

4.2 J-2

Microfauna Analysis:

Depth: (23-132) m

Lithology: Chalky limestone and chert

Fauna: *Truncorotaloides rohri*
Acarinina pentacamerata
Nummulites spp
Morozovella aragoensis
Acarinina bullbrooki

Age: Middle Eocene

Formation: Mokattam or Samalut Formation

Depth: (142-242) m

Lithology: Hard white limestone, chalky limestone and chert

Fauna: *Alveolina sp*
Acarinina soldadoensis
Acarinina pentacamerata
Morozovella subbotina
Morozovella formosa formosa
Morozovella aragoensis

Age: Lower Eocene

Formation: Thebes or Egma Formation

Depth: (252-271) m

Lithology: Chalky limestone and some shale

Fauna: *Morozovella velasconesis*
Morozovella angulata
Morozovella subbotina
Plarotaloites pseudomenardii
Acarinina mckanni
Acarinina soldadoensis

Age: Late Paleocene

Formation: Esna Formation

Depth: (271-293) m

Lithology: Clay to shale

Fauna: *Morozovella pseudobulloides*

Morozovella trinidadensis
Globigerina triloculinoides
Globigerina fringa
Age: Early Paleocene
Formation: Esta Formation

Depth: (305-453) m

Lithology: Chalky limestone and some chert, clay

Fauna: *Bolovinooides draco draco*
Globotruncana aegyptiaca
Globotruncana arca
Ganssarina gansseri
Bolivina incrassata
Globotruncanita suturarti formis

Age: Maastrichtian (Early-Middle-Late)

Formation: Sudr Chalk

Depth: (453-556) m

Lithology: clay, calcareous claystone, phosphatic band (dark brown)

Fauna: *Globotruncanita falsosutuarti*
Globotruncanita calcarata
Globorotaloides conicus
Globotruncana arca

Age: Campanian (Early-Middle-Late)

Formation: Duwi Formation

Depth: (560-619) m

Lithology: White, chalky limestone and sandy limestone

Fauna: *Dicarinella concavata*
Discarbis turonicus
Discarinella asymmetrica

Age: Conacian-Santonian

Formation: Matulla Formation

Depth: (626-779) m

Lithology: White limestone, oolitic limestone, dolomitic limestone and

sandy limestone
Fauna: *Discarbis turonicus*
Ostracoda spp
Discarbis minute
Heterohelix reussi
Whetinema archo cretacea
Marginotruncana sigari
Marginotruncana marginata
Nozzatinella aegyptiaca
Age: Turonian (Early-Middle-Late)
Formation: Wata Formation and Abu Qa'ada Formation

Depth: (779-823) m

Lithology: Shale or clay (Dark brown)

Fauna: *Hedbergella derlioensis*
Ostracoda spp
Cytherella sp
Heterohelix reussi

Age: Latest Cenomanian to Earliest Turonian

Formation Abu Qa'ada Formation

4.3 J-3

Microfaunal Analysis:

Depth: (2-80) m

Lithology: Chalky limestone, chert and clay in the base

Fauna: *Globotruncana aegyptiaca*
Globotruncana fornicata
Bolivinooides draco draco
Globotruncanita stuartiformis
Globotruncana arca

Age: Maastrichtian (Early-Middle-Late)

Formation Sudr Formation

Depth: (80-234) m

Lithology: Dark brown calcareous claystone and phosphatic beds

Fauna: *Globorotaloides conicus*
Globotruncana arca
Globotruncanita falsosutuarti
Globotruncana fornicata

Age: Campanian (Early-Middle-Late)

Formation: Duwi Formation

Depth: (241-300) m

Lithology: Chalky limestone, sandy limestone, chert and white sandy marly limestone.

Fauna: *Dicarinella concavata*
Discorbis turonicus
Heterohelix globulosa
Marginotruncana sp
Ostracoda sp

Age: Conacian-Santonian

Formation: Matulla Formation

Depth: (303-470) m

Lithology: Oolitic limestone, clay in the base, marly limestone and sandy limestone, some glauconite occurrence in these samples.

Fauna: *Discorbis turonicus*

Ostracoda spp
Marginotruncana sp
Age: Turonian (Early-Middle-Late)
Formation: Wata Formation (Late Turonian)-Abu Qa'ada Formation
(Early Turonian)

Depth: (490-771) m

Lithology: Oolitic limestone, dolomitic limestone, sandy shale, shally sand, sandstone (calcareous) pyrite, gluconite, and some sand

Fauna: *Heterohelix spp*
Hedbergella sp
Ostracoda sp
Cytherella spp
Thomosinella aegyptiaca
Nazzazata aegyptiaca
Flabellamina aegyptiaca
Arenaceous formis
Daxia cenomana

Age: Cenomanian (Early-Middle- Late)
Formation: Raha Formation

Depth: (781-800) m

Lithology: Sandstone, well sorted, well round, well mature.

Fauna: Unfossiliferous

Age: May be Early Cretaceous (Albian)

Formation: Malha Formation

4.4 J-4



Microfaunal Analysis:

Depth: (0-88) m
Lithology: Chalky limestone, chert and white limestone
Fauna: Globigerina linaperta
Globigerina cocena
Morozovella formosa
Morozovella aragaensis
Acarinina soldadoensis
Acarinina bullbrooki
Age: Eocene
Formation: Egma Formation

Depth: (88-118) m
Lithology: Chalk & marly limestone
Fauna: Morozovella velascoensis
Morozovella acuta
Morozovella Pseudobulloides
Morozovella rex
Planorotalites pseudomenardii
Age: Paleocene
Formation: Esna Formation

Depth: (118-278) m
Lithology: Chalk, chert and white limestone
Fauna: Heterohelix striata
Bolivinoies draco
Bolivina incrassata
Rosita fornicata
Rugoglobigerina rugosa
Globotruncana aegyptiaca
Ganssarina gansseria
Age: Maastrichtian
Formation: Sudr Formation

Depth: (278-388) m
Lithology: Calcareous claystone, phosphatic limestone, and chert

Fauna: Globotruncana arca
 Globotruncana elevata
 Globotruncana ventricosa
 Globotruncana bulloides
 Globorotalites conicus
Age: Campanian
Formation: Duwi Formation

Depth: (388-448) m
Lithology: White chalk, argillaceous limestone, and glauconite
Fauna: Whiteinella baltica
 Dicarinella concavata
 Marginotruncana coronata
 Rosita fornicata
 Discorbis bakerensis
Age: Coniacian-Santonian
Formation: Matulla Formation

Depth: (448-628) m
Lithology: white limestone, dolomitic limestone
Fauna: Discorbis minuta
 Discorbis turonicus
 Nazzazatinella sp
 Hedbergella simplex
 Marginotruncana sigali
 Heterohelix reussi
Age: (middle-Late) Turonian
Formation: Wata Formation

Depth: (628-678) m
Lithology: Calcareous shale, greyish limestone, and marly limestone
Fauna: Whiteinella archaeocrecea
 Heterohelix moremani
 Hedbergella delrioensis
 Ostracoda spp
 Nazzazatinella aegyptica
 Heterohelix reussi

Age: Earliest Turonian to latest Cenomanian
Formation: Abu Qa'ada Formation

Depth: (678-838) m
Lithology: Dolomitic limestone, oolitic limestone, sandy limestone and gluconit
Fauna: Thomasinella aegyptica
 Cibicides beadnelli
 Gumbelitria cenomani
 Ammobaculites sp
 Thomasinella fragmentaria
 Hedbergella delriaensis
 Nazzazata simplex
 Oster sp and Ostracoda spp

Age: (Early-Middle-Late) Cenomanian.
Formation: Raha or Galala Formation

Depth: (838-1108) m
Lithology: Sandstone, sand some clay and paleosoil
Fauna: Flabellamina sp
 Ammobaculites sp
 Ostracoda sp
 Hedbergella sp

Age: Early Cretaceous
Formation: Malha Formation

Depth: (1108-1130) m
Lithology: Black shale (coal) and gravelly sand
Fauna: Fossile plant, and arenaceous fauna
Age: Jurassic
Formation: Amir Formation

4.5 J-5

Microfaunal Analysis:

Depth:	(0-168) m
Lithology:	White limestone, dolomitic limestone
Fauna:	Discorbis minuta Discorbis turonicus Nazzazatinella sp Hedbergella simplex Marginotruncana sigali Heterohelix reussi
Age:	(middle-Late) Turonian
Formation:	Wata Formation
Depth:	(168-220) m
Lithology:	Calcareous shale, greyish limestone, and marly limestone
Fauna:	Whiteinella archaeocretacea Heterohelix moremani Hedbergella delrioensis Ostracoda spp Nazzazatinella aegyptica Heterohelix reussi
Age:	Earliest Turonian to latest Cenomanian
Formation:	Abu Qa'ada Formation
Depth:	(220-310) m
Lithology:	Dolomitic limestone, oolitic limestone, sandy limestone, and gluconit
Fauna:	Thomasinella aegyptica Cibicides beadnelli Gumbelitria cenomani Ammobaculites sp Thomasinella fragmentaria Hedbergella delriaensis Nazzazata simplex Oster sp and Ostracoda spp
Age:	(Early-Middle- Late) Cenomanian.
Formation:	Raha or Galala Formation

Depth: (310 -- 498) m
Lithology: Sandstone, sand, some clay and palcosoil
Fauna: Flabellamina sp
Ammobaculites sp
Ostracoda sp
Hedbgella sp
Age: Early Cretaceous
Formation: Malha Formation

Depth: (498-504) m
Lithology: Dolomitic limestone
Fauna: Spiriferes sp
Crinoides stem
Products sp
Alge & Ostracoda
Age: Palezoic
Formation: Um Bogma or Abu Thora Formation

4.6 J-6



Micro-faunal Analysis:

Depth: (0-2)
Lithology: Marly limestone
Fauna: Morozovella velasocoensis
Morozovella subbotina
Morozovella angulata
Morozovella pseudobulloides
Acarinina soldadoensis
Age: (Late-Middle) Paleocene

Depth: (2-90) m
Lithology: Chalky limestone and chert
Fauna: Hedbergella delrioensis
Heterohelix globulosa
Heterohelix striata
Gyroidina girardana
Buliminella carseyae
Pseudoguembelina excolata
Rugoglobigerina rugosa
Globotruncana aegyptiaca
Globotruncanita stuarti
Globotruncanita arca
Ganssarina gansseri
Bolivina incrassata
Globotruncana esnahensis
Globotruncana linneiana
Globorotalites conicus
Age: Maastrichtian to Late Campanian
Formation: Sudr Formation

Depth: (98-130) m
Lithology: Yellowish to white sandstone
Fauna: Barren
Age: May be Coniacian – Santonian
Formation: Tarif Member

Depth: (138-488) m
Lithology: Dolomitic limestone, marly limestone, shelly limestone
Fauna: *Discorbis turonicus*
Discorbis minuta
Cythereis rawashensis
Brachycythereis angulata
Hedbergella simplex
Whiteinella baltica
Whiteinella archaeocretacea
Heterohelix reussi
Marginotruncana sigali
Marginotruncana pseudolinnciana
Nazzazatinella aegyptica
Cytherella parallela
Veenicythereis jezzienensis
Gumelitria cenomani
Thomasinella sp
Rotalipora brotzen
Globigerinelloides bentoensis
Age: Turonian to Cenomanian
Formation: Galala-Wata Formation

Depth: (488-810) m
Lithology: Sandstone with some shale and limestone
Fauna: *Arenaceous formis*
Ammobaculites sp
Ostracoda ssp
Age: Early Cretaceous
Formation: Malha Formation

Depth: (810-900) m
Lithology: Limy clay and sandstone
Fauna: *Astaculus sp*
Ammobaculites sp
Age: May be Jurassic
Formation: Amir Formation

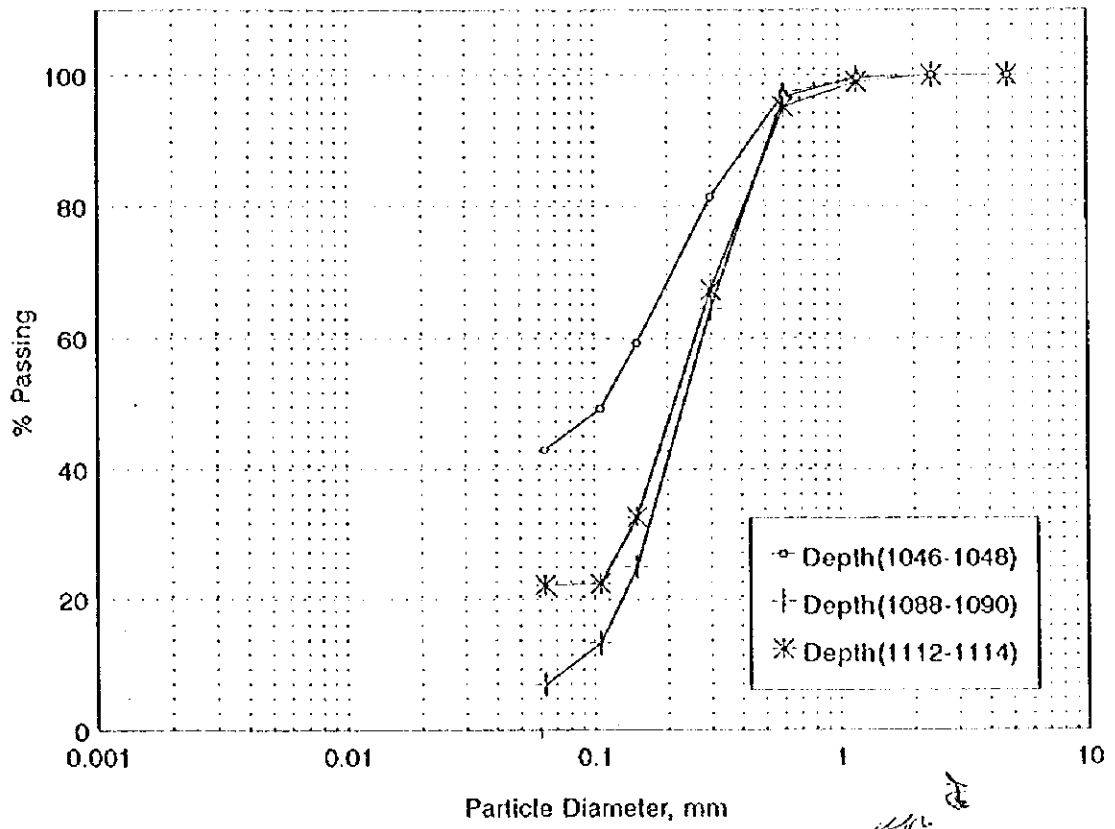
Part-5 GRAIN SIZE ANALYSIS

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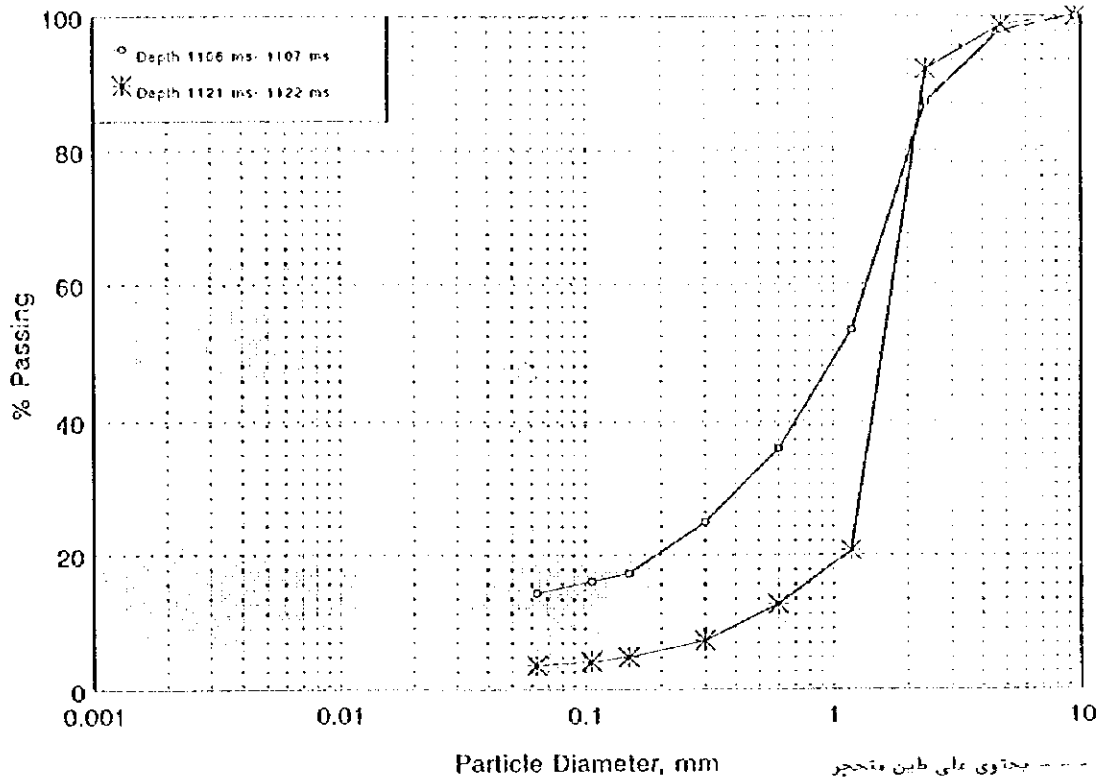
5.1 J-1

Grain Size Distribution for Samples (J-1)

