20	1602.82	1602.63
P-180	J-160	J-B26	111.56	100	PVC	110	0.00	0.00	0.00	0.00	1602.97	1604.39
P-197	J-B26	J-171	157.28	100	PVC(new)	110	-1.89	0.24	1.20	0.19	1604.39	1604.58
P-369	J-B26	J-B28a	119.18	100	PVC	110	1.23	0.16	0.55	0.07	1604.39	1604.33
P-183	J-B28a	J-B29a	101.19	100	PVC	110	1.22	0.16	0.53	0.05	1604.33	1604.27
P-184	J-B29a	J-B35a	99.97	100	PVC(new)	110	1.22	0.16	0.54	0.05	1604.27	1604.22
P-185	J-B35a	J-B35b	157.28	100	PVC(new)	110	-0.11	0.01	0.01	0.00	1604.22	1604.22
P-216	J-B35a	J-188	506.27	100	PVC	110	0.90	0.11	0.30	0.15	1604.22	1604.07
P-186	J-B35b	J-B29b	96.62	100	PVC	110	-1.33	0.17	0.63	0.06	1604.22	1604.28
P-211	J-B35b	J-185	201.17	100	PVC	110	0.90	0.11	0.30	0.06	1604.22	1604.16
P-195	J-B29b	J-B29a	155.45	100	PVC(new)	110	0.34	0.04	0.05	0.01	1604.28	1604.27
P-200	J-B29b	J-B31a	98.15	100	PVC	110	-0.77	0.10	0.23	0.02	1604.28	1604.30
P-201	J-B29b	J-B28b	107.29	100	PVC	110	-1.22	0.16	0.53	0.06	1604.28	1604.34
P-189	J-B28b	J-B31c	83.82	100	PVC	110	-1.97	0.25	1.30	0.11	1604.34	1604.45
P-196	J-B28b	J-B28a	154.84	100	PVC(new)	110	0.41	0.05	0.07	0.01	1604.34	1604.33
P-190	J-B31c	J-171	32.31	100	PVC	110	-3.70	0.47	4.17	0.13	1604.45	1604.58
P-191	J-171	J-B25c	113.69	80	PVC(new)	110	0.00	0.00	0.00	0.00	1604.58	1604.91
P-198	J-171	J-B27	160.32	100	PVC(new)	110	-5.59	0.71	8.94	1.43	1604.58	1606.02
P-213	J-B25c	J-160	153.92	200	PVC(new)	110	41.70	1.33	12.57	1.94	1604.91	1602.97
P-214	J-B25c	J-B25a	107.29	80	PVC(new)	110	0.43	0.09	0.23	0.03	1604.91	1604.88
P-193	J-B31a	J-B31b	160.32	100	PVC	110	-1.09	0.14	0.44	0.07	1604.30	1604.37
P-194	J-B31b	J-B31c	105.16	100	PVC	110	-1.41	0.18	0.70	0.07	1604.37	1604.45
P-199	J-B27	J-B17a	124.05	100	PVC(new)	110	-6.54	0.83	11.93	1.48	1606.02	1607.50
P-204	J-177	Kama Village	380.09	100	PVC	110	8.46	1.08	19.21	7.30	1604.25	1596.95
P-205	J-177	J-179	246.58	100	PVC	110	1.57	0.20	0.85	0.21	1604.25	1604.04
P-206	J-179	J-B32a	79.55	100	PVC	110	1.57	0.20	0.85	0.07	1604.04	1603.97
P-207	J-B32a	J-B32b	94.79	100	PVC	110	0.84	0.11	0.27	0.03	1603.97	1603.95
P-215	J-B25a	J-B25b	58.52	80	PVC(new)	110	0.21	0.04	0.06	0.00	1604.88	1604.88
P-219	J-B61c	J-B61b	71.63	80	PVC(new)	110	4.34	0.86	16.56	1.19	1583.20	1582.01
P-239	J-B61c	J-B22a	248.41	100	PVC(new)	110	-5.62	0.72	9.01	2.24	1583.20	1585.44
P-220	J-B61b	J-B61a	57	80	PVC(new)	110	1.43	0.28	2.12	0.12	1582.01	1581.89
P-234	J-B61b	J-B97	216.71	80	PVC(new)	110	1.57	0.31	2.51	0.55	1582.01	1581.47
P-232	J-B22a	J-B21b	102.41	100	PVC(new)	110	0.00	0.00	0.00	0.00	1585.44	1586.69
P-246	J-B22a	J-B22b	92.96	100	PVC(new)	110	8.09	1.03	17.71	1.65	1585.44	1583.79
P-226	J-B19 & 20	J-B21a	103.02	100	PVC	110	14.64	1.86	53.01	5.46	1594.78	1589.32

