Annex 6. LIST OF COLLECTED DATA

1. Main drinking water treatment plant out put increase from 5 to 7.5 MGD - Degremont - July 1982. (Copy)
2. Contract Agreement with Degremont on Kandy Water Supply Project (Augmentation) Improvement to Existing Water Purification Plant - NWSDB - Dec. 1980 - (Copy)
3. Financial Assistance for the Augmentation of Kandy Water Supply Scheme - NWSDB - March 198?. (Copy)
4. Computation of average billing rate for domestic consumers per month per household - NWSDB - 198?. - (Computer sheet)
5. Contract document of Athgala Water Supply scheme - NWSDB - Feb. 1988 - (Original)
6. Contract document of Anamadua Water Supply scheme - NWSDB - June 1987 - (Original)
7. Contract document of Water Supply scheme for Biyagama Investment Promotion Zone - NWSDB - Jan. 1984 - (Original)
8. Design Criteria for Water Supply Scheme - NWSDB - - (Partial copy)
9. Present Water Tariff and Consumer Instructions - NWSDB - (Copy)
10. Water Tariff - Municipal council, Kandy - Jan. 1982 - (Original)
11. Water Tariff - Municipal council, Kandy - Jan. 1988 - (Original)
12. Electricity Charges - Municipal council, Kandy - Jan. 1988 - (Original)
13. Tariffs and charges for the Supply of Electrical Energy - Ceylon Electricity Board - Nob. 1987 - (Copy)
14. Water Supply and Sanitation Project Identification Report 1986-1995 - Suunnittelukeskus oy - Planceenter Ltd. - Jan. 1986 - (Copy)
15. Kandy District Water supply and Sanitation Project, Phase I, Project Document (Annex 1) 1987-1990 - Suunnittelukeskus oy - Planceenter Ltd. - Aug. 1987 - (Copy)
16. Kandy Urban Water Supply Present situation and Recommendations - NWSDB.

Assistant General Manager, Regional Service Central, Kandy -

17. Harispattuwa Water Supply and Sanitation Project, Progress Report for the First Half of 1986 - Suunnittelukeskus oy - Planceenter Ltd.- 1986 (Partial Copy)
18. USAID Project for Kandy District, List of Supplied Facilities (Specification) - Connell Bros. Co., Ltd. -
19. NWSDB Regional Budgets 1988 - NWSDB - Jul. 1988 - (Copy)
20. NWSDB Summary Budget Request O&M for Yatinuwara Scheme - NWSDB - Oct. 1987 - (Copy)
21. Operation Record of Kandy Water Supply, Jan.'68 to Oct.'88 - MCK - (Partial copy)
22. Annual Budget on Water Works of MCK 1983 to 1988 - MCK - (copy)
23. Well Drilling and Water Quarterly Record for the Plant Genetic Resources Center in Peradeniya - Environmental Laboratories Ltd. - Aug. 1987 -(Copy)
24. Hydrological Data for Year 1960/61～85/86 - Department of Irrigation - (Copy)
25. Daily Water Level Data at Pradeniya Gauging Station on Mahaweli River, Jan. '78 to Sep. '88 - Irrigation Department - (Copy)
26. Water Supply Scheme Town of Kandy Treatment Station Tender Document - Ministry of Transport and Works Public Works Department - Sep. 1958 - (Partial Copy)
27. Water Supply Scheme Town of Kandy, Form of Tender - Department of Water Supply and Drainage - Mar. 1959 - (Partial Copy)
28. Sri Lanka Water Supply and Sanitation Sector Study Graft Final Report - World Bank - Jul. 1987 - (Copy)
29. Price Escalation Data of Basic Items for Construction - Prepared by NWSDB - Oct. 1988 - (Copy)
30. Laborer's structure per Unit Volume of Construction Works - NWSDB - Aug. 1979 - (Copy)
31. Related Drawings on The Existing Facilities of Kandy Water Supply Scheme

Annex 7. RESULTS OF THE TEST EXECUTED IN THE SITE

Water quality investigation was carried out in accordance with the following procedure;

1. Site Test

Following tests were carried out in the Site on 17th & 18th Oct.,1988

1). Water Analysis (General)
2). Back Washing Test of Sand Filter
3). Coagulation Test

2. Analysis in the Laboratory in Japan

Following analyses were carried out in the Laboratory in Japan using the samples which were taken in Kandy Water Treatment Plant.