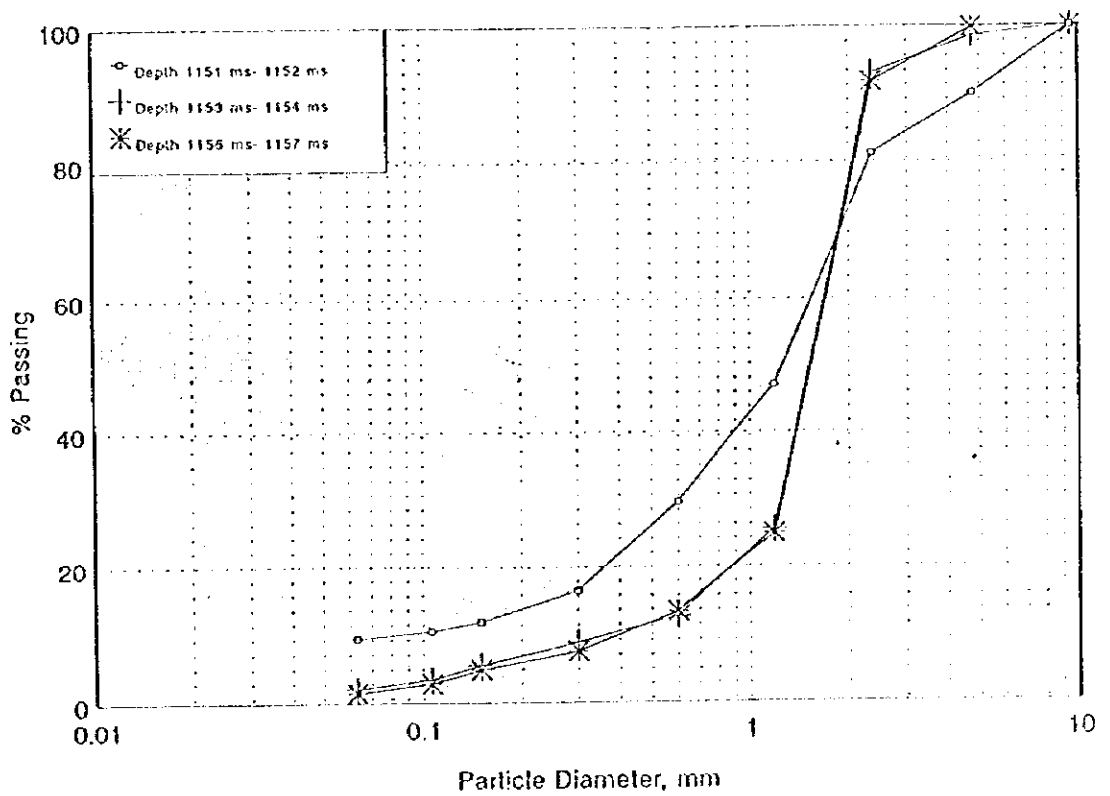


5.2 J-2

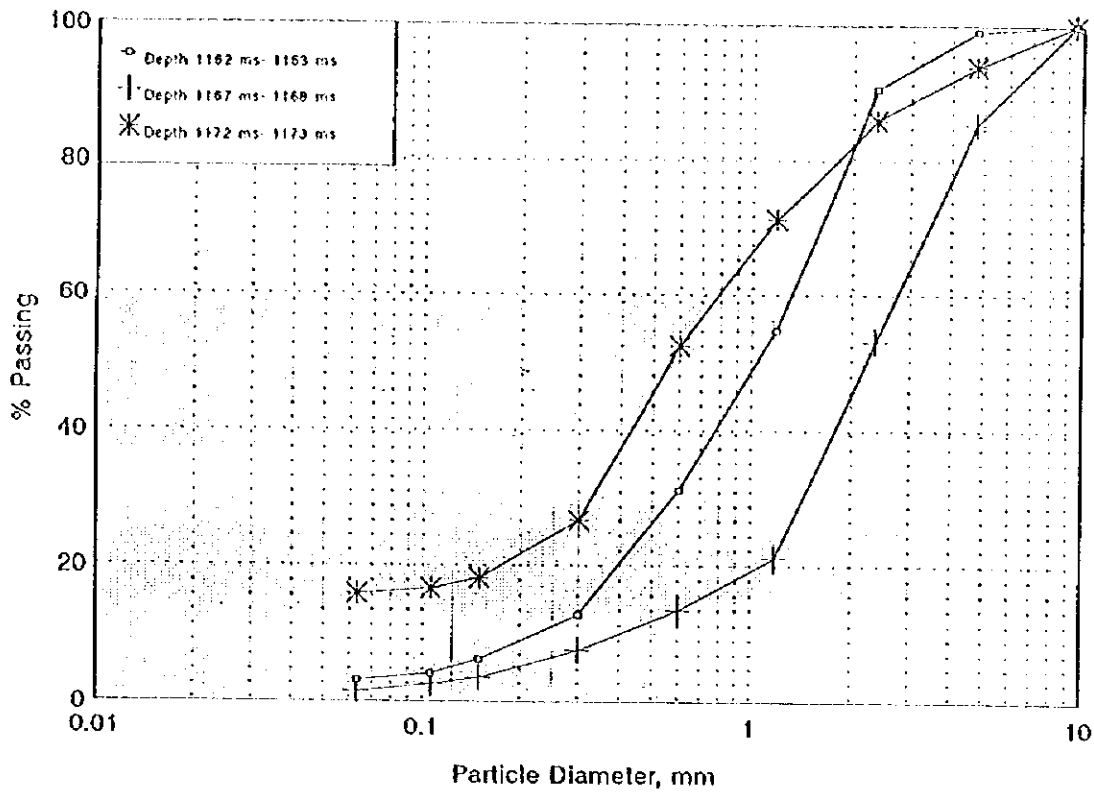
Grain Size Distribution Well J2



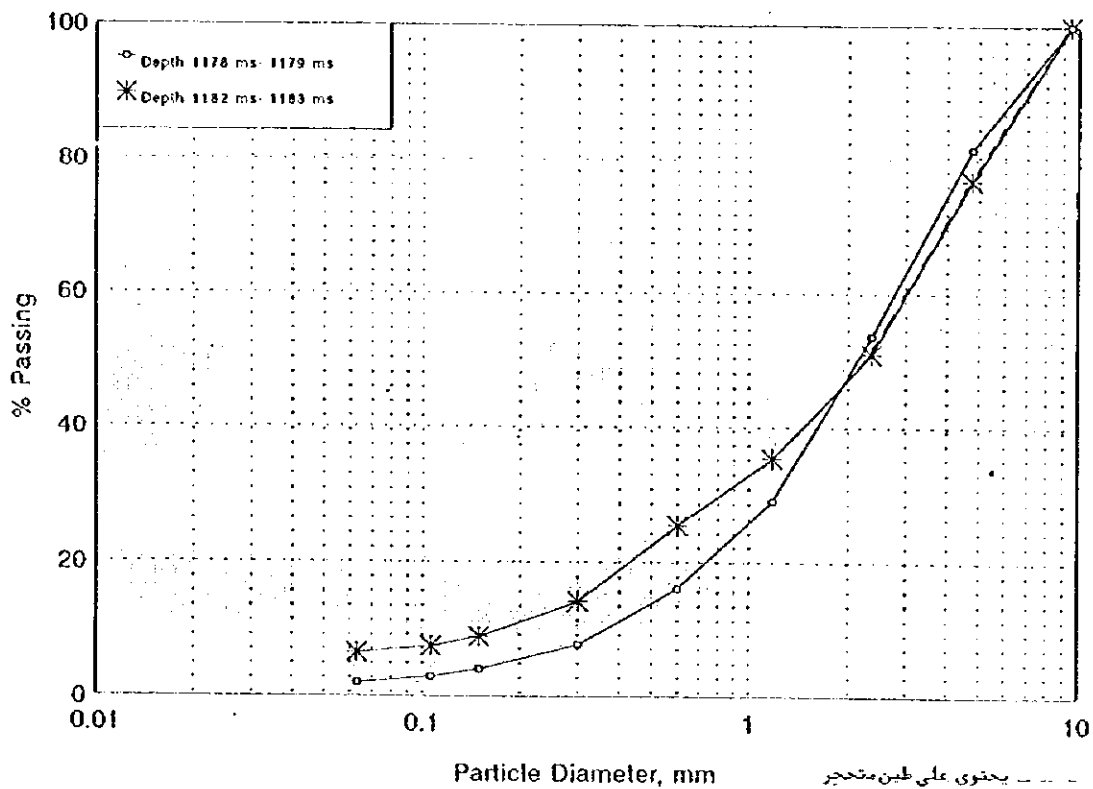
Grain Size Distribution Well J2



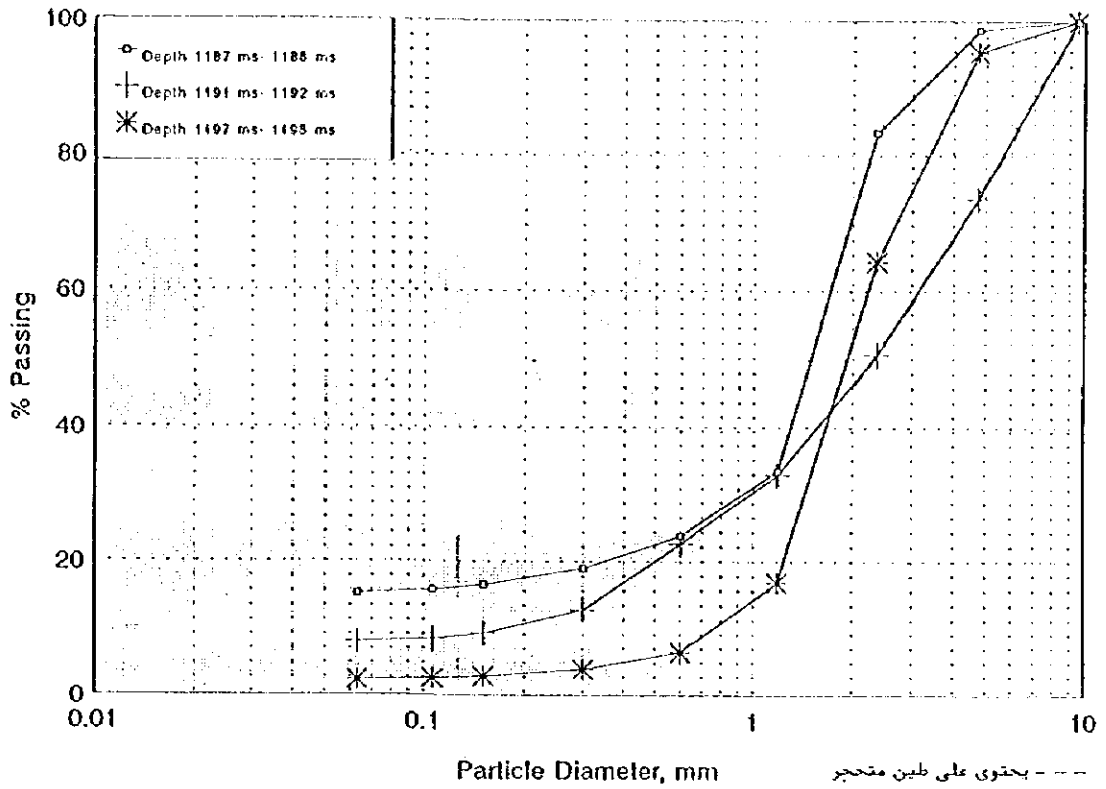
Grain Size Distribution Well J2



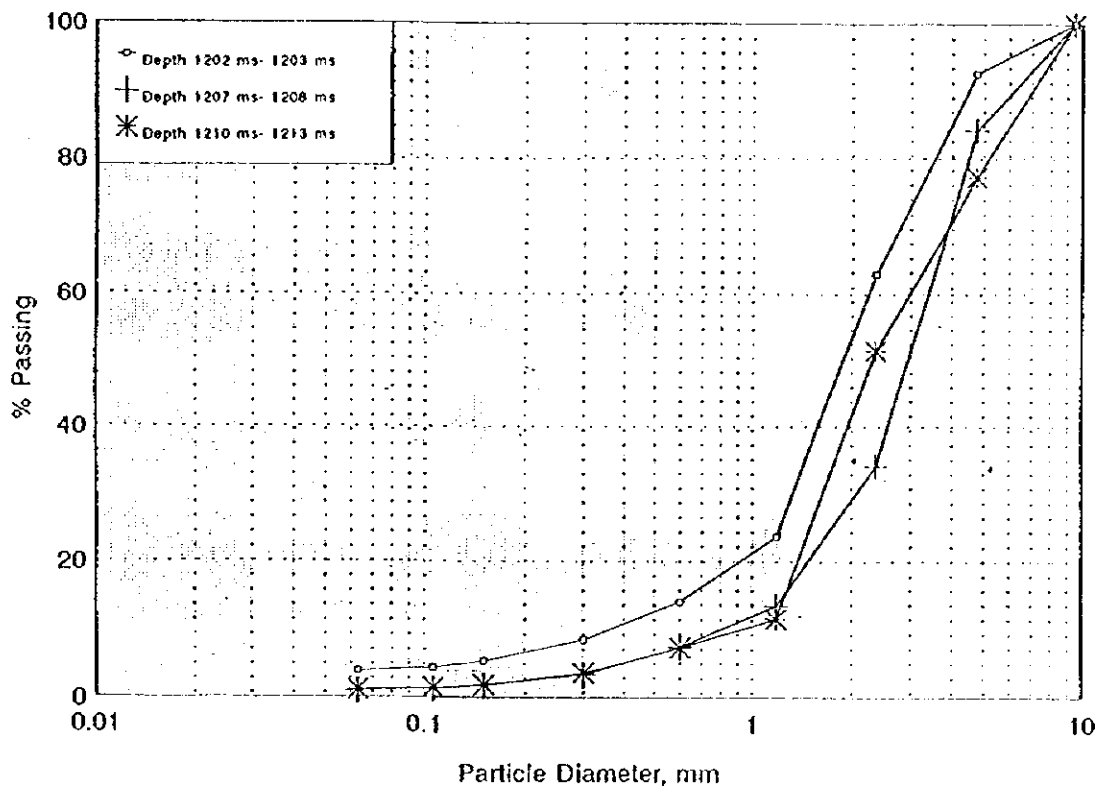
Grain Size Distribution Well J2



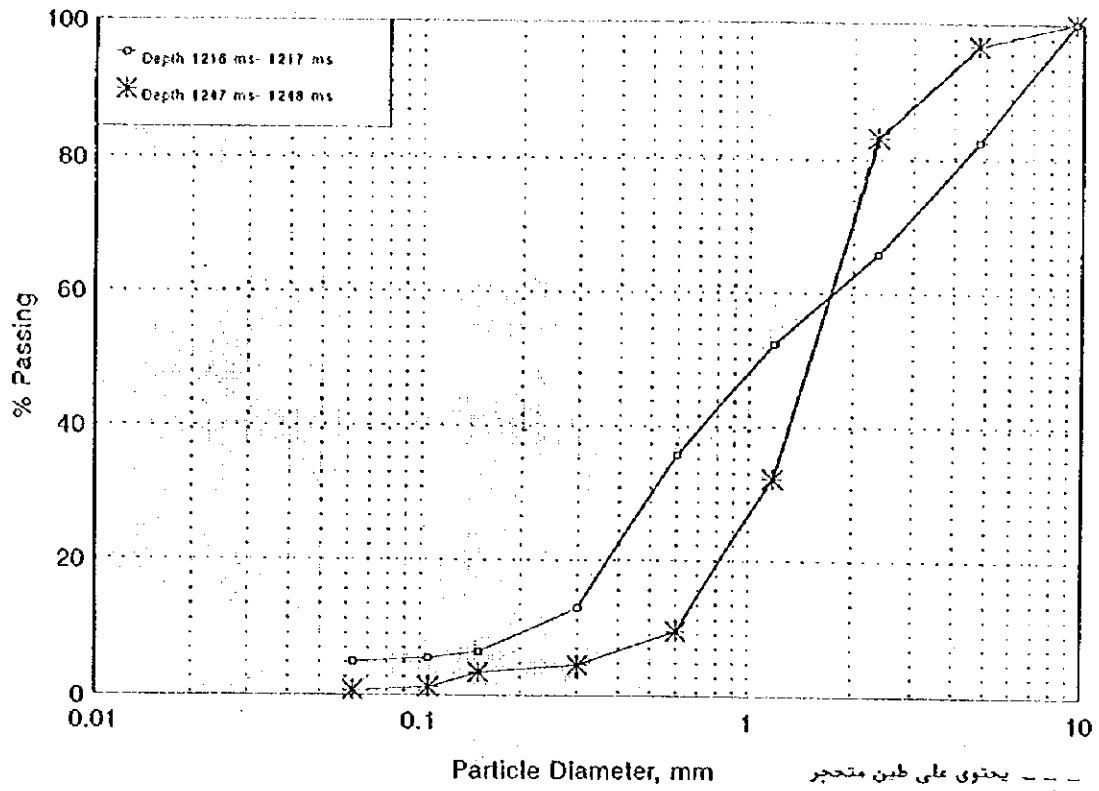
Grain Size Distribution Well J2



Grain Size Distribution Well J2



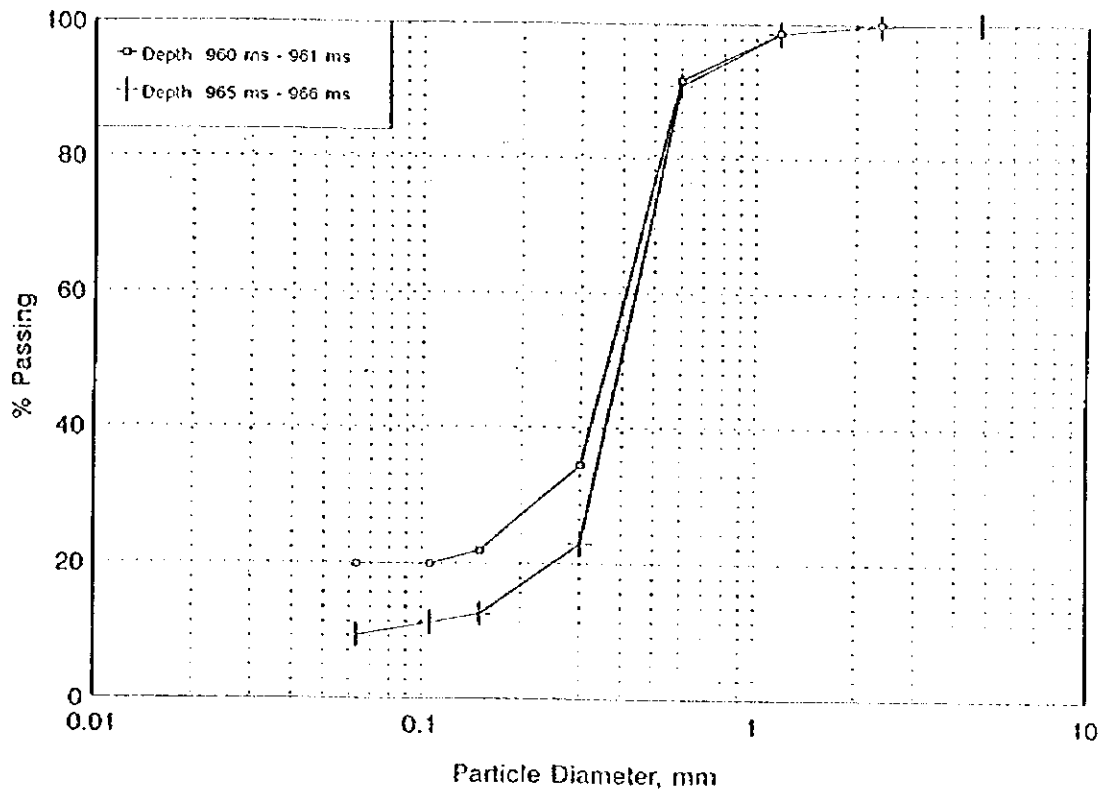
Grain Size Distribution Well J2



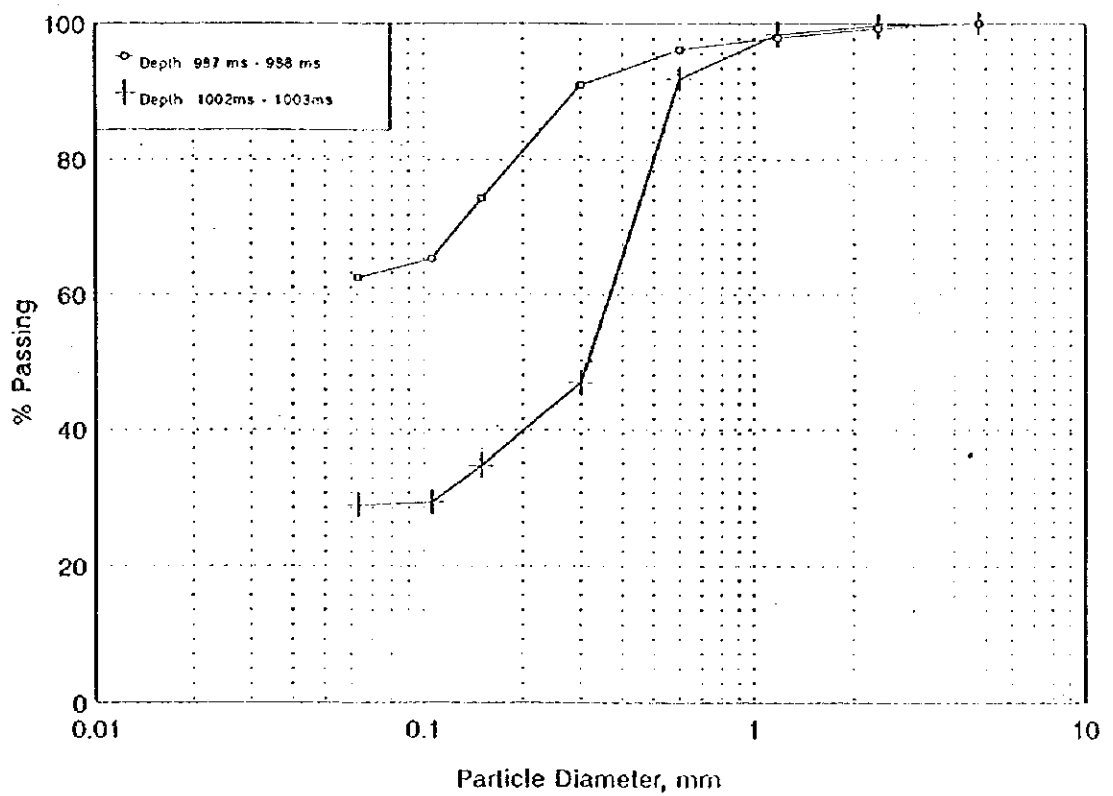
5.3 J-3



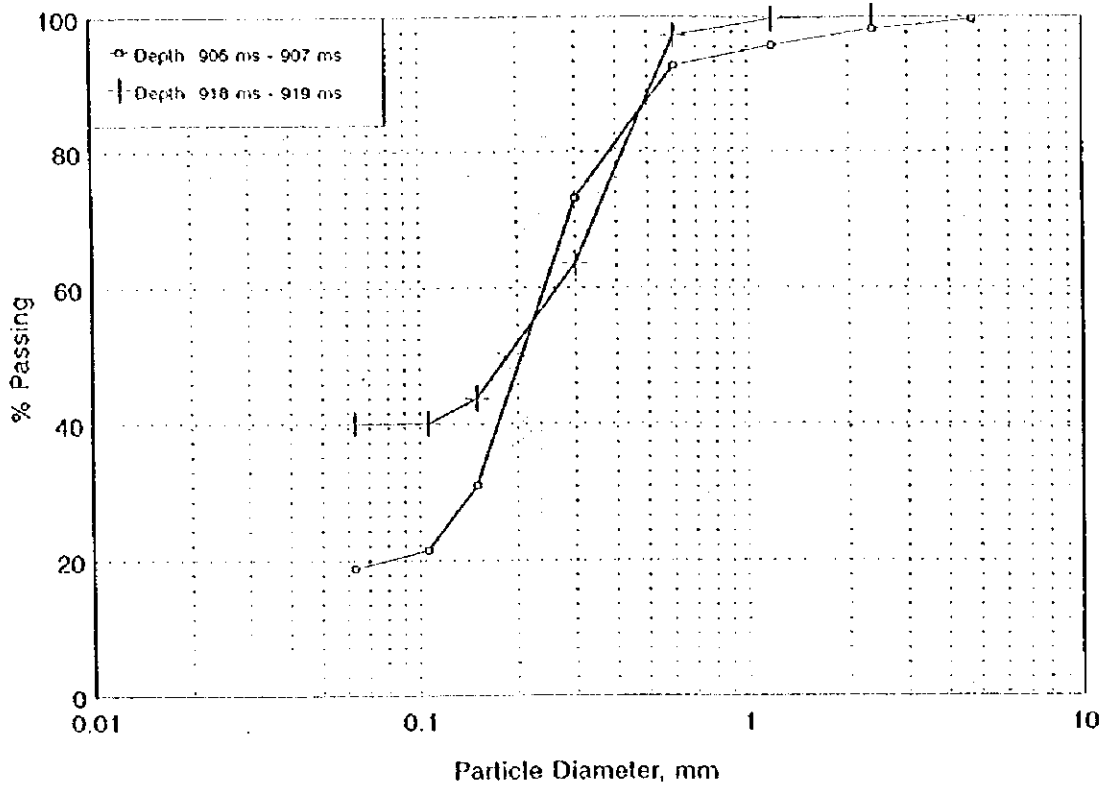
Grain Size Distribution Well J3



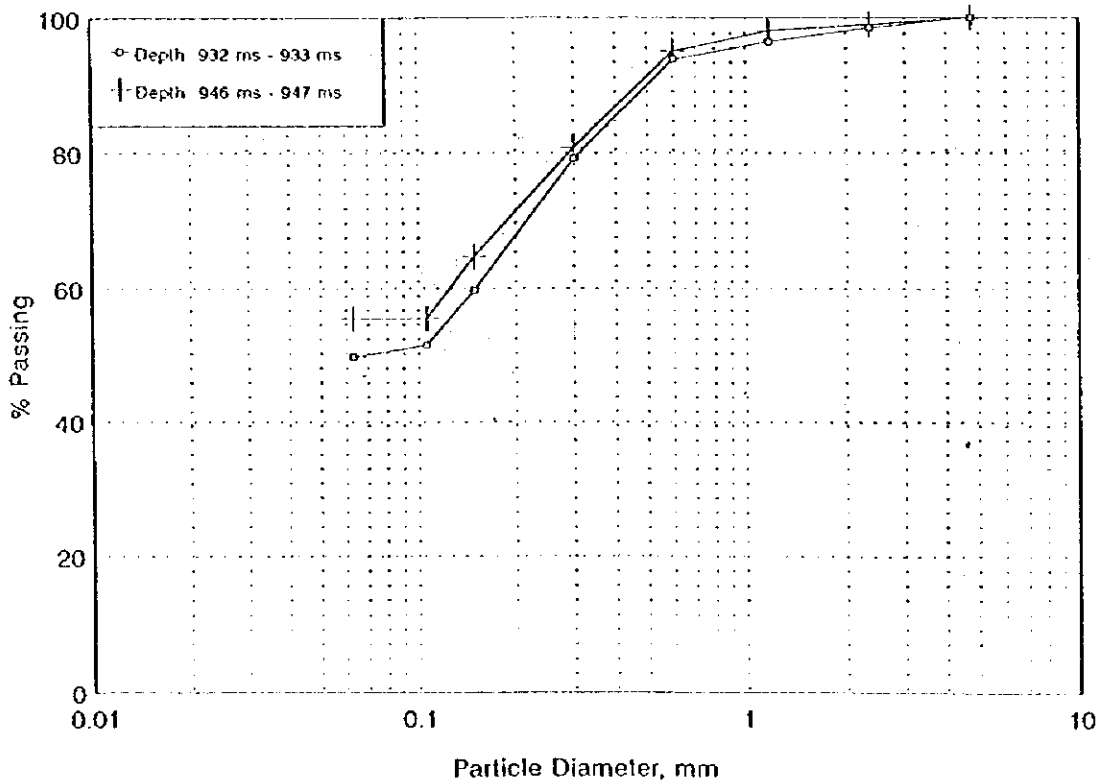
Grain Size Distribution Well J3



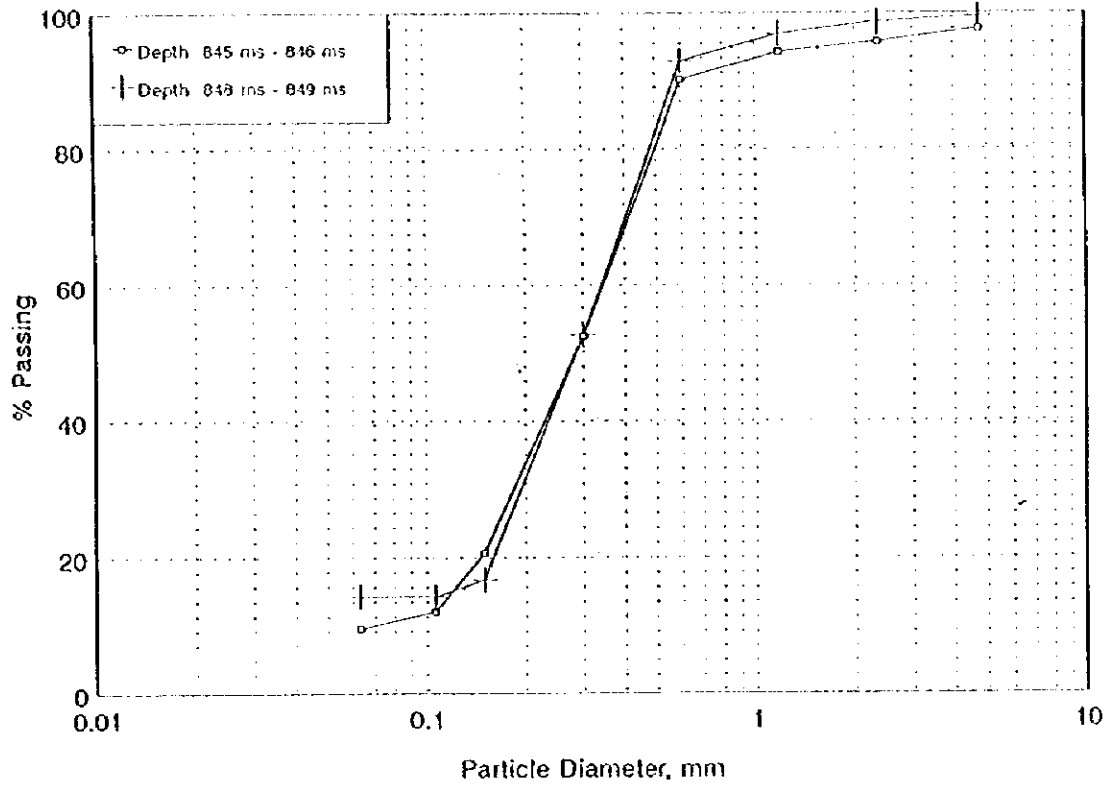
Grain Size Distribution Well J3



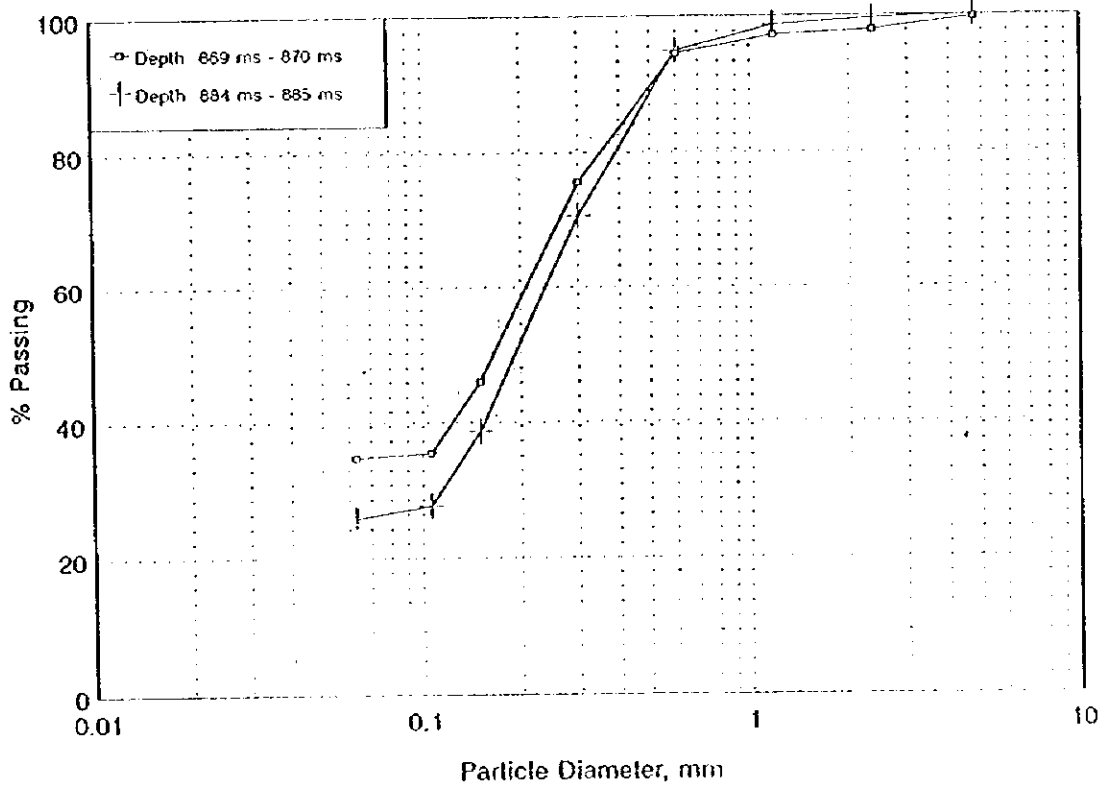
Grain Size Distribution Well J3



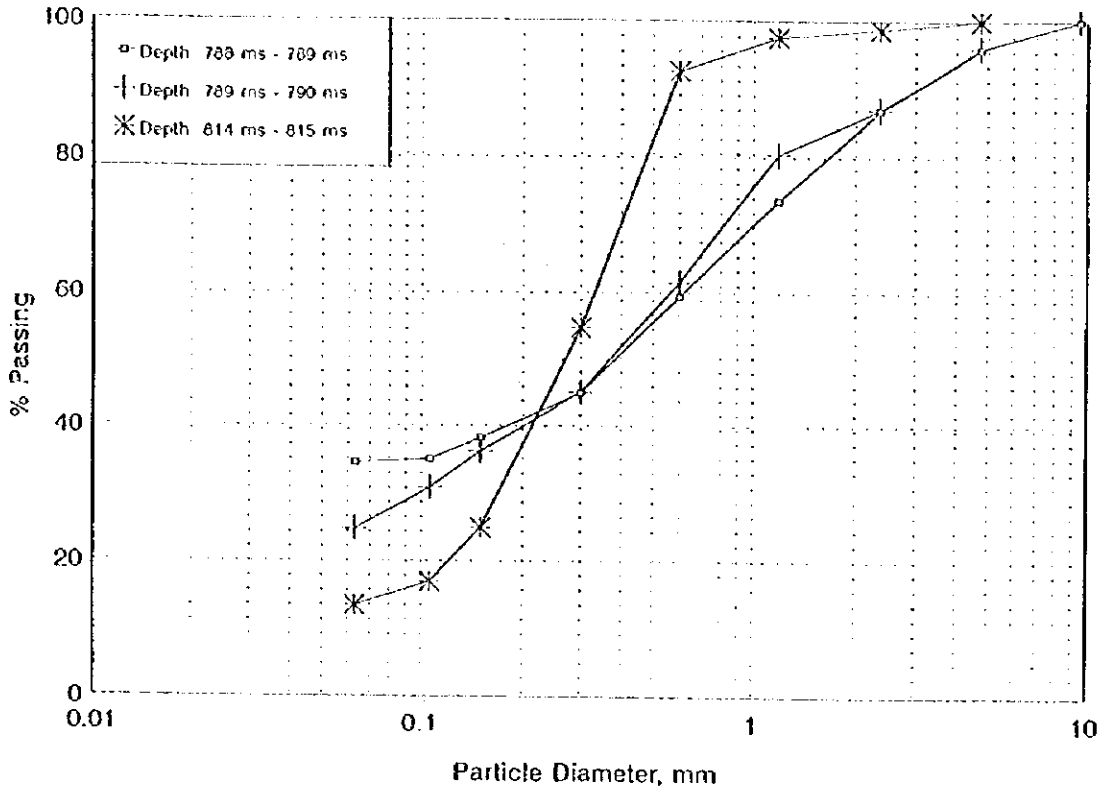
Grain Size Distribution Well J3



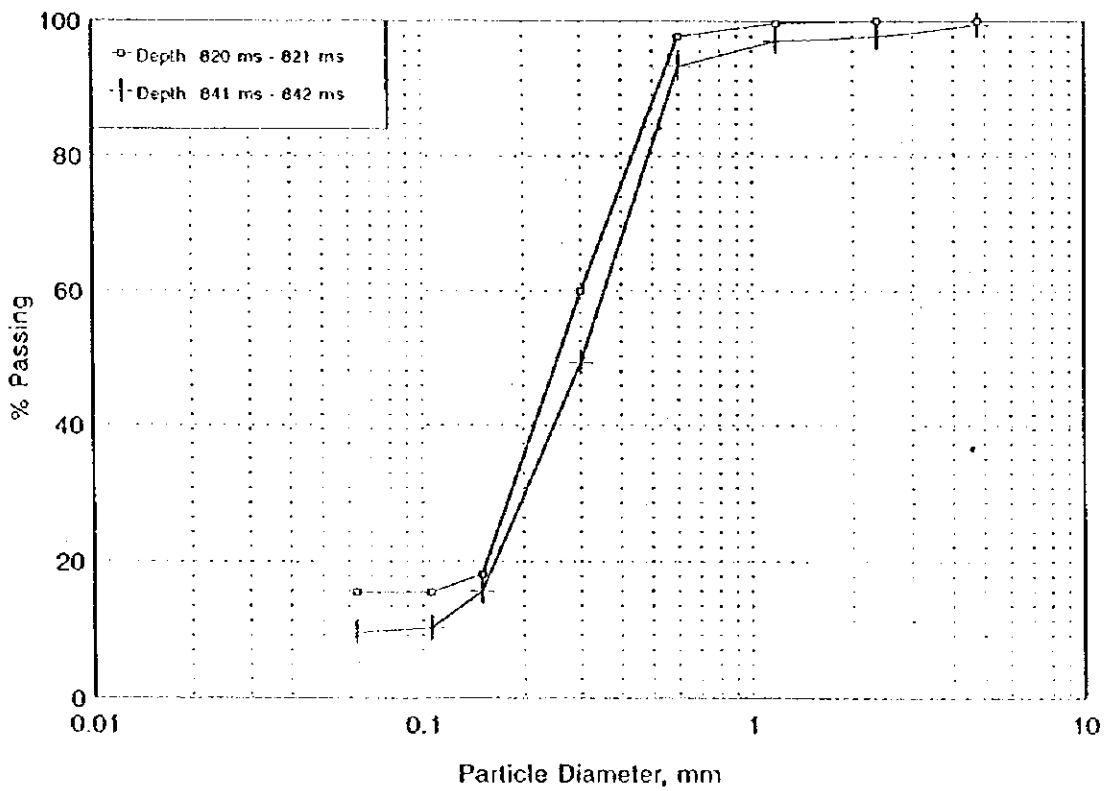
Grain Size Distribution Well J3



Grain Size Distribution Well J3



Grain Size Distribution Well J3

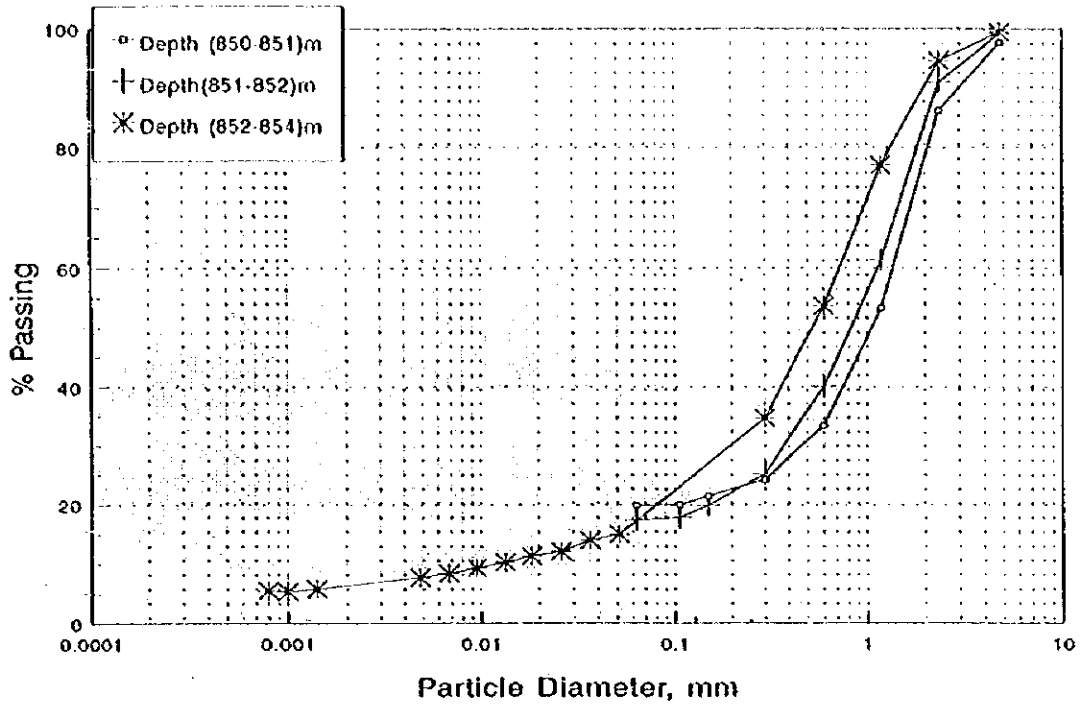


S.4 J-4



Grain Size Distribution

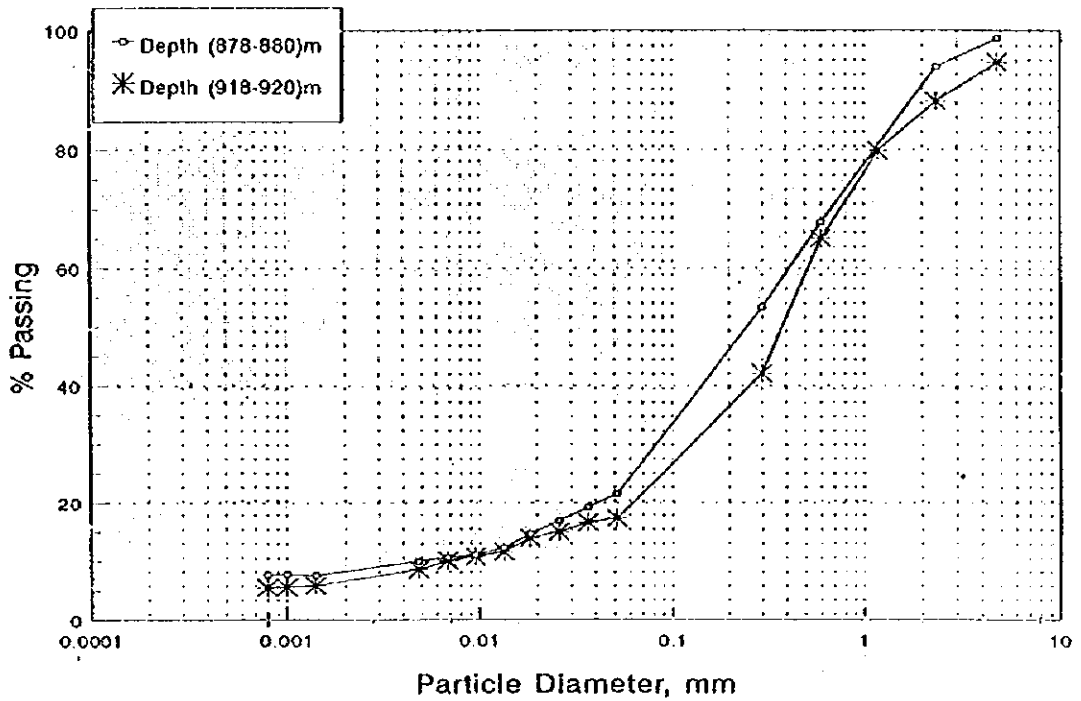
Borehole J4



Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

Grain Size Distribution

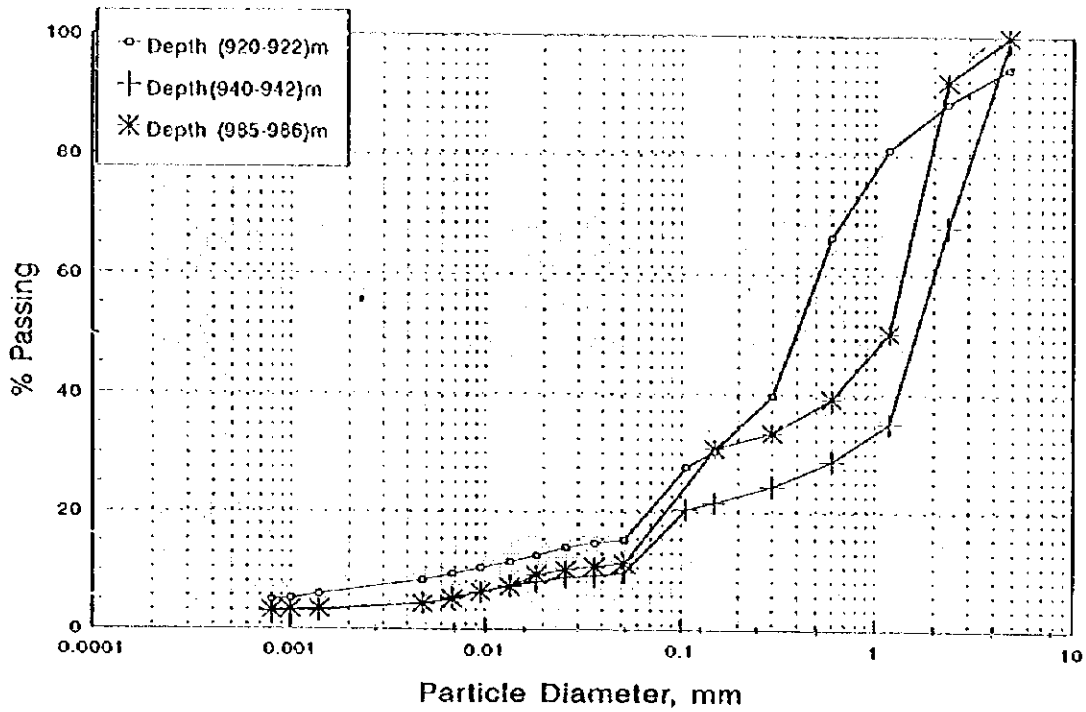
Borehole J4



Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

Grain Size Distribution

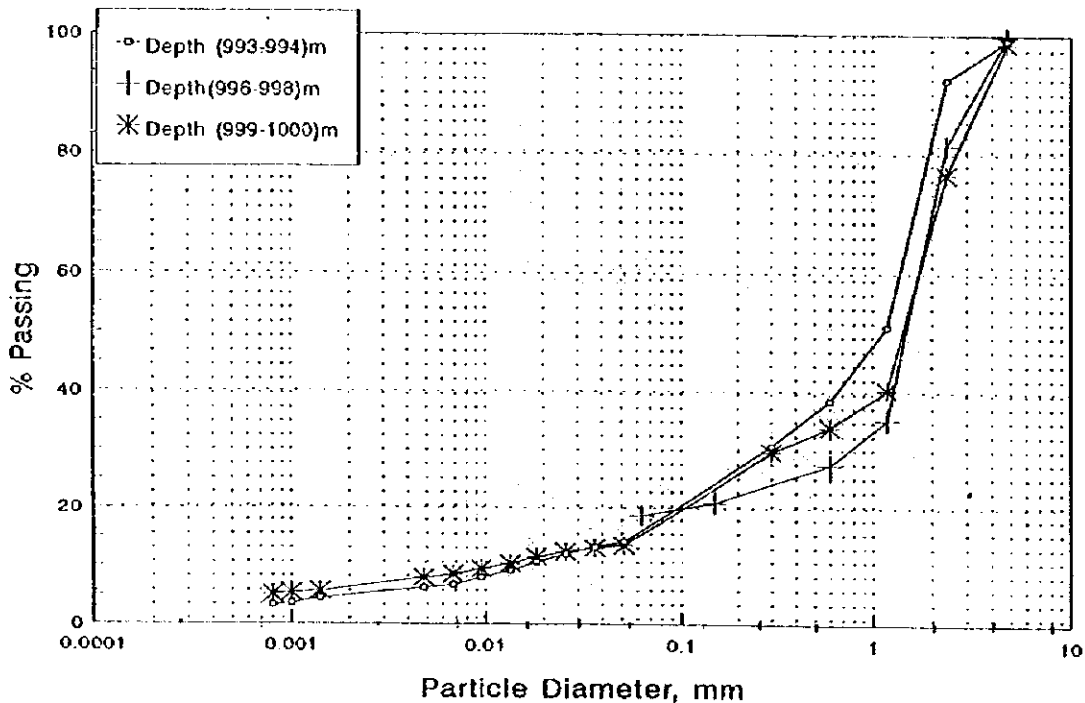
Borehole J4



Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

Grain Size Distribution

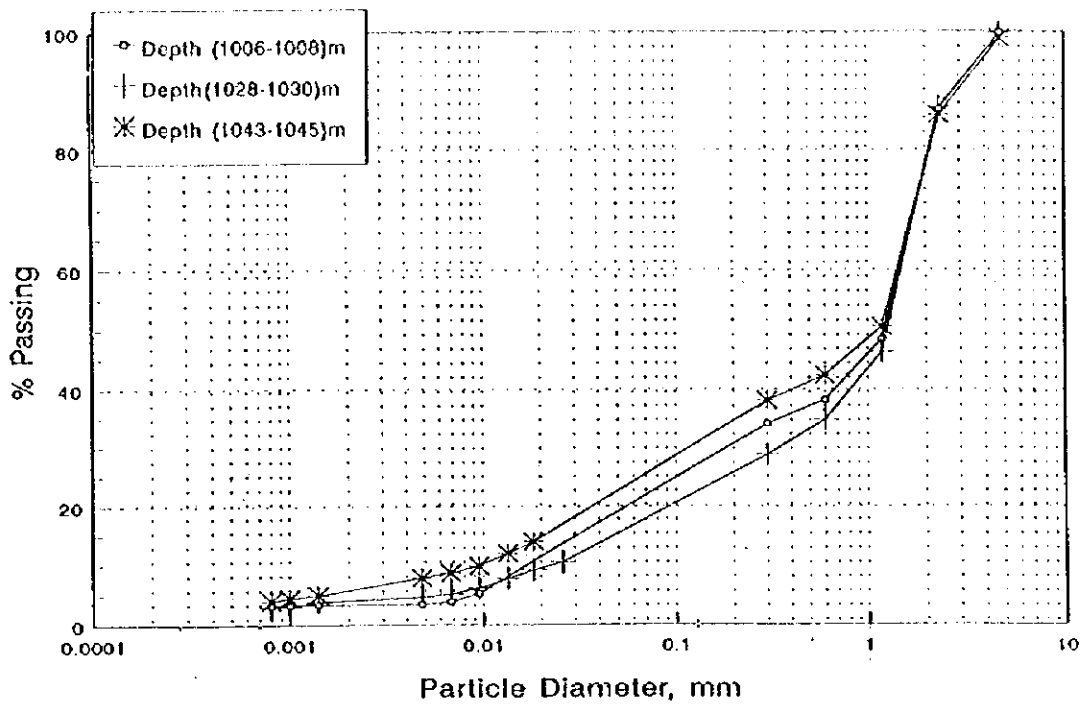
Borehole J4



Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

Grain Size Distribution

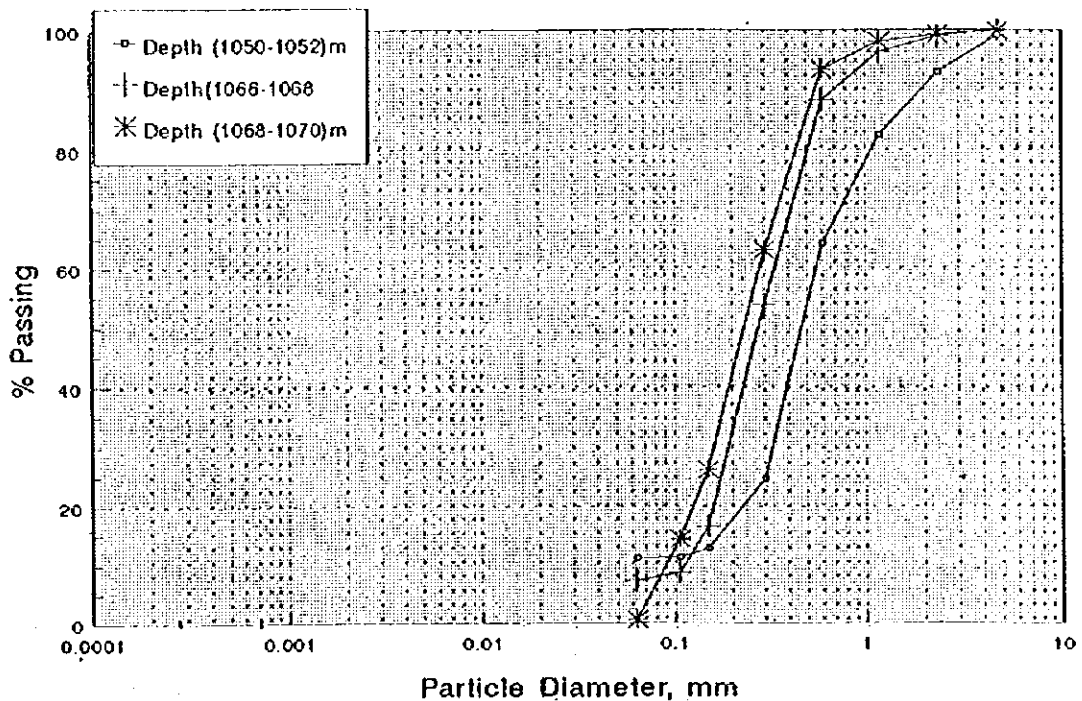
Borehole J4



Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

Grain Size Distribution

Borehole J4

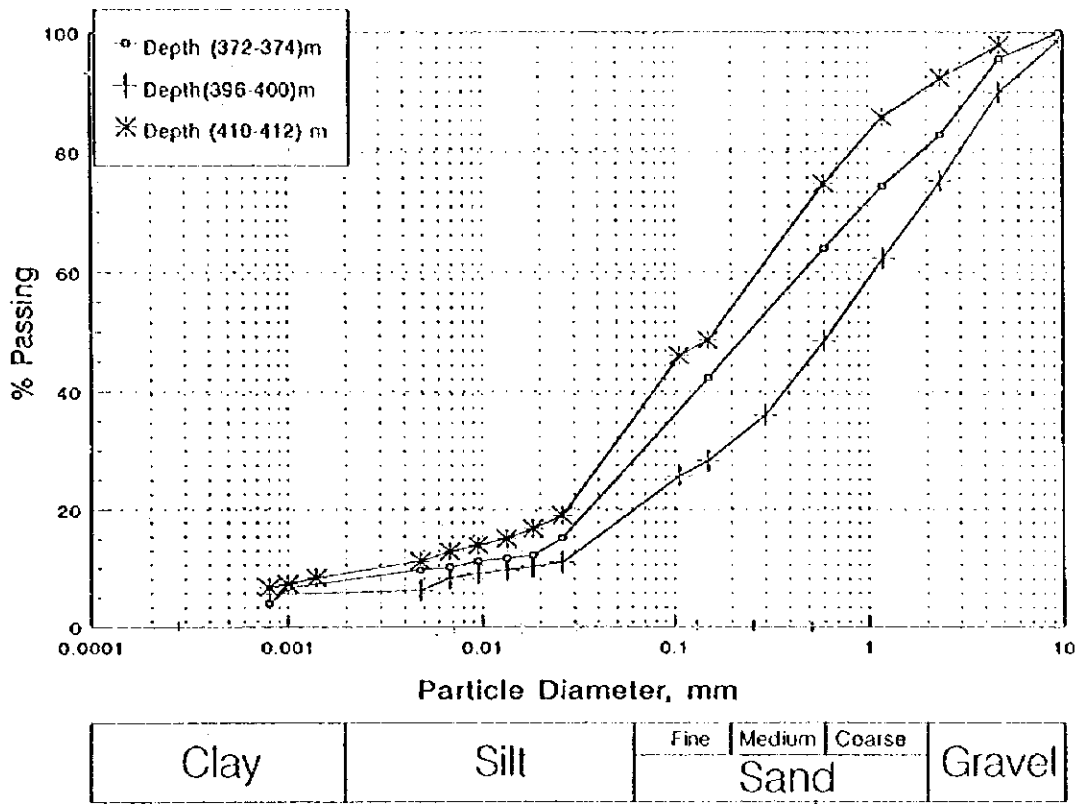


Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

5.5 J-5

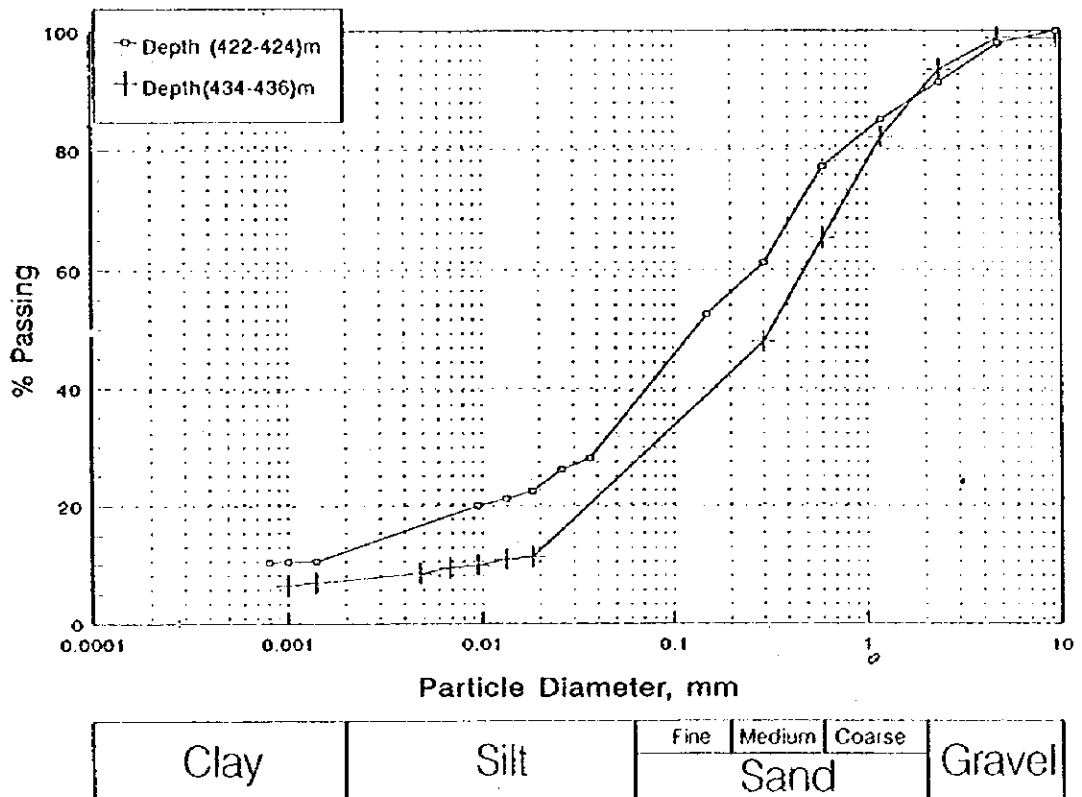
Grain Size Distribution

Borehole J5



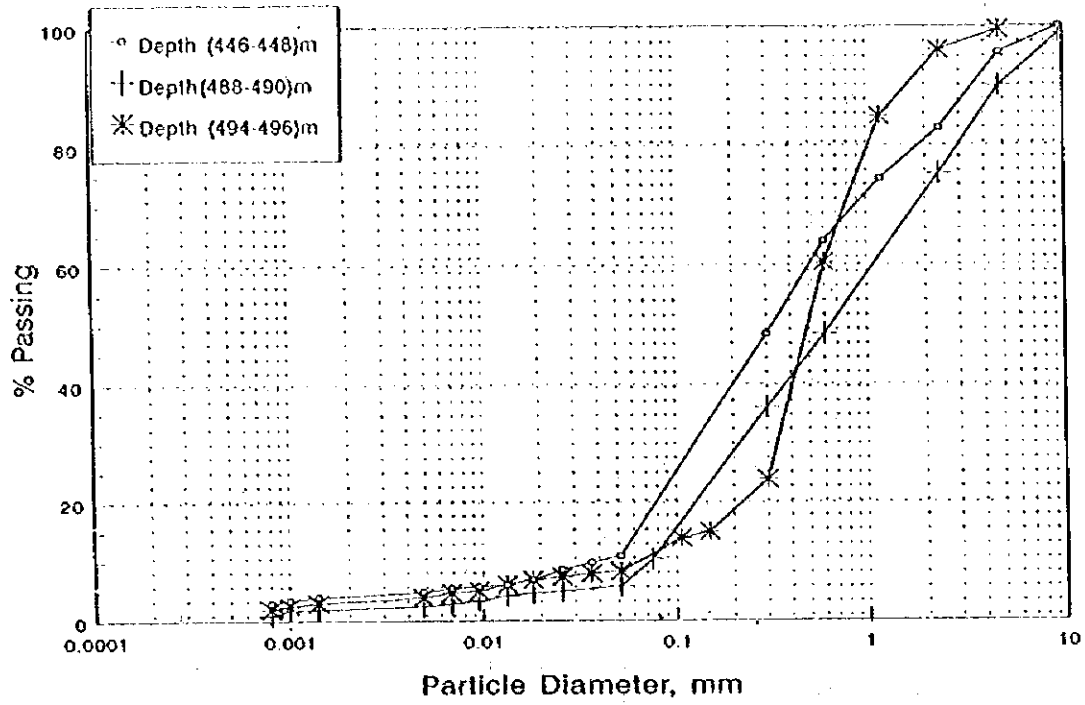
Grain Size Distribution

Borehole J5



Grain Size Distribution

Borehole J5

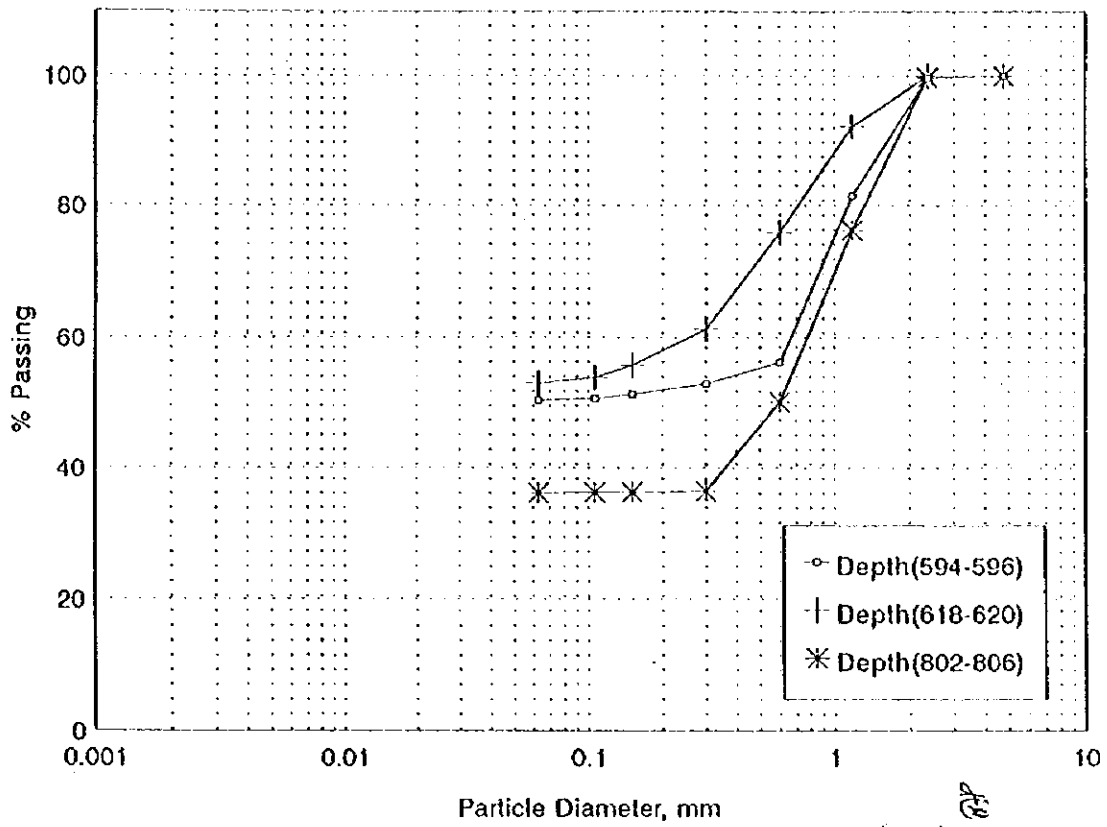


Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

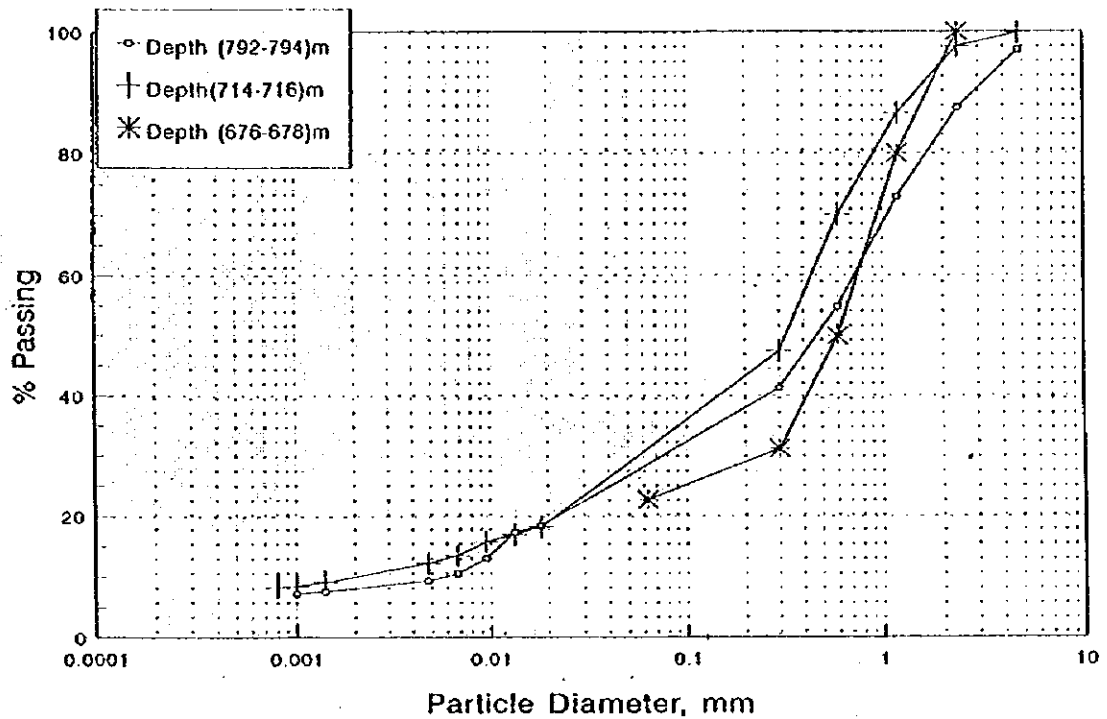
5.6 J-6



Grain Size Distribution for Samples (J-6)



Grain Size Distribution Borehole J6



Clay	Silt	Fine	Medium	Coarse	Gravel
		Sand			

Part-6

GROUNDWATER DEVELOPMENT PLAN

6.1 Detailed Design Conditions and Specifications



Groundwater Development Plans for South Sinai Groundwater Resources Study

Note : [] and [---] means that the requirement of description is not necessary.

No	Item	Unit	Common	Plan 1		Plan 2		Plan 3		Plan 4			Plan 5				
				potable	non-potable	potable	non-potable	potable	non-potable	4A	4B	4C	4A	4B	4C	5A	5B
1	Design Condition																
-1	Main purpose of water supply	--		potable													
-2	Service area	--		Ras Sudr, Abu Zenima, Abu Rudeis	Nuweiba, Dahab	El Tur	Sudr El Heitan	Malha	Themed	Typical case	Typical case	Typical case	Typical case	Typical case	Typical case	Typical case	Typical case
-3	Target year			2017	2017	2007	2017	2017	2017	---	---	---	---	---	---	---	---
-4	Service population	person		235,845	204,112	110,023	---	---	---	100	500	1,000					
-5	Tourist	person		11,548	24,794	713	0	0	0	0	0	0	0	0	0	0	0
-6	Development land area	hectare		---	---	---	714	840	714	---	---	---	---	---	---	---	---
-7	Development water capacity	m ³ /day		57,500	56,000	5,300	11,700	13,700	11,700	5	25	50					
-8	Location of water sources	--		south of Nakhel	south of Themed	north of El Tur	near dev area	near dev. area	near dev. area	near dev. area	near dev. area	near dev. area	near dev. area	near dev. area	near dev. area	near dev. area	near dev. area