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Pipe Report

Pipe	Start	End	Length (m)	Dia. (mm)	Material	C	Q (l/s)	V (m/s)	I (m/km)	Headloss (m)	Start Hydraulic Grade (m)	End Hydraulic Grade (m)
P-355	J-B19 & 20	PRV-7-Out	21.03	200	PVC	110	-39.62	1.26	11.44	0.24	1594.78	1595.02
P-368	J-B19 & 20	J-B22a	182.27	100	PVC(new)	110	14.37	1.83	51.26	9.34	1594.78	1585.44
P-227	J-B21a	J-B23a	201.17	100	PVC	110	6.27	0.80	11.04	2.22	1589.32	1587.10
P-228	J-B23a	J-B12c	57.91	100	PVC	110	5.74	0.73	9.38	0.54	1587.10	1586.56
P-274	J-B12c	J-B23b	201.47	100	PVC	110	5.08	0.65	7.48	1.51	1586.56	1585.05
P-229	J-B12c	J-B12b	270.36	100	PVC	110	0.00	0.00	0.00	0.00	1586.56	1602.60
P-230	J-B12b	J-B12a	109.42	100	PVC	110	-0.66	0.08	0.17	0.02	1602.60	1602.62
P-231	J-B12a	J-B13	18.29	100	PVC	110	-0.82	0.10	0.26	0.00	1602.62	1602.63
P-233	J-B21b	J-B21a	176.78	100	PVC(new)	110	-7.37	0.94	14.91	2.64	1586.69	1589.32
P-237	J-B97	J-B66b	110.95	80	PVC(new)	110	0.00	0.00	0.00	0.00	1581.47	1582.18
P-349	J-B97	J-240	379.48	80	PVC(new)	110	1.44	0.29	2.15	0.82	1581.47	1580.65
P-238	J-B66b	J-B67	141.12	80	PVC(new)	110	0.21	0.04	0.06	0.01	1582.18	1582.17
P-241	J-B66b	J-B66a	201.47	80	PVC(new)	110	-0.64	0.13	0.47	0.10	1582.18	1582.28
P-242	J-B66a	J-B62a	96.62	80	PVC(new)	110	-1.02	0.20	1.14	0.11	1582.28	1582.39
P-243	J-B62a	J-B65	22.56	100	PVC(new)	110	5.94	0.76	10.00	0.23	1582.39	1582.16
P-244	J-B65	J-B62b	149.35	100	PVC(new)	110	5.68	0.72	9.19	1.37	1582.16	1580.79
P-251	J-B62b	J-B86b	137.46	100	PVC(new)	110	5.25	0.67	7.96	1.09	1580.79	1579.69
P-247	J-B22b	J-B62a	95.4	100	PVC(new)	110	7.33	0.93	14.75	1.41	1583.79	1582.39
P-252	J-B86b	J-B64a	67.67	100	PVC(new)	110	1.00	0.13	0.37	0.03	1579.69	1579.67
P-254	J-B86b	J-B86a	74.98	100	PVC	110	2.56	0.33	2.11	0.16	1579.69	1579.54
P-253	J-B64a	J-B64b	225.86	100	PVC	110	0.43	0.05	0.08	0.02	1579.67	1579.65
P-256	J-B86a	J-B87 & 107	391.36	100	PVC	110	0.76	0.10	0.22	0.09	1579.54	1579.45