1). Filter media analysis
2). Measurement of the diameter of the filter media of the filtration plant and sand & silt accumulated in the Plant.
3). Water Analysis (Detail)

2.1. Site Test

1). Water Analysis (General)

Chart No.1

Date	17 Oct 1988						18 Oct 1988				
Sampling Point	Pre-aeratopn	Post-aeration	Pre-Pulsator	Post-Pulsator	Post-filter	Final tank	Post-aeration	Pre-Pulsator	Post-Pulsator	Post-filte r	Final tank
Atom Temp ℃	31	31	31	31	31	31	20	20	20	20	20
Water Temp ℃	19	19	19	19	19	18	18	18	18	18	18
PH	7.1	6.8	7.0	6.8	7.0	–	7.9	7.7	7.7	7.5	–
Turbidity Ntu	15	17	7.3	14	1.2	1.2	12	10	9	1.4	1.4
Colour	2～5	2～5	<2	<2	<2	<2	10	10	7	<2	<2
Residual cl mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	2	<0.1	<0.1	<0.1	<0.1	1.5
Total Fe	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

Remarks : 1). Chlorine injection point is just before the final tank.
2). Water Analysis shows the following results;
(1). Filter is operated under the over-load condition.
(2). Function of Pulsator could not be sufficiently fulfilled with.

2). Back washing test of Sand filter

Chart No. 2

Test1 : Back wash by existing method		Test2 : Back wash by trial method	
Process & Time	Turbidity of back washing waste water	Process & Time	Turbidity of back washing waste water
Decloqging 1 min	—	Decloqging 1min	—
↓		↓	
Back wash by air 1 min	576 NTU	Back wash by air & water 1min	168 NTU
Back wash by air 2 min	830	Back wash by air & water 2min	204
Back wash by air 3 min	980	Back wash by air & water 3min	
Back wash by air 5 min	980	Back wash by air & water 5min	
↓		Back wash by air & water10min	
Back wash by water 1 min	980	↓	
Back wash by water 2 min	910	Back wash by water 1 min	89
Back wash by water 5 min	330	Back wash by water 2 min	46
Back wash by water 8 min	35	Back wash by water 5 min	15
Back wash by water 12 min	20		
Back wash by water 15 min	7		

Remarks: 1) Test 2 was carried out just after Test 1 using the same filter.

2) It is very difficult to say that the corrupted material in the filter is not washed out sufficiently by the existing

3). Coagulation Test

18. Oct 1988

1. Method

Water sample (1 lit.) → 1%Alum dosing → Neutralization (PH=7) by 5% $Ca(OH)_2$
→ Rapid Mixing (3min) → Flocculation (10min) → Setlling

2. Water sample

1) Sampling point : Post-aeration 2) Quality : PH 7.7, Turbidity 19 NTU

3. Test Result

Chart No. 3

Test NO	①	②	③	④	*1⑤
Q'ty of Alum to be dosed (ml)	2	3	5	7	5
PH after Alum dosing	7.4	5.8	5.5	5.0	4.7
Q'ty of $Ca(OH)_2$ for neutralization (ml)	0	0.5	0.55	0.8	2.8
Appearance of flocc	×	◎	○	○	△
Settling spead of flocc (cm/min)	−	10	5	3	5
Turbidity of clarified water (NTU)	13	0.5	0.9	1.0	0.3

＊1 : Note
Test NO⑤ was carried out by dosing 10%PAC instead of Alum

4. Conclusion

1) Good flocc can be obtained when dosing is suitable.
2) Recommendable dosing rate of 1% Alum is 10 ppm.
3) Neutralization Process is inevitable after Alum dosing
(No flocc was found without Neutralization)

Annex 8. LABORATORY ANALYSIS IN JAPAN

1). Filter Media Analysis

1.1. Test Method

In accordance with thte following method, sampling of the filter media was carried out on 18th Oct., 1988. Analysis of the turbidity of the samples was measured on 4th Nov., 1988 in the laboratory in Japan.