-9	Water quality standard	--		potable	potable	potable	potable	potable	potable	potable	potable	potable	potable	potable	potable	potable	potable
-10	Allowable inner pipe pressure	kg/cm ²		10	10	10	10	10	10	10	10	10	10	10	10	10	10
-11	Voltage of power supply	50 Hz															
	100 kW >	volts		380	380	380	380	380	380	380	380	380	380	380	380	380	380
	100 kW <	volts		3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600	3,300/6,600

No	Item	Unit	Common	Plan 1	Plan 2	Plan 3	Plan 4			Plan 5								
							4A	4B	4C	4A	4B	4C	5A	5B	5C			
2	Specification of Facilities																	
2-1	Intake Facilities																	
-1	Wells :																	
	Nos. of total	nos		92	90	9	19	22	19	1	1	1	1	1	1	1	1	2
	Nos. of stand-by	nos		12	12	2	3	3	3	0	0	0	0	0	0	0	0	0
	Water capacity per a well	m ³ /day		720	720	720	720	720	720	5	5	5	5	5	5	5	5	25
		m ³ /hr		30	30	30	30	30	30	1	1	1	1	1	1	1	1	5
	Planned operation time	hr/day		24	24	24	24	24	24	5	5	5	5	5	5	5	5	5
	Diameter of Pumping House	m φ		0.300	0.300	0.300	0.300	0.300	0.300	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Diameter of Screen & S-Trap	m φ		0.200	0.200	0.300	0.200	0.200	0.200	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Well depth (Maximum)	GL-m		1,000	1,000	155	1,000	1,000	1,000	20	20	20	20	20	20	20	20	20
	Depth of Pumping House	m		800	800	120	800	800	800									
	Depth of Screen	m		150	150	30	150	150	150									
	Depth of Sand Trap	m		50	50	5	50	50	50									
	Dynamic water level	GL-m		300	300	120	300	300	300									
	Static water level	GL-m		280	280	100	280	280	280									
-2	Well Pumps :																	
	Nos. (nos of stand-by)	nos		92	90	9	19	22	19	1	1	1	1	1	1	1	1	2
	Type	--		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
	(Reference Products A)	Atria		BG8A16	BG8A16	BG8A6	BG8A16	BG8A16	BG8A16									
	(Reference Products B)	MS-M																
	Capacity	m ³ /hr		30	30	30	30	30	30									
	Pump Head	m		315	315	124	315	315	315									
	Motor Power	KW		45	45	18.5	45	45	45									
-3	Well house	nos		92	90	9	19	22	19	1	1	1	1	1	1	1	1	2
-4	Collection pipeline (well to Collected Tank)																	
	Diameter	m φ		0.125 ~ 0.9	0.125 ~ 0.8	0.125 ~ 0.3	0.125	0.125	0.125	0.040	0.040	0.125	0.125	0.080	0.080	0.080	0.080	0.080
	Material	--		pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel	pvc,steel

No	Item	Unit	Common	Plan 1	Plan 2	Plan 3	Plan 4			Plan 5			
							4A	4B	4C	5A	5B	5C	
2-2	Conveyance Facilities												
-1	No.1 Pumping Station												
	(1) Collected tanks												
	Nos.	nos		2	2	1							
	Type	--		rectangular	rectangular	rectangular							
	Capacity	m ³		600	600	120							
	Retention time	hr		0.5	0.5	0.5							
	Structure	--		concrete	concrete	concrete							
	(2) Booster pumps												
	Nos. (nos of stand-by)	nos		4(1)	4(1)								
	Type	--		Horizontal	Horizontal								
	(Reference Products)	DV-LF		315FK	317FK								
	Capacity	m ³ /min		13.5	13.0								
	Pump Head	m		58	95								
	Motor Power	kW		152	335								
	Prevention of Water Hammer			need	no need								
	(3) Other equipment												
	Crane	nos		1	1								
	Control panel	set		1	1								
	Electric facility	set		1	1								
	Emergency Generator	nos		1	1								
	//	PS		600	1,500								
	Building (adm./control/maintenance)	nos		1	1								

No	Item	Unit	Common	Plan 1	Plan 2	Plan 3	Plan 4			Plan 5		
							4A	4B	4C	5A	5B	5C
-2	No2 Pumping Station											
	(1) Pump Sump											
	Nos.	nos			2							
	Type	--			rectangular							
	Capacity	m ³			600							
	Retention time	hr			0.5							
	Structure	--			concrete							
	(2) Booster pumps											
	Nos. (nos of stand-by)	nos			4(1)							
	Type	--			Horizontal							
	(Reference products)	DV-LF			317FK							
	Capacity	m ³ /min			13.0							
	Pump Head	m			95							
	Motor Power	kW			335							
	Prevention of Water Hammer				need							
	(3) Other equipment											
	Crane	nos			1							