P-268	J-168	J-B11b	186.54	150	PVC(new)	110	20.92	1.18	14.24	2.66	1648.30	1645.64
P-255	J-B10c	J-B11b	164.59	100	PVC(new)	110	-0.83	0.11	0.26	0.04	1645.60	1645.64
P-261	J-B10c	J-168	309.98	25	PVC	110	-0.14	0.29	8.71	2.70	1645.60	1648.30
P-262	J-B11b	J-B11a	123.75	100	PVC	110	13.02	1.66	42.70	5.28	1645.64	1640.35
P-265	J-B11b	J-B10b	132.89	100	PVC(new)	110	6.11	0.78	10.52	1.40	1645.64	1644.24
P-263	J-B11a	J-B9-523&74&A saroufa North	217.32	100	PVC	110	9.63	1.23	24.44	5.31	1640.35	1635.04
P-264	J-B11a	J-B9	224.94	80	PVC(new)	110	2.39	0.48	5.52	1.24	1640.35	1639.11
P-266	J-B10b	J-B10a	245.06	80	PVC(new)	110	0.80	0.16	0.72	0.18	1644.24	1644.06
P-267	J-B10b	Okiufa Village	252.68	100	PVC(new)	110	4.38	0.56	5.69	1.44	1644.24	1642.80
P-270	J-B2	J-B8	269.14	100	PVC(new)	110	-3.33	0.42	3.42	0.92	1655.99	1656.91
P-272	J-B33b	J-B33c	211.53	100	PVC	110	1.05	0.13	0.41	0.09	1624.16	1624.07
P-275	J-B23b	J-B69 & 72	85.34	100	PVC	110	4.65	0.59	6.35	0.54	1585.05	1584.51
P-276	J-B69 & 72	J-B115	89.31	100	PVC	110	1.43	0.18	0.71	0.06	1584.51	1584.44
P-277	J-B115	J-B21b	205.74	100	PVC(new)	110	-6.22	0.79	10.89	2.24	1584.44	1586.69
P-278	J-B115	J-B68	71.02	100	PVC	110	2.88	0.37	2.62	0.19	1584.44	1584.26
P-308	J-B115	J-B63	210.31	100	PVC	110	3.47	0.44	3.70	0.78	1584.44	1583.67
P-311	J-B68	J-B71a	211.23	50	lvanized i	110	0.77	0.39	6.61	1.40	1584.26	1582.86
P-292	J-B9-521&522	Goroka University	60.05	100	PVC	110	-7.77	0.99	16.43	0.99	1661.60	1662.59
P-316	WTP outlet	J-237	796.14	280	DIP	110	85.06	1.38	9.13	7.27	1679.53	1672.26
P-300	J-B96 & Komiufa	J-B89	55.78	100	PVC	110	7.05	0.90	13.71	0.76	1637.63	1636.87
P-304	J-B89	J-B94 & 95	86.26	100	PVC	110	4.45	0.57	5.86	0.51	1636.87	1636.36
P-303	J-B90 & 93	J-B91 & 92	87.48	100	PVC	110	0.86	0.11	0.28	0.02	1635.96	1635.94
P-305	J-B94 & 95	J-B90 & 93	89.31	100	PVC	110	3.86	0.49	4.50	0.40	1636.36	1635.96
P-307	J-B73	J-97	423.98	100	PVC	110	7.61	0.97	15.80	6.70	1585.47	1578.78