Sample No.	Condition of Sampling	Sampling Points
A-1-1	Just before the normal back washing	Surface of the filter
A-1-2	ditto	15cm below the surface of the filter
A-1-3	ditto	30cm below the surface of the filter
A-1-4	ditto	45cm below the surface of the filter
A-1-5	ditto	60cm below the surface of the filter
A-2-1	Just after the normal back washing	Surface of the filter
A-2-2	ditto	15cm below the surface of the filter
A-2-3	ditto	30cm below the surface of the filter
A-2-4	ditto	45cm below the surface of the filter
A-2-5	ditto	60cm below the surface of the filter
A-3-1	Just after back washing both air and water	Surface of the filter
A-3-2	ditto	15cm below the surface of the filter
A-3-3	ditto	30cm below the surface of the filter
A-3-4	ditto	45cm below the surface of the filter
A-3-5	ditto	60cm below the surface of the filter

1.2. Test Results

Chart No.4

Sample No.	Turbidity(Degree)
A-1-1	70
A-1-2	70
A-1-3	60
A-1-4	40
A-1-5	35
A-2-1	12
A-2-2	16
A-2-3	14
A-2-4	7
A-2-5	14
A-3-1	10
A-3-2	5
A-3-3	3
A-3-4	10
A-3-5	20

Remarks : 1) Above test was carried out in accordance with the Japanese standards.

2). Measurement of the diameter of the filter media of the filtration plant and Sand & Silt accumulated in the Plant

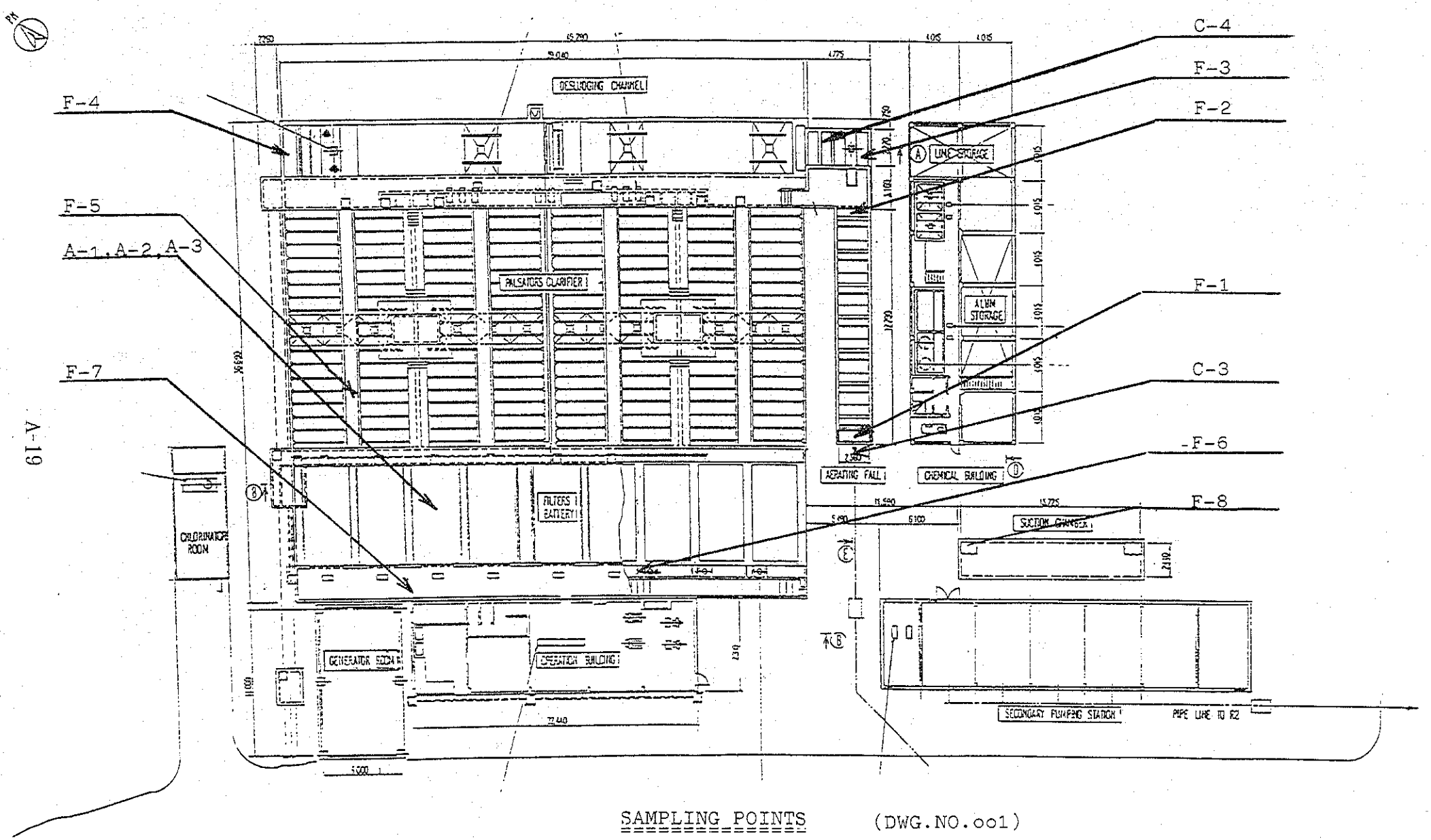
2.1. Test Method

In accordance with the following condition, sampling was carried out in 18th Oct., 1988. Measurement of each sample was carried out on 4th Nov., 1988 in the laboratory in Japan.