	Control panel	set			1							
	Electric facility	set			1							
	Emergency Generator	nos			1							
	//	PS			1,500							
	Building (admi/control/maintenance)	nos			1							

No	Item	Unit	Common	Plan 1	Plan 2	Plan 3	Plan 4			Plan 5		
							4A	4B	4C	5A	5B	5C
-3	No3 Pumping Station											
	(1) Pump Sump											
	Nos.	nos			2							
	Type	--			rectangular							
	Capacity	m ³			600							
	Retention time	hr			0.5							
	Structure	--			concrete							
	(2) Booster pumps											
	Nos. (nos of stand-by)	nos			4(1)							
	Type	--			Horizontal							
	(Reference products)	DV-LF			317FK							
	Capacity	m ³ /min			13.0							
	Pump Head	m			95							
	Motor Power	kW			335							
	Prevention of Water Hammer				no need							
	(3) Other equipment											
	Crane	nos			1							
	Control panel	set			1							
	Electric facility	set			1							
	Emergency Generator	nos			1							
	#	PS			1,500							
	Building (admi/control/maintenance)	nos			1							

No	Item	Unit	Common	Plan 1	Plan 2	Plan 3	Plan 4			Plan 5			
							4A	4B	4C	5A	5B	5C	
-4	No4 Pumping Station												
	(1) Pump Sump												
	Nos.	nos			2								
	Type	--			rectangular								
	Capacity	m ³			600								
	Retention time	hr			0.5								
	Structure	--			concrete								
	(2) Booster pumps												
	Nos. (nos of stand-by)	nos			4(1)								
	Type	--			Horizontal								
	(Reference products)	DV-LF			317FK								
	Capacity	m ³ /min			13.0								
	Pump Head	m			90								
	Motor Power	kW			335								
	Prevention of Water Hammer				need								
	(3) Other equipment												
	Crane	nos			1								
	Control panel	set			1								
	Electric facility	set			1								
	Emergency Generator	nos			1								
	"	PS			1,500								
	Building (admi/control/maintenance)	nos			1								

No	Item	Unit	Common	Plan 1	Plan 2	Plan 3	Plan 4			Plan 5			
							4A	4B	4C	5A	5B	5C	
-5	Surge Tank												
	Nos.	nos		1	4								
	Type	--		rectangular	rectangular								
	Capacity	m ³		25	25								
	Structure	--		concrete	concrete								
-6	Pressure reduce tank												
	Nos.	nos		4	7								
	Type	--		rectangular	rectangular								
	Capacity	m ³		400	400								
	Retention time	min		10	10								
	Structure	--		concrete	concrete								
-7	Conveyance pipeline (Collected tank to Reservoir)												
	Diameter	m		0.6 ~ 0.9	0.6 ~ 1.2	0.45							
	Length	km		64	189	9							
	Material	--		steel	steel	steel							
-8	Distribution water reservoir												
	Nos.	nos		4	4	2	19	22	19	1	1	1	2
	Type	--		circle	circle	circle	circle	circle	circle	square	square	square	square
	Capacity	m ³		7,250	7,250	1,400	360	360	360	5	25	25	25
	Diameter	m φ		43.0	43.0	19.0	11.0	11.0	11.0	---	---	---	---
	Width/Length	m □		---	---	---	---	---	---	1.6	3.0	4.0	4.0
	Water Depth	m		5.0	5.0	5.0	4.0	4.0	4.0	2.0	3.0	3.5	3.5
	Retention time	hr		12.0	12.0	12.0	12.0	12.0	12.0	24.0	24.0	24.0	24.0
	Structure	--		concrete	concrete	concrete	concrete	concrete	concrete	concrete	concrete	concrete	concrete

6.2 Hydraulic Calculation

I I) Calculation for Total Head of Well Pumps and Friction Loss of the Collection Pipeline

[Hazen-Williams Formula : for Pressure Pipe]

$$h_f = I \times L$$

$$I = 10.666 \times (Ch \times 1.85) \times (D^{-4.87}) \times (Q^{1.85})$$

[Manning Formula : for Gravity Pipe]

$$h_f = I \times L$$

$$I = [(n \times Q) / (0.312 \times D^{8/3})]^2$$

[Plan 1 : Unit Extracted Water Capacity per a Well : Q = 720 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number (---)	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Well No	Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss h _f (m)	Hydraulic Gradient I (---)	Friction Loss h _f (m)			
Well on the Ground	300	220.0	0.00833	0.125	1	0.68	120	0.013	0.00541	1.6	0.00790	2.4	W1	312.1	301.6
Junction A	500	520.0	0.00833	0.15	1	0.47	120	0.013	0.00223	1.1	0.00299	1.5	W2	310.6	301.6