Networks Calculation at Peak Hour (GOROKA, Year 2003)

Pipe Report

Pipe	Start	End	Length (m)	Dia. (mm)	Material	C	Q (l/s)	V (m/s)	I (m/km)	Headloss (m)	Start Hydraulic Grade (m)	End Hydraulic Grade (m)
P-309	J-B63	J-B70	90.83	100	PVC	110	2.98	0.38	2.79	0.25	1583.67	1583.41
P-312	J-B71a	J-B71b	186.54	25	alvanized i	110	0.41	0.83	60.25	11.24	1582.86	1571.62
P-314	J-B36a	J-B36b	247.19	100	PVC	110	0.97	0.12	0.35	0.09	1653.89	1653.80
P-317	J-237	J-17	508.71	280	DIP	110	85.06	1.38	9.13	4.65	1672.26	1667.61
P-331	J-238	J-B117c	72.54	50	PVC	110	0.13	0.07	0.24	0.02	1658.90	1658.88
P-336	J-238	J-239	89	300	DIP	110	129.86	1.84	14.28	1.27	1658.90	1657.63
P-370	J-238	J-B83	274.62	50	PVC	110	0.81	0.41	7.29	2.00	1658.90	1656.90
P-346	J-239	PRV-4-In	797.97	250	DIP	110	89.46	1.82	17.41	13.89	1657.63	1643.74
P-347	PRV-4-Out	J-113	28.35	250	DIP	110	89.46	1.82	17.41	0.49	1630.03	1629.53
P-350	J-240	Fimito Village	190.8	50	PVC	110	1.44	0.73	21.24	4.05	1580.65	1576.60
P-356	PRV-7-In	J-160	588.26	200	PVC	110	-39.62	1.26	11.44	6.73	1596.24	1602.97
P-360	PRV-9-Out	J-55	24.69	150	PVC(new)	110	32.19	1.82	31.62	0.78	1645.03	1644.25
P-362	PRV-10-Out	J-91	27.43	100	PVC	110	9.47	1.21	23.69	0.65	1600.04	1599.39
P-365	J-241	Goroka University	1023.21	100	PVC	110	2.60	0.33	2.17	2.22	1664.81	1662.59
P-367	J-B30a	J-12	121.62	100	PVC	110	-1.47	0.19	0.76	0.09	1654.17	1654.26
P-373	PRV-11-In	J-241	24.38	150	PVC	110	-24.46	1.38	19.03	0.46	1664.34	1664.81

添付資料１３　費用対便益分析

費用対便益分析

計測期間　　50 年

費用

C-1 建設費
C-2 維持管理費の増分

便益

B-1 給水量増大による収入増
B-2 漏水量減少による便益
B-3 取水量減少による河川への負荷軽減、処理水量減量による薬品費の減額

便益算定の条件

S-1 現行の施設で対象地域の水需要を満たす。但し、現状のコスト、漏水率など各施設の能力は低下することはない。
S-2 コスト、漏水率など計画目標値が達成できる。

S-1、S-2を比較し費用、便益を夫々各々算定する。

費用対便益比（CBR : Cost Benefit Ratio）

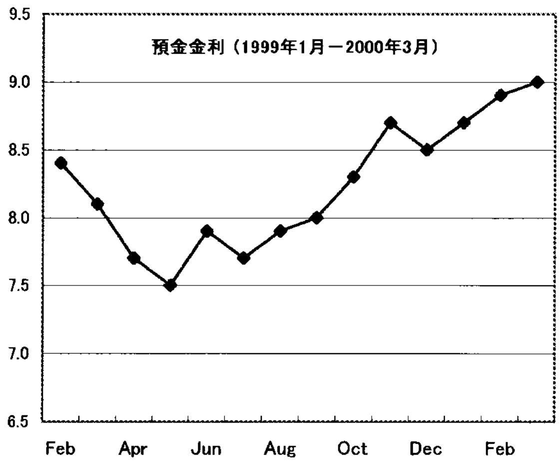
$$CBR = \frac{\Sigma（現在価値化総便益）}{\Sigma（現在価値化総費用）}$$

$$= \frac{\Sigma\{（年度別便益）／（1+r)^j\}}{\{（年度別建設費＋年度別維持管理費－残存価値）／（1+r)^j\}}$$

r：割引率、 j：年度

割引率　　8.2 %　　1999年2月～2000年3月までの平均預金金利を採用する。

	預金金利
Feb	8.4
Mar	8.1
Apr	7.7
May	7.5
Jun	7.9
Jul	7.7
Aug	7.9
Sep	8.0
Oct	8.3
Nov	8.7
Dec	8.5
Jan-2000	8.7
Feb	8.9
Mar	9.0
平均	8.2



Source: Quaterly Economic Bulletin, Bank of Papua New Guinea, March 2000

費用

C-1 建設費

為替レート:PGK 1=JPY 41.14

	JPY	PGK	建設費
Lorengau	224,770,000	5,463,539	5,463,539
Goroka	402,631,000	9,786,850	9,786,850

注)耐用年数 40年

C-2 維持管理費

2003年

	維持管理費
Lorengau	98,522
Goroka	258,481

総費用

50年間

	建設費	維持管理費	残存価値	総費用
Lorengau	5,697,091	1,276,655	26,549	6,947,197
Goroka	10,205,212	3,349,417	47,558	13,507,071