Sample No.	Sampling Point
B	Filter media in the filter
C-1	Sand & Silt accumulated in the low water intake
C-2	Sand & Silt accumulated in the Intake pump pit
C-3	Sand & Silt accumulated in the Inflow piping line
C-4	Sand & Silt accumulated in the pit just after the rapid mixing

2.2. Test Result

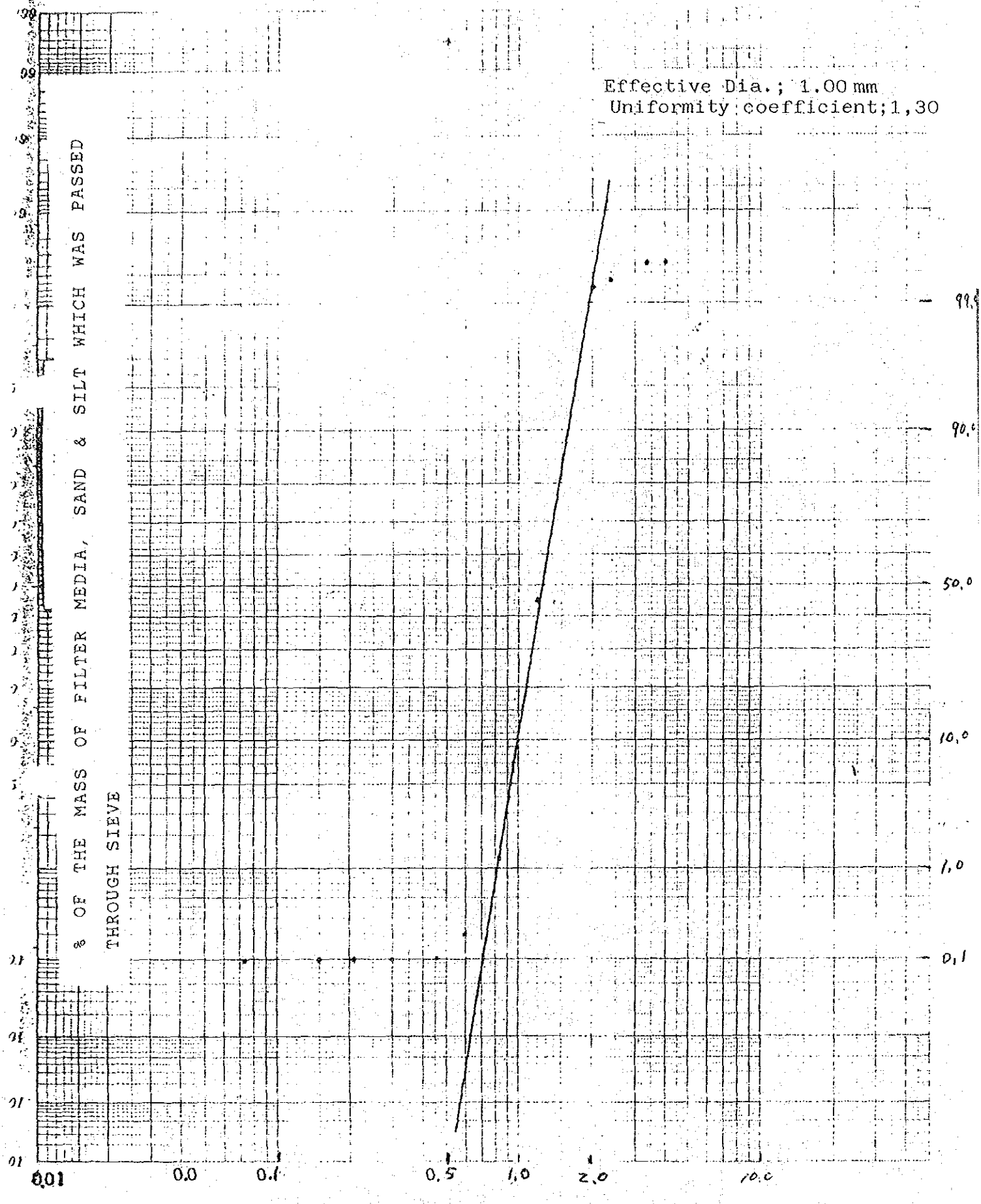
Test result is as per the attached graphs(Graph No.1 - 6).