Junction B	500	520.0	0.01667	0.2	1	0.53	120	0.013	0.00198	1.0	0.00258	1.3	W3	309.3	301.6
Junction C	500	520.0	0.02500	0.25	1	0.51	120	0.013	0.00141	0.7	0.00176	0.9	W4	308.4	301.6
Junction D	500	520.0	0.03333	0.25	1	0.68	120	0.013	0.00240	1.2	0.00314	1.6	W5	306.8	301.6
Junction E	500	520.0	0.04167	0.3	1	0.59	120	0.013	0.00149	0.7	0.00185	0.9	W6	305.9	301.6
Junction F	500	520.0	0.05000	0.3	1	0.71	120	0.013	0.00209	1.0	0.00267	1.3	W7	304.6	301.6
Junction G	500	520.0	0.05833	0.35	1	0.61	120	0.013	0.00131	0.7	0.00160	0.8	W8	303.8	301.6
Junction H	500	520.0	0.06667	0.35	1	0.69	120	0.013	0.00168	0.8	0.00208	1.0	W9	302.7	301.6
Junction I	500	520.0	0.07500	0.35	1	0.78	120	0.013	0.00209	1.0	0.00264	1.3	W10	301.4	301.6
Junction TA	500	520.0	0.08333	0.4	1	0.66	120	0.013	0.00153	0.7	0.00160	0.8			
Junction TB	4,000		0.25000	0.7	1	0.65	120	0.013	0.00066	2.7	0.00073	2.9			
Collected Tank	200	515.0	0.75000	0.9	1	1.18	120	0.013	0.00149	0.3	0.00171	0.3			
Total	9,500		0.75000							13.6		17.1			

Required Total Head of Well Pump

≈ 312.1 ⇒ 315 m

[Plan 2 : Unit Extracted Water Capacity per a Well : Q = 720 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Well No	Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss h _f (m)	Hydraulic Gradient I (---)	Friction Loss h _f (m)			
Well on the Ground	300	210.0	0.00833	0.125	1	0.68	120	0.013	1.6	0.00790	2.4	W1	308.6	301.6	
Junction A	500	510.0	0.00833	0.15	1	0.47	120	0.013	1.1	0.00299	1.5	W2	307.1	301.6	
Junction B	500	510.0	0.01667	0.2	1	0.53	120	0.013	1.0	0.00238	1.3	W3	305.8	301.6	
Junction C	500	510.0	0.02500	0.25	1	0.51	120	0.013	0.7	0.00176	0.9	W4	305.0	301.6	
Junction D	500	510.0	0.03333	0.25	1	0.68	120	0.013	1.2	0.00314	1.6	W5	303.4	301.6	
Junction E	500	510.0	0.04167	0.25	1	0.85	120	0.013	1.8	0.00490	2.4	W6	300.9	301.6	
Junction F	500	510.0	0.05000	0.25	1	1.02	120	0.013	2.5	0.00706	3.5	W7	297.4	301.6	
Junction G	500	510.0	0.05833	0.25	1	1.19	120	0.013	3.4	0.00960	4.8	W8	292.6	301.6	
Junction H	500	510.0	0.06667	0.25	1	1.36	120	0.013	4.3	0.01254	6.3	W9	286.3	301.6	
Junction I	500	510.0	0.07500	0.3	1	1.06	120	0.013	2.2	0.00600	3.0	W10	283.3	301.6	
Junction TA	500	510.0	0.08333	0.3	1	1.18	120	0.013	2.7	0.00741	3.7				
Junction TB	4,000		0.25000	0.6	1	0.88	120	0.013	5.6	0.00165	6.6				
Collected Tank	200	480.0	0.75000	0.8	1	1.49	120	0.013	0.5	0.00321	0.6				
Total	9,500		0.75000						28.8		38.6				

Required Total Head of Well Pump

= 308.6 => 315 m

[Plan 3 : Unit Extracted Water Capacity per a Well : Q = 720 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Well No	Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss hl (m)	Hydraulic Gradient I (---)	Friction Loss hl (m)			
Well		0.0													
Junction A	50	120.0	0.00833	0.125	1	0.68	120	0.013	0.00541	0.3	0.00790	0.4	W1	120.4	120.3
Junction B	2,000	120.0	0.00833	0.15	1	0.47	120	0.013	0.00223	4.5	0.00299	6.0	W2	120.4	120.3
Junction C	2,000	120.0	0.01667	0.2	1	0.53	120	0.013	0.00198	4.0	0.00258	5.2	W3	120.4	120.3
Junction G	2,500	80.0	0.02500	0.25	1	0.51	120	0.013	0.00141	3.5	0.00176	4.4		#REF!	#REF!
Junction D	2,000	80.0	0.00833	0.15	1	0.47	120	0.013	0.00223	4.5	0.00299	6.0	W4	120.4	120.3
Junction E	2,000	80.0	0.01667	0.2	1	0.53	120	0.013	0.00198	4.0	0.00258	5.2	W5	120.4	120.3
Junction F	500	80.0	0.02500	0.2	1	0.80	120	0.013	0.00418	2.1	0.00580	2.9	W6	120.4	120.3
Junction G	1,000	50.0	0.05000	0.3	1	0.71	120	0.013	0.00209	2.1	0.00267	2.7		120.4	120.3
Collected Tank															
Junction H	2,000	70.0	0.00833	0.15	1	0.47	120	0.013	0.00223	4.5	0.00299	6.0	W7	120.4	120.3
Junction I	2,000	70.0	0.01667	0.2	1	0.53	120	0.013	0.00198	4.0	0.00258	5.2	W8	120.4	120.3
Junction J	1,500	70.0	0.02500	0.2	1								W9	120.4	120.3
Collected Tank															
Reservoir (WL)	9,000	50.0	0.07500	0.45	1	0.47	120	0.013	0.00062	5.5	0.00069	6.2			
Total	26,530	38.0	0.07500												
			0.07500											33.2	43.8