便益

B-1 給水量増加

有収率75%として水道料金収入の増分を計測する。

	従来 [K]	実施後 [K]	便益 [K]
Lorengau	0	339,950	339,950
Goroka	600,000	1,081,345	481,345

B-2 配水管路更新事業

配水管路を更新しない場合(S-1)と更新する場合(S-2)の漏水量を比較して便益を計測する。

	年間配水量	漏水率 [%]		漏水量 [m3]		減量
	[m3]	S-1	S-2	S-1	S-2	[m3]
Lorengau	558,085	59.8	25.0	333,735	139,521	194,214
Goroka	2,826,925	46.4	25.0	1,311,693	706,731	604,962

配水管路更新事業実施による便益

	減量	水道料金 注	無収水減量	生産コスト	無効水減量	便益
	[m3]	[K/m3]	[m3]	K/[m3]	[m3]	[K]
Lorengau	194,214	0.81	157,313	0.55	107,652	264,965
Goroka	604,962	0.51	308,531	0.31	189,099	497,630

注1: ゴロカ市水道収支実績より
Popondeta支所収支実績より

B-3 取水量の減少(Goroka)

取水量が減少することによる薬品費の節約、河川への負荷軽減(汚水を放流可能な水質まで処理するコスト)による便益

取水量の減少分	薬品費減少	処理コスト 注	便益
[m3]	[K]	[K]	[K]
1,523,510	151,789	685,580	837,369

注2: ゴロカ市下水支出実績より
1m3=K 0.45

総便益

50年間

	B-1	B-2	B-3		総便益
Lorengau	4,405,100	3,433,440	0		7,838,539
Goroka	6,237,312	6,448,325	10,850,694		23,536,331

CBR
1.13
1.74

総費用

	Lorengau			Goroka		
経過年数	建設費	維持管理費	残存価値	建設費	維持管理費	残存価値
0	5,463,539	98,522		9,786,850	258,481	
1		91,055			238,892	
2		84,155			220,787	
3		77,777			204,055	
4		71,883			188,590	
5		66,435			174,298	
6		61,400			161,089	
7		56,747			148,880	
8		52,446			137,597	
9		48,472			127,170	
10		44,798			117,532	
11		41,403			108,625	
12		38,265			100,393	
13		35,365			92,784	
14		32,685			85,753	
15		30,208			79,254	
16		27,919			73,247	
17		25,803			67,696	
18		23,847			62,566	
19		22,040			57,824	
20		20,370			53,442	
21		18,826			49,392	
22		17,399			45,649	
23		16,081			42,189	
24		14,862			38,992	
25		13,736			36,037	
26		12,695			33,306	
27		11,733			30,782	
28		10,843			28,449	
29		10,022			26,293	
30		9,262			24,300	
31		8,560			22,459	
32		7,912			20,757	
33		7,312			19,184	
34		6,758			17,730	
35		6,246			16,386	
36		5,772			15,144	
37		5,335			13,997	
38		4,931			12,936	
39		4,557			11,955	
40	233,552	4,212		418,362	11,049	
41		3,892			10,212	
42		3,597			9,438	
43		3,325			8,723	
44		3,073			8,062	
45		2,840			7,451	
46		2,625			6,886	
47		2,426			6,364	
48		2,242			5,882	
49		2,072			5,436	
50		1,915	26,549		5,024	47,558
合計	5,697,091	1,276,655	26,549	10,205,212	3,349,417	47,558