Required Total Head of Well Pump = 120.4 m → 124 m

[Plan 4A : Unit Extracted Water Capacity per a Well : Q = 720 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number (---)	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Well No	Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss hl (m)	Hydraulic Gradient I (---)	Friction Loss hl (m)			
Well		180.0	0.00833	0.125	1	0.68	120	0.013	0.00541	1.6	0.00790	2.4	W1	306.7	
on the Ground	300	480.0													
Water Reservoir	50	483.0	0.00833	0.1	1	1.06	120	0.013	0.01603	0.8	0.02597	1.3			
Total	350		0.00833							2.4		3.7			

Required Total Head of Pump = 305.8 => 315 m

[Plan 4B : Unit Extracted Water Capacity per a Well : Q = 720 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number (---)	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Well No	Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss hl (m)	Hydraulic Gradient I (---)	Friction Loss hl (m)			
Well		240.0	0.00833	0.125	1	0.68	120	0.013	0.00541	1.6	0.00790	2.4	W1	306.7	
on the Ground	300	540.0													
Water Reservoir	50	543.0	0.00833	0.1	1	1.06	120	0.013	0.01603	0.8	0.02597	1.3			
Total	350		0.00833							2.4		3.7			

Required Total Head of Well Pump = 305.8 => 315 m

[Plan 4C : Unit Extracted Water Capacity per a Well : Q = 720 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number (---)	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Well No	Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss hl (m)	Hydraulic Gradient I (---)	Friction Loss hl (m)			
Well		230.0	0.00833	0.125	1	0.68	120	0.013	0.00541	1.6	0.00790	2.4	W1	306.7	
on the Ground	300	530.0													
Water Reservoir	50	533.0	0.00833	0.1	1	1.06	120	0.013	0.01603	0.8	0.02597	1.3			
Total	350		0.00833							2.4		3.7			

Required Total Head of Well Pump = 305.8 => 315 m

[Plan SA : Unit Extracted Water Capacity per a Well : Q = 200 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number (---)	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss hl (m)	Hydraulic Gradient I (---)	Friction Loss hl (m)		
Well		-22.0												
on the Ground	25	0.0	0.00028	0.04	1	0.22	120	0.013	0.00257	0.1	0.00383	0.1	W1	24.8
Water Reservoir	50	2.5	0.00028	0.04	1	0.22	120	0.013	0.00257	0.1	0.00383	0.2		
Total	75		0.00028							0.2		0.3		
Required Total Head of Well Pump = 24.8 => 26 m														

[Plan SB & SC : Unit Extracted Water Capacity per a Well : Q = 500 m³/day]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number (---)	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Required Total Head of Well Pump (m)	Minimum Total Head of Well Pump (m)
									Hydraulic Gradient I (---)	Friction Loss hl (m)	Hydraulic Gradient I (---)	Friction Loss hl (m)		
Well		-22.0												
on the Ground	25	0.0	0.00139	0.08	1	0.28	120	0.013	0.00173	0.0	0.00237	0.1	W1	24.7
Water Reservoir	50	2.5	0.00139	0.08	1	0.28	120	0.013	0.00173	0.1	0.00237	0.1		
Total	75		0.00139							0.1		0.2		
Required Total Head of Well Pump = 24.7 => 26 m														

[II] Calculation for Total Head of Booster Pumps and Friction Loss of the Conveyance Pipeline

[Hazen-Williams Formula : for Pressure Pipe]

$$h_f = I \times L$$

$$I = 10.666 \times (C_h^{-1.85}) \times (D^{-4.87}) \times (Q^{1.85})$$

[Manning Formula : for Gravity Pipe]

$$h_f = I \times L$$

$$I = \frac{1.49 \times Q}{(0.312 \times D^{8/3})^{1/2}}$$

[Plan 1 - Conveyance Pipeline]

Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula			By Manning Formula			Well No	Required Total Head of Pump (m)	Water Level in Pipeline (m)
									Hydraulic Gradient I (---)	Friction Loss h _f (m)	Friction Loss h _f (m)	Hydraulic Gradient I (---)	Friction Loss h _f (m)				
Collected Tank (Pumping Station)	11,000	512.0	0.666	0.9	1	1.05	120	0.013	0.00120	13.2	0.00135	14.9	37.9	Full			
Highest Place on Hill	15,500	535.0	0.666	0.7	1	1.73	120	0.013	0.00407	63.0	0.00516	80.0				80.0	
PRT 1	6,000	435.0	0.666	0.6	1	2.36	120	0.013	0.00862	51.7	0.01174	70.4				70.4	
PRT 2	7,500	335.0	0.666	0.6	1	2.36	120	0.013	0.00862	64.6	0.01174	88.1				88.1	
PRT 3	11,000	235.0	0.666	0.7	1	1.73	120	0.013	0.00407	44.7	0.00516	56.8				56.8	
PRT 4	13,000	135.0	0.666	0.7	1	1.73	120	0.013	0.00407	52.9	0.00516	67.1				67.1	
Distribution Water Reservoir	75.0																
Total	64,000		0.666							290.1					377.2		

[Plan 2 : Conveyance Pipeline]

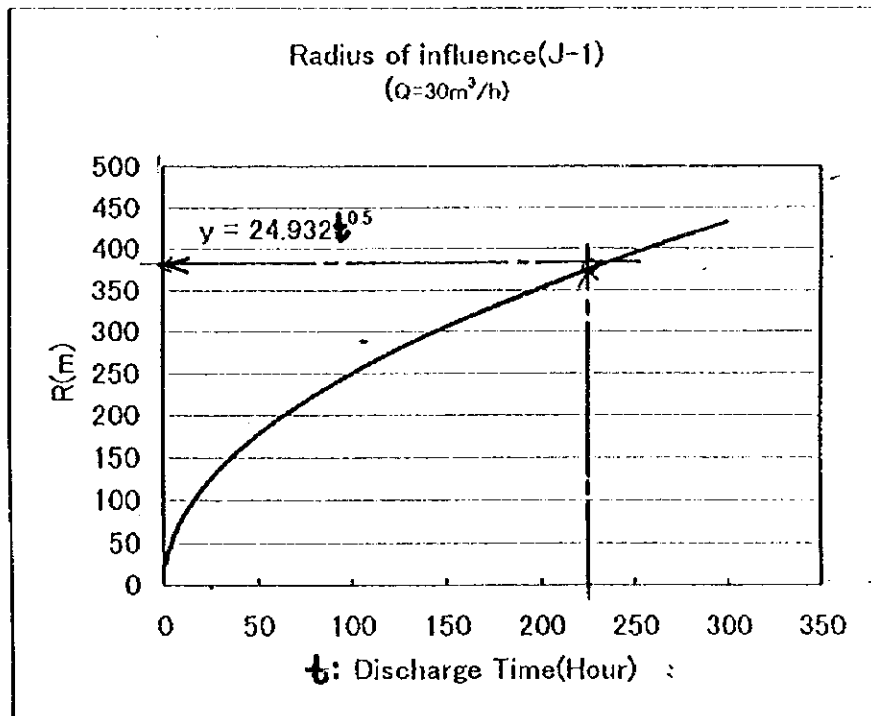
Point	Pipe Length L (m)	Altitude above Sea Level H (m)	Water Flow Rate Q (m ³ /sec)	Pipe Diameter D (m)	Pipe Number (---)	Flow Velocity (m/sec)	Coefficient Related to the Pipe Condition Ch (---)	Roughness Coefficient n	By Hazen-Williams Formula		By Manning Formula		Required Total Head of Pump (m)	Water Level in Pipeline (m)
									Hydraulic Gradient I (---)	Friction Loss h _f (m)	Hydraulic Gradient I (---)	Friction Loss h _f (m)		
No1 P/S (LWL)	34,000	477.0	0.648	1.2	1	0.57	120	0.013	0.00028	9.5	0.00028	9.4	92.5	Full
No2 P/S (HWL)		560.0												
(LWL)	11,000	557.0	0.648	1.0	1	0.83	120	0.013	0.00068	7.5	0.00073	8.0	90.5	Full
No3 P/S (HWL)		640.0												
(LWL)	12,000	637.0	0.648	1.1	1	0.68	120	0.013	0.00043	5.1	0.00044	5.3	88.1	Full
No4 P/S (HWL)		720.0												
(LWL)	57,000	717.0	0.648	1.1	1	0.68	120	0.013	0.00043	24.4	0.00044	25.0	87.4	Full
Highest Place on Hill	16,000	780.0	0.648	0.7	1	1.68	120	0.013	0.00387	61.9	0.00489	78.2	78.2	78.2
PRT 1	12,000	680.0	0.648	0.65	1	1.95	120	0.013	0.00555	66.6	0.00725	67.0	87.0	87.0
PRT 2	11,000	580.0	0.648	0.65	1	1.95	120	0.013	0.00555	61.0	0.00725	61.0	79.8	79.8
PRT 3	11,000	480.0	0.648	0.65	1	1.95	120	0.013	0.00555	61.0	0.00725	61.0	79.8	79.8
PRT 4	7,000	380.0	0.648	0.6	1	2.29	120	0.013	0.00819	57.3	0.01112	57.8	77.8	77.8
PRT 5	7,000	280.0	0.648	0.6	1	2.29	120	0.013	0.00819	57.3	0.01112	57.8	77.8	77.8
PRT 6	8,000	180.0	0.648	0.6	1	2.29	120	0.013	0.00819	65.5	0.01112	66.0	88.9	88.9
PRT 7	3,000	80.0	0.648	0.7	1	1.68	120	0.013	0.00387	11.6	0.00489	12.1	14.7	14.7
Distribution Water Reservoir		50.0												
Total	189,000		0.648							488.8		631.6		

6.3 Interval of Well Distance

Interval of Well

Interval of Well Distance

Discharge Time (Hr)	Radius of Influence (m)	Required Interval Well Distance (m)
1	25	50
2	35	70
3	43	86
4	50	100
6	61	122
10	79	158
20	111	222
24	122	244
40	158	316
50	176	352
60	193	386
120	273	546
240	386	772
300	432	864



6.4 Water Hammer Analysis

PCI PLAN 1

BASIC LEVEL 515.000 M
 DELTA T 1.86835 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	THICKNESS MM	ELASTIC MODULUS (LONG.)	UPPER PIPE NO.	CONDITION	LOSS	INTERVAL	PIPELINE CONSTANT	DIVISION
						PUMP SURGE VALVE	PIPE LINE	TIME SEC		
1	11000.0	SS 1	900	8.0	2.100	1 0 0 0 0 1	18.000	22.4202	1.3123	12

[PUMP DATA]

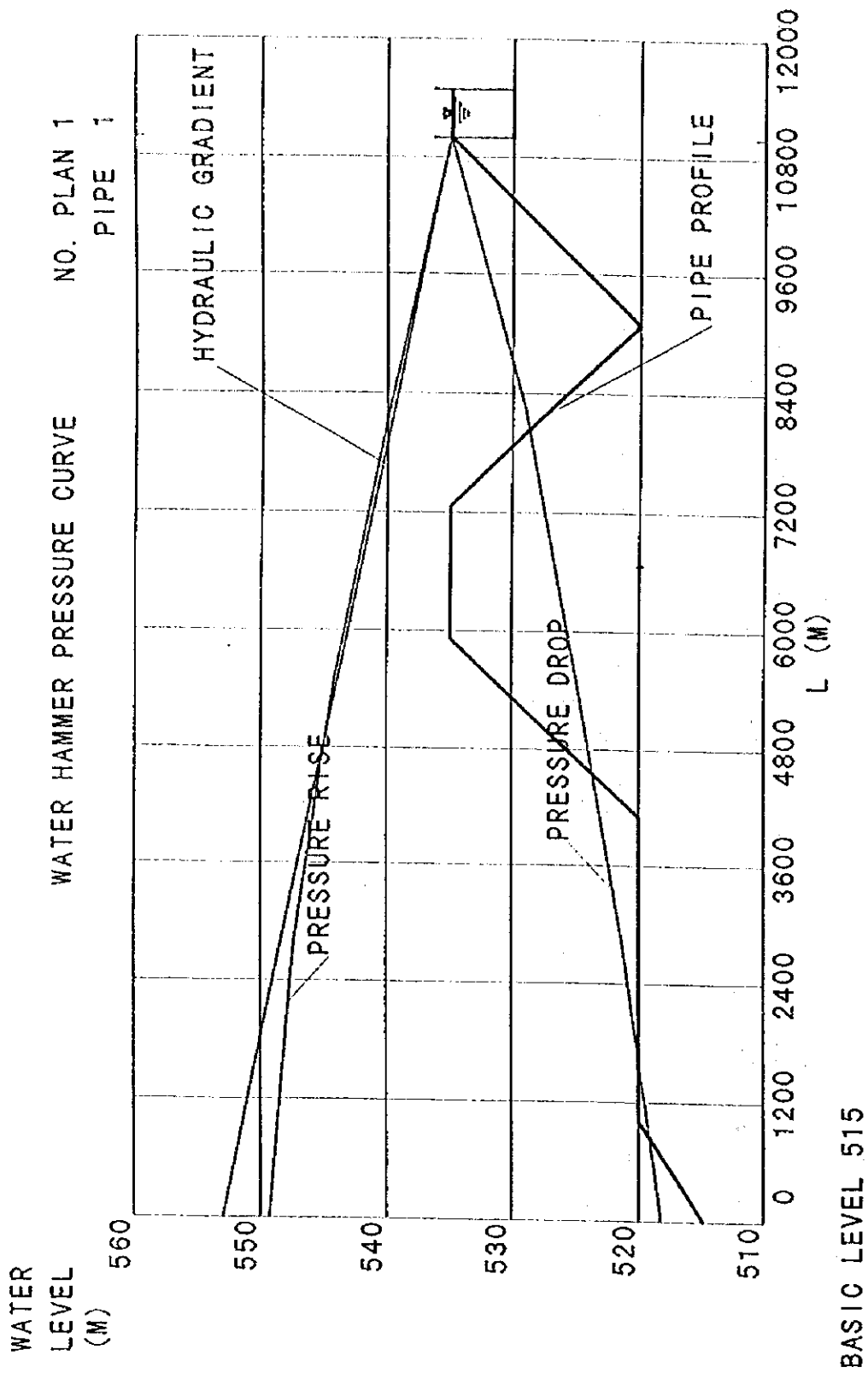
NO	QTY	TYPE	VALVE CLOSING	NO	V	TOTAL HEAD M	CAPACITY M3/M	MOTOR KW	POLE	TYPE	GD2 (WHEEL) KG-M2	SPEED EFF. min-1 %	START CONDITION						
													HEAD M	FLOW RATE M3/M	SPEED	TORQUE			
1	3	1	1	0	0	38.000	13.300	132.0	4	0	12.000	400.000	1480	85	0.0393	38.000	13.300	1.000	1.000

[PIPELINE ROUTE]

1

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	7270.0	535.00	1000.0	520.00	4100.0	520.00
			9100.0	520.00	11000.0	535.00
					5900.0	535.00



PCI PLAN 1

BASIC LEVEL 515.000 M
 DELTA T 2.24202 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	DIA. MM	THICKNESS MM	ELASTIC MODULUS (LONG.)	UPPER PIPE NO.	CONDITON	LOSS	INTERVAL	PIPELINE DIVISION
							PUMP SURGE VALVE END FLOW RATE M3/M	PIPE LINE	TIME SEC	CONSTANT
1	6600.0	SS 1	900	8.0	2.100	1	0 0 0 0	10.800	13.4521	1.3123
2	4400.0	SS 1	900	8.0	2.100	1	0 0 0 1	7.200	8.9681	1.3123

[PUMP DATA]

NO	TYPE	VALVE CLOSING	V-NO	TOTAL HEAD M	CAPACITY M3/M	MOTOR KW	POLE	TYPE	GD2 (WHEEL) KG-M2	SPEED EFF. min-1 %	START CONDITION
1	3	1	0	38.000	13.300	132.0	4	0	12.000	1480 85	HEAD FLOW RATE M3/M
											SPEED TORQUE
											13.300 1.000 1.000

[SURGE TANK DATA]

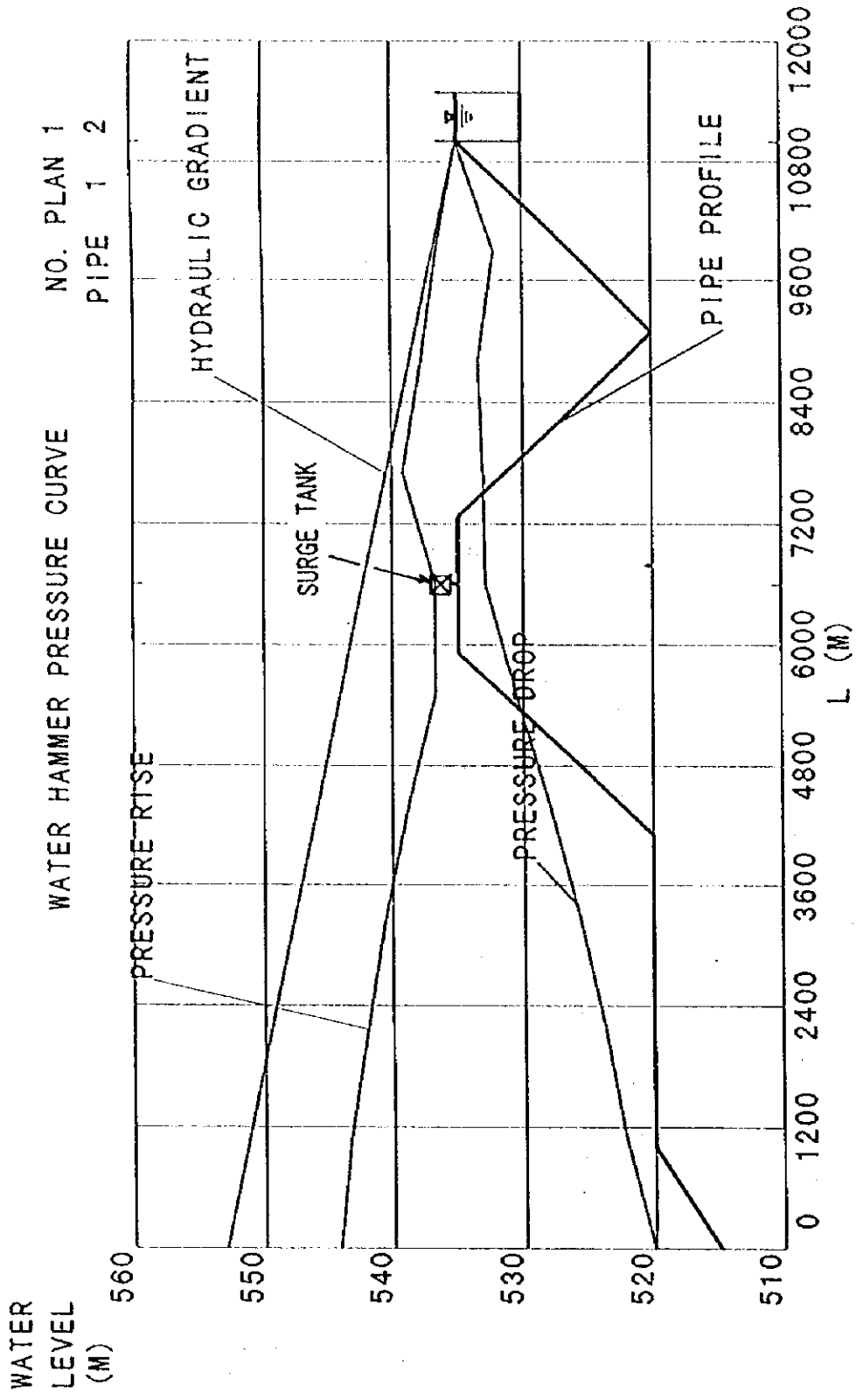
NO	TYPE	HEAD M	AREA M2	SECTION FRICTION LOSS M	DIS-TANCE M	PIPE MATERIAL	THIC-KNESS MM	ELASTIC MODULAS	INTERVAL TIME SEC	PIPELINE DIVISION	INITIAL AIR M3	LOSS M
1	1	0	13.300	7.347	0	0	0	0.000	0.000	0	0	0.000

[PIPELINE ROUTE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	7270.0	535.00	4100.0	520.00	5900.0	535.00

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	7270.0	535.00	4100.0	520.00	5900.0	535.00



PCI PLAN 2-1

BASIC LEVEL 480.000 M
 DELTA T .11838 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	DIA. MM	THICKNESS MM	ELASTIC MODULUS (LONG.)	UPPER PIPE NO.	CONDITION	PUMP	SURGE VALVE	END FLOW RATE M3/M	LOSS PIPE LINE	END VALVE	INTERVAL TIME SEC	PIPELINE CONSTANT	DIVISION
1	34000.0	SgP1	1200	9.5	2.100		1 0 0 0	1	0 0 0	1 39.000	15.000	.000	71.5012	.7154	604

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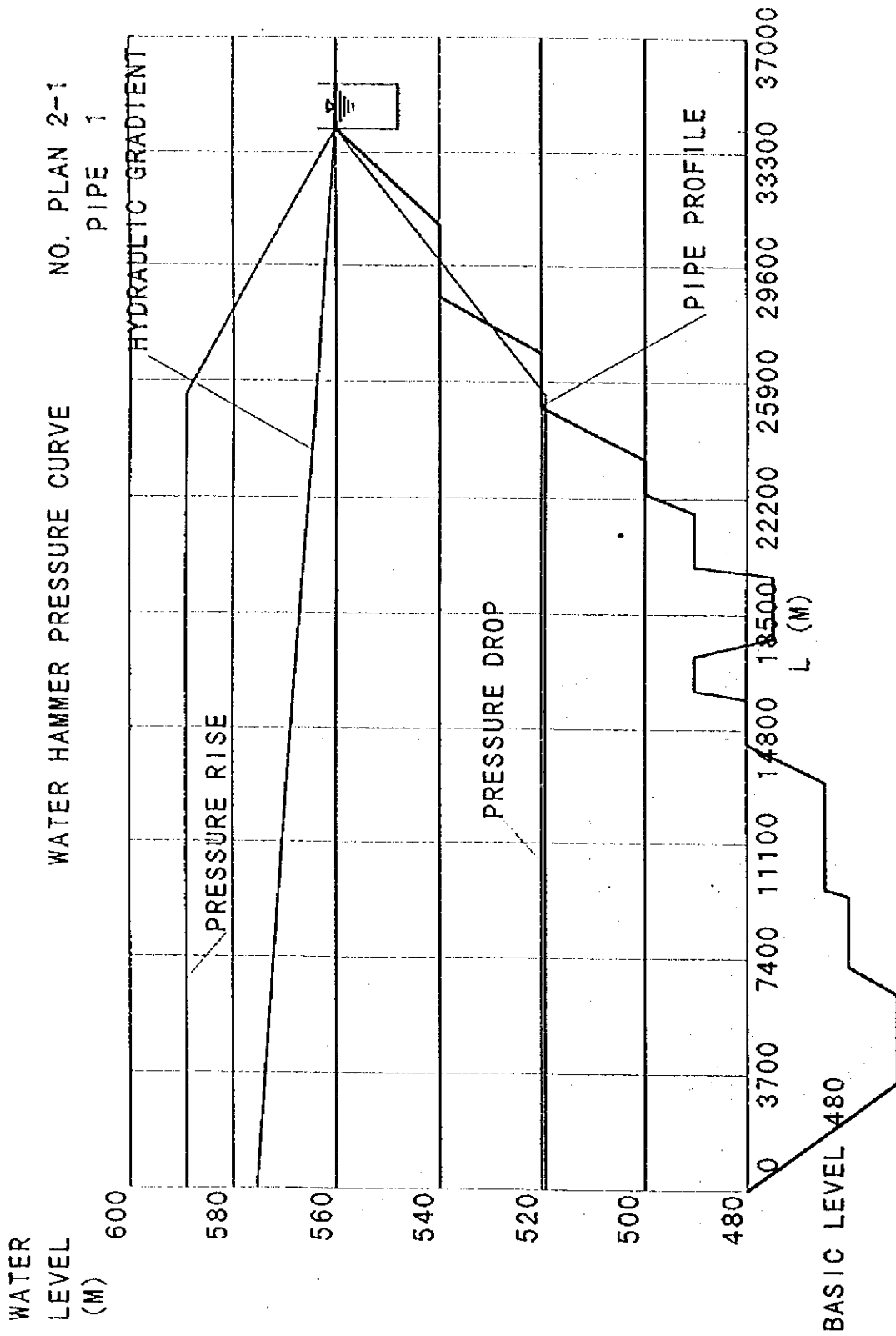
NO	Q'TY	TYPE	VALVE CLOSING	TYPE OF VALVE	TOTAL HEAD M	CAPACITY M3/M	MOTOR KW	POLE	TYPE	GD2 (WHEEL) KG-M2	SPEED EFF. min-1 %	START CONDITION	HEAD M	FLOW RATE M3/M	SPEED TORQUE
1	3	1	1	0	95.000	13.000	335.0	4	0	59.000	1480 84	---	95.000	13.000	1.000

[PIPELINE ROUTE]

1

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	0	480.00	3500.0	450.00	6300.0	450.00	7200.0	460.00	14300.0	480.00
	9500.0	460.00	9700.0	465.00	13100.0	465.00	14300.0	480.00	17700.0	475.00
	15700.0	480.00	16000.0	490.00	17100.0	490.00	17700.0	475.00	22300.0	500.00
	19700.0	475.00	20000.0	490.00	21700.0	490.00	22300.0	500.00	28600.0	540.00
	23400.0	500.00	25100.0	520.00	26800.0	520.00	28600.0	540.00		
	30900.0	540.00	34000.0	560.00						



PC1 PLAN 2-2

BASIC LEVEL 560.000 M
 DELTA T .11798 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	DIA. MM	THICKNESS MM	ELASTIC MODULUS (LONG.)	UPPER PIPE NO.	CONDITION	LOSS	INTERVAL	PIPELINE DIVISION
							PUMP SURGE VALVE	PIPE LINE	TIME SEC	CONSTANT
1	6000.0	SGP1	900	7.9	2.100		1 0 0 0 0 1	15.000	12.2698	1.3079 104

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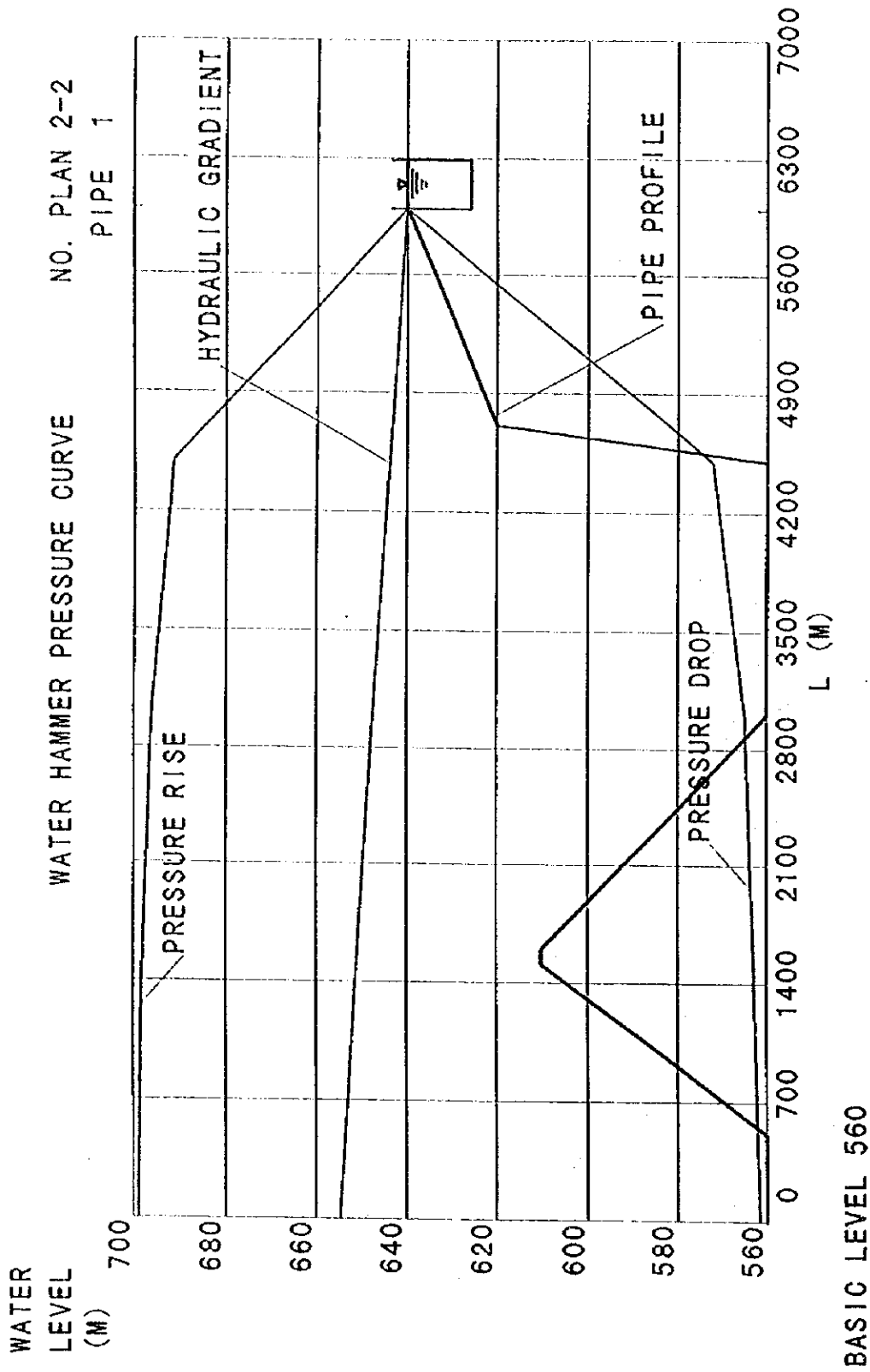
NO	QTY	TYPE	VALVE CLOSING	TYPE	MOTOR KW	POLE	TYPE	GD2 (WHEEL) KG-M2	SPEED EFF. min-1 %	START CONDITION
1	3	1	1	0	335.0	4	0	59.000	1480 84	HEAD FLOW RATE M ³ /M 95.000 13.000 1.000 1.000

[PIPELINE ROUTE]

1

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	3000.0	560.00	1500.0	610.00	1600.0	610.00
		560.00	4700.0	620.00	6000.0	640.00



PC1 PLAN 2-2

BASIC LEVEL 560.000 M
 DELTA T .11798 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	THICKNESS MM	ELASTIC MODULUS (LONG.)	UPPER PIPE NO.	CONDITION			LOSS	END VALVE	INTERVAL TIME SEC	PIPELINE CONSTANT	DIVISION
						-- PUMP --	SURGE VALVE	END FLOW RATE M3/M	PIPE LINE		SEC		
1	1500.0	SGP1	7.9	2.100	1	0	0	0	3.800	.000	3.0675	1.3079	26
2	3700.0	SGP1	7.9	2.100	1	0	0	0	9.200	.000	7.5664	1.3079	64
3	800.0	SGP1	7.9	2.100	2	0	0	1	2.000	.000	1.6360	1.3079	14

[PUMP DATA]

NO	QTY	TYPE	VALVE CLOSING	TYPE OF VALVE	NO	KW	POLE	TYPE	GD2 (WHEEL) KG-M2	SPEED EFF. %	START CONDITION
1	3	1	1	V-	0	335.0	4	0	59.000	1480.84	HEAD FLOW RATE M3/M
											SPEED TORQUE
											13.000
											1.000
											1.000

[SURGE TANK DATA]

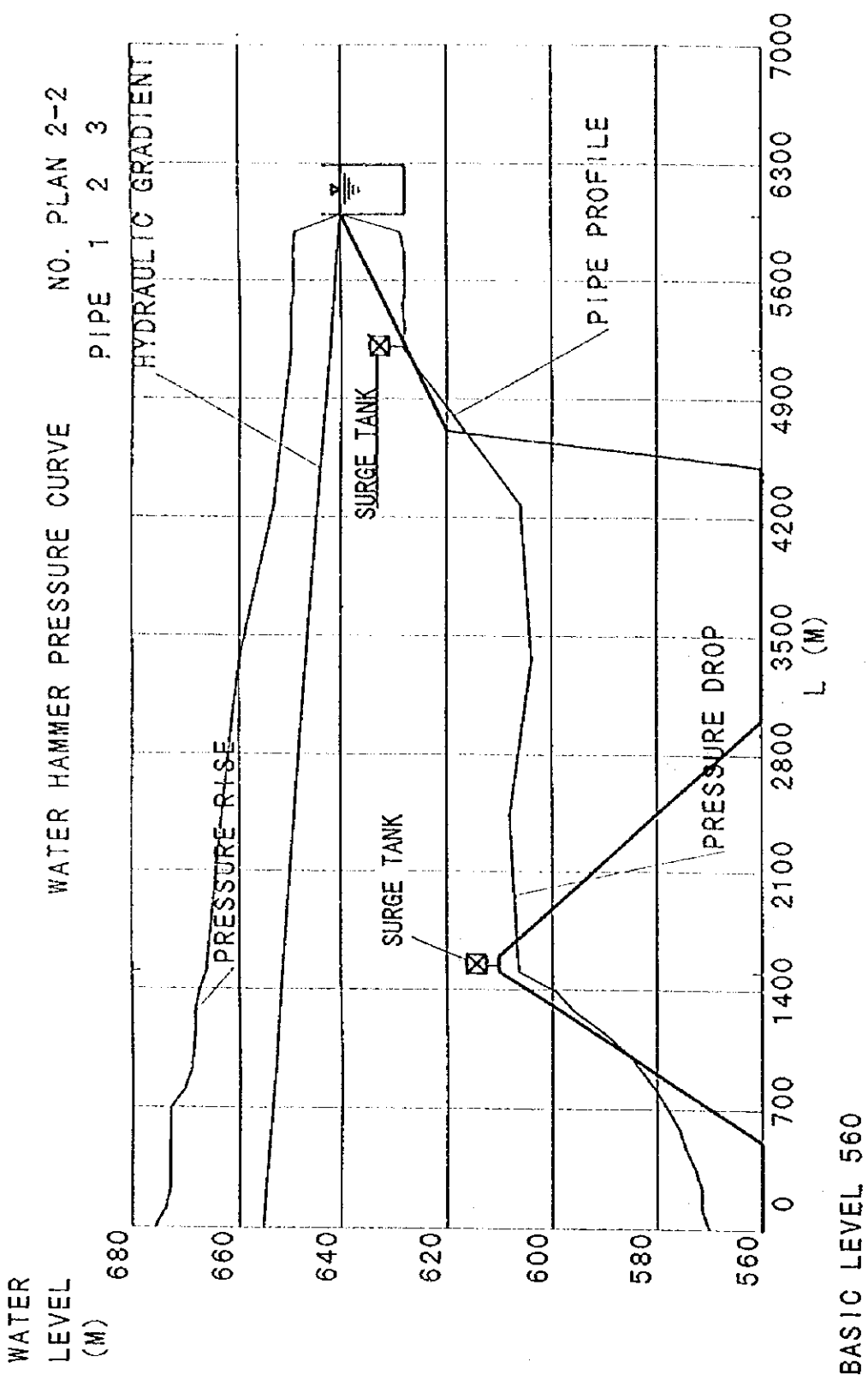
NO	TYPE	HEAD M	AREA M2	SECTION FRICTION LOSS M	DIS-TANCE M	PIPE MATERIAL	DIA. MM	THICKNESS MM	ELASTIC MODULUS	INTERVAL TIME SEC	PIPELINE CONSTANT	DIVISION	INITIAL AIR	LOSS M
1	1	0	13.000	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000
2	1	0	13.000	7.347	.0	0	0	.0	.000	.0000	.000	0	.0	.000

[PIPELINE ROUTE]

1 2 3

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	3000.0	560.00	500.0	560.00	1500.0	610.00	1600.0	610.00
		560.00	4500.0	560.00	4700.0	620.00	6000.0	640.00



PCI PLAN 2-3

BASIC LEVEL 640.000 M
 DELTA T .11796 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	SGPI	DIA. MM	THICKNESS MM	ELASTIC MODULUS (LONG.)	UPPER PIPE NO.	CONDITION	LOSS	INTERVAL TIME SEC	PIPELINE CONSTANT	DIVISION
1	17000.0			1100	9.5	2.100		1 0 0 0 0 1	PIPE LINE 15.000	END VALVE .000	34.9147	.8718 296

[PUMP DATA]

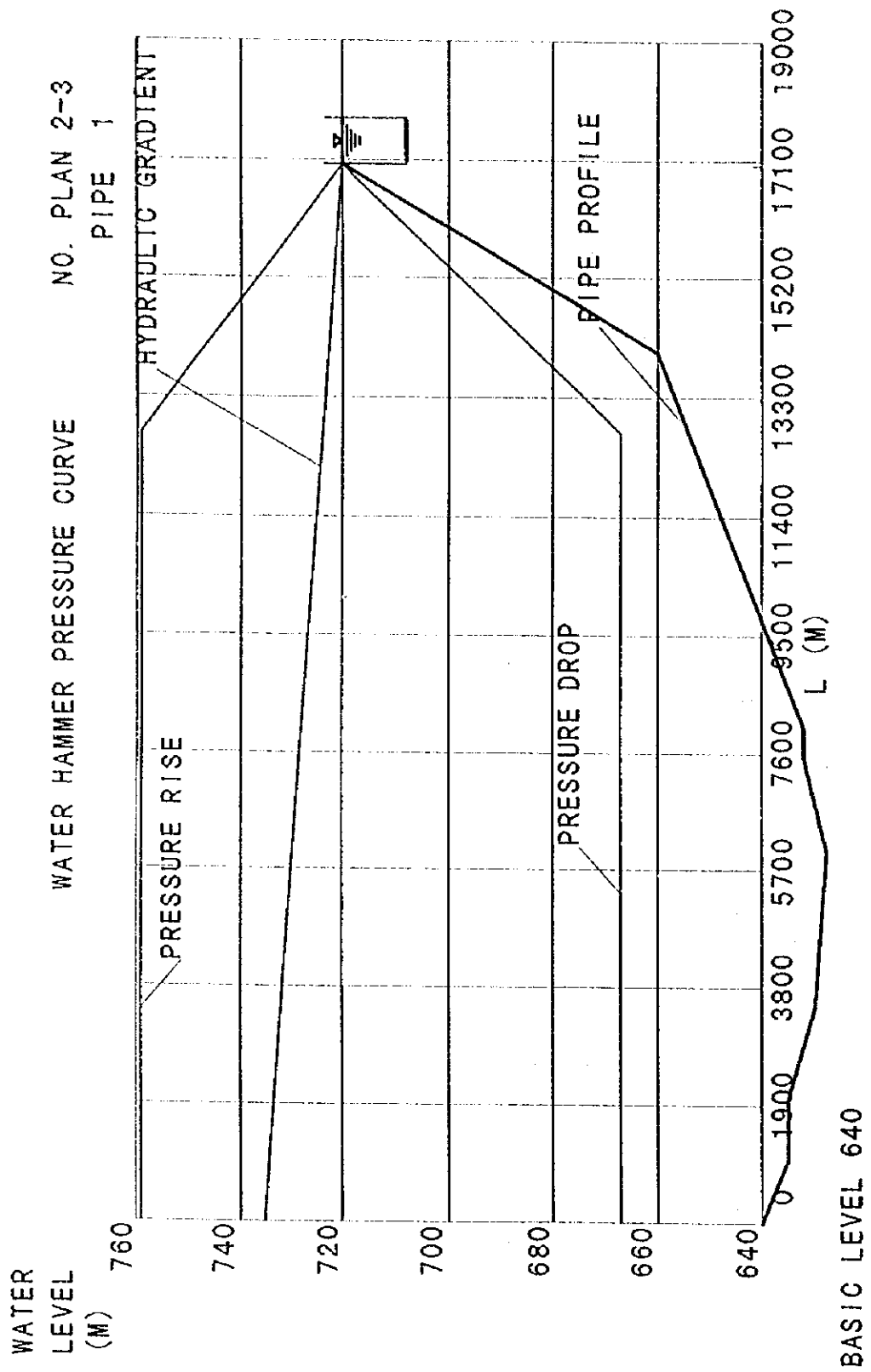
NO	TYPE	VALVE CLOSING	NO	V-	TOTAL HEAD M	CAPACITY M3/M	MOTOR KW	POLE	TYPE	GD2 (WHEEL) KG-M2	SPEED EFF. min-1 %	START CONDITION
1	3	1	0	0	95.000	13.000	335.0	4	0	59.000	1480 84	HEAD FLOW RATE 13.000 M3/M SPEED TORQUE 1.000 1.000

[PIPELINE ROUTE]

1

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	0	640.00	2000.0	635.00	3500.0	630.00	14000.0	660.00
	6000.0	628.00	8000.0	632.00				
	17000.0	720.00						



PCI PLAN 2-4

BASIC LEVEL 720.000 M
DELTA T .12454 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	DIA. MM	THICKNESS MM	ELASTIC MODULUS (LONG.)	UPPER PIPE NO.	CONDITION	PUMP	SURGE VALVE	END VALVE	FLOW RATE M3/M	PIPELINE CONSTANT	DIVISION
1	57000.0	SGP1	1100	9.5	2.100		1 0 0 0 0 1			.000	39.000	30.000	940
										.000	117.0669	.8718	