総便益

	Lorengau			Goroka		
経過年数	収入増	漏水増減		収入増	漏水増減	取水
0	339,950	264,965		481,345	497,630	837,369
1	314,187	244,885		444,866	459,916	773,908
2	290,376	226,326		411,152	425,061	715,257
3	268,370	209,174		379,992	392,848	661,051
4	248,031	193,321		351,195	363,076	610,953
5	229,234	178,670		324,579	335,560	564,652
6	211,861	165,130		299,981	310,129	521,859
7	195,805	152,615		277,246	286,626	482,310
8	180,966	141,049		256,235	264,904	445,758
9	167,251	130,360		236,816	244,828	411,976
10	154,576	120,480		218,869	226,273	380,754
11	142,861	111,350		202,282	209,125	351,898
12	132,035	102,911		186,952	193,277	325,229
13	122,028	95,112		172,784	178,629	300,582
14	112,780	87,904		159,689	165,091	277,802
15	104,233	81,242		147,587	152,580	256,748
16	96,334	75,085		136,402	141,017	237,291
17	89,033	69,395		126,065	130,330	219,307
18	82,286	64,135		116,511	120,452	202,687
19	76,050	59,275		107,681	111,324	187,326
20	70,286	54,783		99,520	102,887	173,130
21	64,959	50,631		91,978	95,090	160,009
22	60,036	46,794		85,007	87,883	147,883
23	55,487	43,248		78,565	81,223	136,675
24	51,282	39,970		72,611	75,068	126,317
25	47,395	36,941		67,108	69,378	116,744
26	43,803	34,141		62,022	64,121	107,897
27	40,484	31,554		57,322	59,261	99,720
28	37,416	29,163		52,978	54,770	92,162
29	34,580	26,952		48,963	50,619	85,178
30	31,959	24,910		45,252	46,783	78,723
31	29,537	23,022		41,823	43,238	72,756
32	27,299	21,277		38,653	39,961	67,243
33	25,230	19,665		35,724	36,932	62,147
34	23,318	18,174		33,016	34,133	57,437
35	21,551	16,797		30,514	31,547	53,084
36	19,917	15,524		28,202	29,156	49,061
37	18,408	14,348		26,064	26,946	45,343
38	17,013	13,260		24,089	24,904	41,906
39	15,724	12,255		22,264	23,017	38,731
40	14,532	11,327		20,576	21,272	35,795
41	13,431	10,468		19,017	19,660	33,083
42	12,413	9,675		17,576	18,170	30,575
43	11,472	8,942		16,244	16,793	28,258
44	10,603	8,264		15,013	15,521	26,117
45	9,799	7,638		13,875	14,344	24,137
46	9,057	7,059		12,823	13,257	22,308
47	8,370	6,524		11,852	12,253	20,617
48	7,736	6,029		10,953	11,324	19,055
49	7,150	5,573		10,123	10,466	17,611
50	6,608	5,150		9,356	9,673	16,276
合計	4,405,100	3,433,440	0	6,237,312	6,448,325	10,850,694

参考 維持管理費の増分

	現状			計画		
	給水人口	配水量 m3/d	漏水率 %	給水人口	配水量 m3/d	漏水率 %
Goroka	33,460	12,500	46.4	35,822	7,745	25.0
Lorengau	4,055	518	59.8	4,341	1,529	25.0

適用水道料金

Goroka	1m3=K 0.51	注1
Lorengau (一般家庭用)	1m3=K 0.61	注2
(営業用)	1m3=K 1.31	

＊ Lorengauの営業用水率は給水量の41%

注1：ゴロカ市収支実績(1999年)より
注2：Popondeta支所収支実績(1999年)。
家庭用　：0.61キナ/m3
公共/営業用水：1.31キナ/m3

物価上昇率

賃金	4.1
インフレ	8.05

Lorengau

歳入	現状(1999)	案件実施後	上昇率		2003年	%
水道料金	Nil		−		339,950	100
その他	Nil					0
合計					339,950	100
歳出	現状(1999)	案件実施後 1999年価格	上昇率	現状 2003年価格	案件実施後 2003年価格	%
[1]人件費	16,800	75,521	4.1	19,729	88,689	28.7
[2]補修費	21,700	15,000	8.1	29,577	20,445	6.6
[3]電力費	40,000	24,683	8.1	54,520	33,643	10.9
[4]燃料費	3,000	3,000	8.1	4,089	4,089	1.3
[5]事務所消耗品費	500	500	8.1	682	682	0.2
[6]薬品費	Nil	43,706	8.1		59,571	19.3
[7]減価償却費	Nil	75,000	8.1		② 102,226	33.0
合計	82,000	237,410		③108,598	① 309,345	100.0

損益	30,605

[1]人件費　PNG水道公社の料金体系を提案組織に適用し算出した。

適用	単価[K/年]	職員数	人件費	備考
GRADE 7	13,080	1	13,080	所長
GRADE 5	8,292	3	24,876	部長
GRADE 3	7,513	5	37,565	作業員
			75,521	