[PUMP DATA]

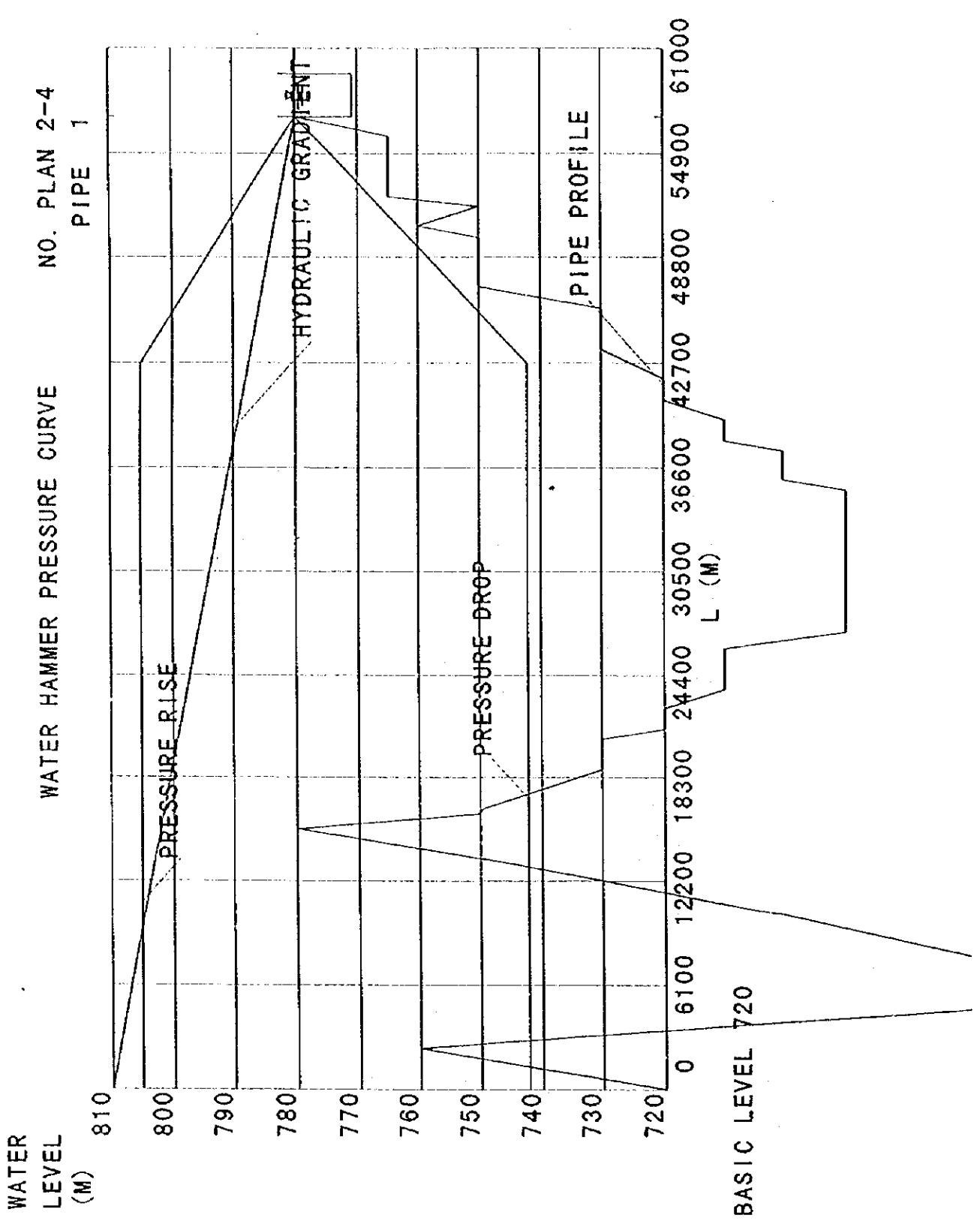
NO	QTY	TYPE	VALVE CLOSING	V-NO	TOTAL HEAD M	CAPACITY M3/M	MOTOR KW	POLE	TYPE	GD2 (WHEEL) KG-M2	SPEED EFF. min-1	START CONDITION	HEAD M	FLOW RATE M3/M	SPEED	TORQUE
1	3	1	1	0	90.000	13.000	335.0	4	0	59.000	1480	84	90.000	13.000	1.000	1.000

[PIPELINE ROUTE]

1

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	0	720.00	2300.0	760.00	4700.0	670.00	5900.0	660.00	13200.0	745.00
	7100.0	660.00	10300.0	700.00	10500.0	705.00	13200.0	745.00	18800.0	730.00
	15300.0	780.00	16200.0	750.00	16400.0	750.00	18800.0	730.00	23500.0	710.00
	20600.0	730.00	21200.0	720.00	22400.0	720.00	23500.0	710.00	35900.0	700.00
	25900.0	710.00	27000.0	690.00	35300.0	690.00	35900.0	700.00	40600.0	720.00
	37600.0	700.00	38200.0	710.00	39400.0	710.00	40600.0	720.00	47100.0	750.00
	41800.0	720.00	43500.0	730.00	45900.0	730.00	47100.0	750.00	52400.0	765.00
	50000.0	750.00	50600.0	760.00	51800.0	750.00	52400.0	765.00		
	55900.0	765.00	57000.0	780.00						



PCI PLAN 2-4

BASIC LEVEL 720.000 M
 DELTA T .12470 SEC

[PIPELINE DATA]

PIPELINE NO	LENGTH M	MATERIAL	DIA. MM	ELASTIC MODULUS (LONG.) MM	UPPER PIPE NO.	THICKNESS	ELASTIC MODULUS (LONG.)	COND. SURGE	PUMP	VALVE	END VALVE	LOSS PIPE-LINE	INTERVAL TIME SEC	PIPELINE CONSTANT	DIVISION
1	15300.0	SGP1	1100	9.5	1	0	0	0	0	0	0	8.000	31.4232	.8718	252
2	41700.0	SGP1	1100	9.5	1	0	0	0	0	0	0	22.000	85.6437	.8718	688

[PUMP DATA]

NO	Q'TY	TYPE	VALVE CLOSING	NO	HEAD M	TOTAL HEAD M	CAPACITY M3/M	MOTOR KW	POLE	TYPE	GD2 KG-M2	GD2 (WHEEL) KG-M2	SPEED EFF. min-1 %	START CONDITION HEAD M	FLOW RATE M3/M	SPEED TORQUE
1	3	1	1	0	90.000	90.000	13.000	335.0	4	0	59.000	.000	1480	90.000	13.000	1.000

[SURGE TANK DATA]

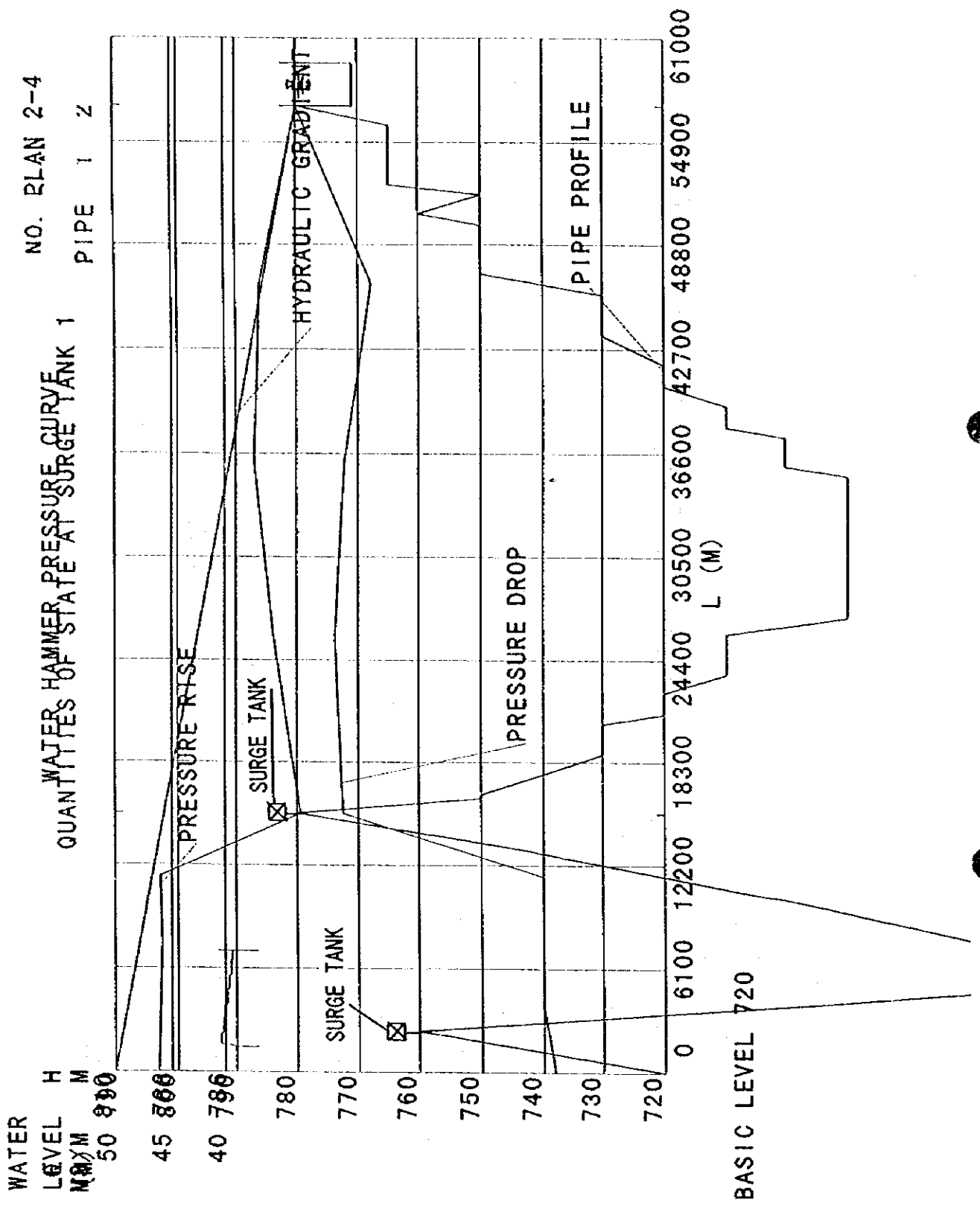
NO	TYPE	NO	HEAD M	SECTION AREA M2	FRIC LOSS M	DIS-TANCE M	PIPE MATERIAL	DIA. MM	THICKNESS MM	ELASTIC MODULUS	INTERVAL TIME SEC	PIPELINE CONSTANT	DIVISION	INITIAL AIR M3	LOSS M
1	1	0	62.000	13.000	7.347	.0	0	0	0	.0	.0000	.000	0	.0	.000

[PIPELINE ROUTE]

1 2

[PROFILE OF PIPELINE]

NO	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M	LENGTH M	LEVEL M
1	0	720.00	2300.0	760.00	4700.0	670.00	5900.0	660.00	13200.0	745.00
	7100.0	660.00	10300.0	700.00	10500.0	705.00	13200.0	745.00	18800.0	730.00
	15300.0	780.00	16200.0	750.00	16400.0	750.00	18800.0	730.00	23500.0	710.00
	20600.0	730.00	21200.0	720.00	22400.0	720.00	23500.0	710.00	35900.0	700.00
	25900.0	710.00	27000.0	690.00	35300.0	690.00	35900.0	700.00	40600.0	720.00
	37600.0	700.00	38200.0	710.00	39400.0	710.00	40600.0	720.00	47100.0	750.00
	41800.0	720.00	43500.0	730.00	45900.0	730.00	47100.0	750.00	51800.0	750.00
	50000.0	750.00	50600.0	760.00	51800.0	750.00	52400.0	765.00		
	55900.0	765.00	57000.0	780.00						



6.5 List of Pipe Materials



I. Bill of Quantity of Pipe Materials

[Unit : km]

Materials	dia (m)	Plan 1	Plan 2	Plan 3	Plan 4			Plan 5			Total
					4A	4B	4C	5A	5B	5C	
h-steel	0.125	18.4	18.0		3.8	4.4	3.8				48.4
pvc	0.100				1.0	1.1	1.0				3.1
"	0.150	32.6	31.5	6.0							70.1
"	0.200	4.5	4.5	8.0							17.0
"	0.250	9.0	27.0	2.5							38.5
"	0.300	9.0	16.6	1.0							26.6
"	0.350	13.5									13.5
"	0.400	12.3									12.3
"	0.450			9.0							9.0
steel	0.125	9.2	9.0	1.1	1.9	2.2	1.9	Not Including			25.3
"	0.550										0.0
"	0.600	13.5	22.5								36.0
"	0.650		34.0								34.0
"	0.700	40.0	19.0								59.0
"	0.800		0.2								0.2
"	0.900	11.2									11.2
"	1.000		11.0								
"	1.100		69.0								69.0
"	1.200		34.0								34.0
Total		173.2	296.3	27.6	6.7	7.7	6.7				507.2

[Symbols]	
steel	Steel Pipe
h-steel	High Pressure Steel Pipe
pvc	Polyvinyl Chloride Pipe

II. List of Pipe Materials

[Symbols]	
P/S	Pumping Station
PRT	Pressure Reduce Tank
steel	Steel Pipe
h-steel	High Pressure Steel Pipe
pvc	Polyvinyl Chloride Pipe

[Plan I]

Classification	Pipeline		Material	Diameter (m)	Max Pressure (m)	No's of Line (Nos)	Unit Length (km)	Total Length (km)	Trench Depth (m)
	Start	End							
Collection	Wells	Ground	h-steel/steel	0.125	520	92	0.3	27.6	-
"	Ground	each Junction	pvc	0.150	15	92	0.3	27.6	
"	Ground	Junction A	pvc	0.150	15	10	0.5	5.0	
"	Junction A	Junction B	pvc	0.200	15	9	0.5	4.5	
"	Junction B	Junction C	pvc	0.250	15	9	0.5	4.5	
"	Junction C	Junction D	pvc	0.250	15	9	0.5	4.5	
"	Junction D	Junction E	pvc	0.300	15	9	0.5	4.5	
"	Junction E	Junction F	pvc	0.300	15	9	0.5	4.5	
"	Junction F	Junction G	pvc	0.350	15	9	0.5	4.5	
"	Junction G	Junction H	pvc	0.350	15	9	0.5	4.5	
"	Junction H	Junction I	pvc	0.350	15	9	0.5	4.5	
"	Junction I	Junction TA	pvc	0.400	15	2	3.1	6.2	
"	"	"	pvc	0.400	15	1	6.1	6.1	
"	Junction TA	Junction TB	steel	0.700	15	1	0.5	0.5	
"	Junction TB	Collected Tank	steel	0.900	15	1	0.2	0.2	
Conveyance	P/S	Highest place	steel	0.900	40	1	11.0	11.0	
"	Highest place	PRT 1	steel	0.700	80	1	15.5	15.5	
"	PRT 1	PRT 2	steel	0.600	70	1	6.0	6.0	
"	PRT 2	PRT 3	steel	0.600	90	1	7.5	7.5	
"	PRT 3	PRT 4	steel	0.700	60	1	11.0	11.0	
"	PRT 4	D.W.Reservoir	steel	0.700	70	1	13.0	13.0	
Total								173.2	

[Plan 2]

Classification	Pipeline		Material	Diameter (m)	Max Pressure (m)	No's of Line (Nos)	Unit Length (km)	Total Length (km)	Trench Depth (m)
	Start	End							
Collection	Wells	Ground	h-steel/steel	0.125	320	90	0.3	27.0	-
"	Ground	each Junction	pvc	0.150	15	90	0.3	27.0	
"	Ground	Junction A	pvc	0.150	15	9	0.5	4.5	
"	Junction A	Junction B	pvc	0.200	15	9	0.5	4.5	
"	Junction B	Junction C	pvc	0.250	15	9	0.5	4.5	
"	Junction C	Junction D	pvc	0.250	15	9	0.5	4.5	
"	Junction D	Junction E	pvc	0.250	15	9	0.5	4.5	
"	Junction E	Junction F	pvc	0.250	15	9	0.5	4.5	
"	Junction F	Junction G	pvc	0.250	15	9	0.5	4.5	
"	Junction G	Junction H	pvc	0.250	15	9	0.5	4.5	
"	Junction H	Junction I	pvc	0.300	15	9	0.5	4.5	
"	Junction I	Junction TA	pvc	0.300	15	2	3.1	6.2	
"	"	"	pvc	0.300	15	1	5.9	5.9	
"	Junction TA	Junction TB	steel	0.600	15	1	0.5	0.5	
"	Junction TB	Collected Tank	steel	0.800	15	1	0.2	0.2	
Conveyance	No1 P/S	No2 P/S	steel	1.200	40	1	34.0	34.0	
"	No2 P/S	No3 P/S	steel	1.000	40	1	11.0	11.0	
"	No3 P/S	No4 P/S	steel	1.100	40	1	12.0	12.0	
"	No4 P/S	Highest Place	steel	1.100	40	1	57.0	57.0	
"	Highest place	PRT 1	steel	0.700	80	1	16.0	16.0	
"	PRT 1	PRT 2	steel	0.650	70	1	12.0	12.0	
"	PRT 2	PRT 3	steel	0.650	90	1	11.0	11.0	
"	PRT 3	PRT 4	steel	0.650	60	1	11.0	11.0	
"	PRT 4	PRT 5	steel	0.600	70	1	7.0	7.0	
"	PRT 5	PRT 6	steel	0.600	90	1	7.0	7.0	
"	PRT 6	PRT 7	steel	0.600	60	1	8.0	8.0	
"	PRT 7	D.W.Reservoir	steel	0.700	70	1	3.0	3.0	
Total								296.3	

[Plan 3]

Classification	Pipeline		Material	Diameter (m)	Max Pressure (m)	No's of Line (Nos)	Unit Length (km)	Total Length (km)	Trench Depth (m)
	Start	End							
Collection	Wells	each Junction	steel	0.125	120	9	0.12	1.1	-
"	Junction A	Junction B	pvc	0.150	30	1	2.0	2.0	-
"	Junction B	Junction C	pvc	0.200	25	1	2.0	2.0	-
"	Junction C	Junction G	pvc	0.250	25	1	2.5	2.5	-
"	Junction D	Junction E	pvc	0.150	20	1	2.0	2.0	-
"	Junction E	Junction F	pvc	0.200	15	1	2.0	2.0	-
"	Junction F	Junction G	pvc	0.200	15	1	0.5	0.5	-
"	Junction G	Collected Tank	pvc	0.300	10	1	1.0	1.0	-
"	Junction H	Junction I	pvc	0.150	30	1	2.0	2.0	-
"	Junction I	Junction J	pvc	0.200	25	1	2.0	2.0	-
"	Junction J	Collected Tank	pvc	0.200	10	1	1.5	1.5	-
Conveyance	Collected Tank	D.W.Reservoir	pvc	0.450	10	1	9.0	9.0	-
Total								27.6	

[Plan 4]

Classification	Pipeline		Material	Diameter (m)	Max Pressure (m)	No's of Line (Nos)	Unit Length (km)	Total Length (km)	Trench Depth (m)
	Start	End							
Plan 4A	Wells	Ground	h-steel/steel	0.125	320	19	0.30	5.7	-
"	Ground	W. Reservoirs	pvc	0.100	10	19	0.05	1.0	-
Plan 4B	Wells	Ground	h-steel/steel	0.125	320	22	0.30	6.6	-
"	Ground	W. Reservoirs	pvc	0.100	10	22	0.05	1.1	-
Plan 4C	Wells	Ground	h-steel/steel	0.125	320	19	0.30	5.7	-
"	Ground	W. Reservoirs	pvc	0.100	10	19	0.05	1.0	-
Total								21.0	

[Plan 5]

Classification	Pipeline		Material	Diameter (m)	Max Pressure (m)	No's of Line (Nos)	Unit Length (km)	Total Length (km)	Trench Depth (m)
	Start	End							
Plan 5A	Wells	Ground	pvc	0.040	30	1	0.025	0.0	-
"	Ground	W. Reservoirs	pvc	0.040	10	1	0.050	0.1	-
Plan 5B	Wells	Ground	pvc	0.080	30	1	0.025	0.0	-
"	Ground	W. Reservoirs	pvc	0.080	10	1	0.050	0.1	-
Plan 5C	Wells	Ground	pvc	0.080	30	2	0.025	0.1	-
"	Ground	W. Reservoirs	pvc	0.080	10	2	0.050	0.1	-
Total								0.3	





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