[2]補修費　機材の更新費も含む。建設費の20%として算出。

[3]電力費　導水ポンプ場の電力費。1644m3/dをポンプ(22kWh、吐出量 1.46m3/min)で送水する。
Lorengau電気代　0.1489 K/kWh
ポンプ場運転時間＝1,644[m3/d]÷1.46[m3/min]÷60[min/hour]＝　18.8 [時間/日]
他の電力費を10%見込んで
年間電力費　24,683 K/年

[6]薬品費　既存浄水場の運転実績より　43,706 K/年

[7]減価償却費　建設費　3,000,000 K
耐用年数　40 年
減価償却費　75,000 K/年

維持管理費増分(減価償却費は除く)

①-②-③=　98,522

歳入	現状(1999)	案件実施後	上昇率		2003年	%
水道料金	600,000		−		1,081,345	100
その他	1,000					0
合計	601,000				1,081,345	100
歳出	現状(1999)	案件実施後 1999年価格	上昇率	現状 2003年価格	2003年	%
[1]人件費	75,628	75,628	4.1	88,815	88,815	10.1
[2]補修費	22,500	50,000	8.1	30,668	68,151	7.7
[3]電力費	8,500	8,500	8.1	11,586	11,586	1.3
[4]車両燃料、保険他	2,500	2,500	8.1	3,408	3,408	0.4
[5]薬品費	60,000	222,140	8.1	81,781	302,779	34.3
[6]借地代(水源)	50,000	50,000	8.1	68,151	68,151	7.7
[7]減価償却費	Nil	250,000	8.1		② 340,753	38.6
合計	219,128	658,768		③ 284,407	① 883,640	100.0

損益	197,705

[1]人件費　ゴロカ市支出実績より

[2]補修費　機材の更新費も含む。建設費の20%として算出。

[3]電力費　ゴロカ市支出実績より

[4]車両燃料、保険他　ゴロカ市支出実績より

[5]薬品費　現地薬品単価、設計注入率より

	単価[K/kg]	注入量(kg/d)	
さらし粉	2.0	15.4	8,707
硫酸バンド	3.5	200	197,885
ソーダ灰	1.0	55	15,548
	計		222,140

[6]借地代(水源)　ゴロカ市支出実績より

[7]減価償却費

事業費	10,000,000	K
耐用年数	40	年
減価償却費	250,000	K/年

維持管理費増分(減価償却費は除く)

①-②-③=　258,481

添付資料１４　参考資料リスト

調査名　パプア・ニューギニア国地方都市給水計画

番号	名称	形態 図書ﾋﾞﾃﾞｵ 地図　写真等	発行機関	発行年
1	ローレンガウ市センサス	データ	マヌス州	2000 年
2	マヌス州学校給水状況	データ	マヌス州	2000 年
3	ローレンガウ市組織図	データ	マヌス州	2000 年
4	ゴロカ市組織図	データ	ゴロカ市	2000 年
5	ゴロカ市予算書	データ	ゴロカ市	2000 年
6	ゴロカ市条例	冊子	ゴロカ市	1987 年
7	マヌス州予算書	データ	マヌス州	2000 年
8	マヌス州腸チフス罹患率	データ	マヌス州	2000 年
9	マヌス州下痢罹患率	データ	マヌス州	2000 年
10	PNG Water Board 予算書	データ	PNG Water Board	2000 年
11	The economy of Papua New Guinea	報告書	AusAID	1999 年
12	Economic & development policies	報告書	Ministry of treasury and corporate affairs	1998 年
13	Quarterly economic bulletin, march 2000 issue	冊子	Bank of Papua New Guinea	2000 年
14	Medium term development strategy 1997-2002	報告書	DNPM	1997 年
15	Public Investment Program, volume 1	報告書	DNPM	1999 年
16	Public Investment Program, volume 3	報告書	DNPM	1995 年
17	Public Investment Program, supplementary budget – development	報告書	DNPM	1999 年
18	National Health Plan 2001 – 2010, Health vision 2010	冊子	Ministry of health	2000 年
19	Design manual	報告書	PNG Water Board	
20	Goroka town sewage plan, Scale = 1:4,000	図面	ゴロカ市	1999 年
21	Goroka town water reticulation plan, Scale = 1:4,000	図面	ゴロカ市	1999 年
22	浄水場予定地測量図	図面	ゴロカ市	2000 年