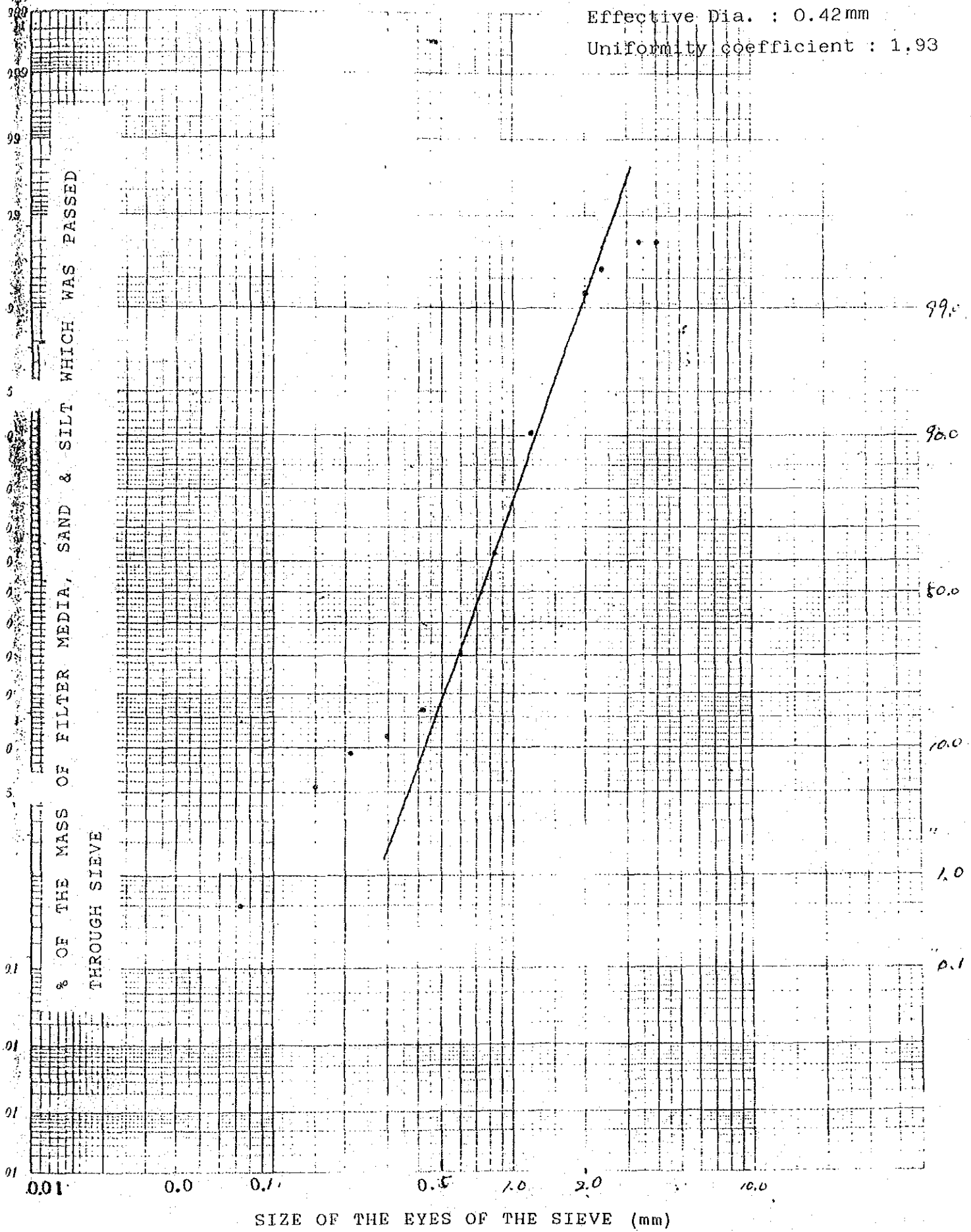
A-19

SAMPLING POINTS (DWG.NO.oo1)

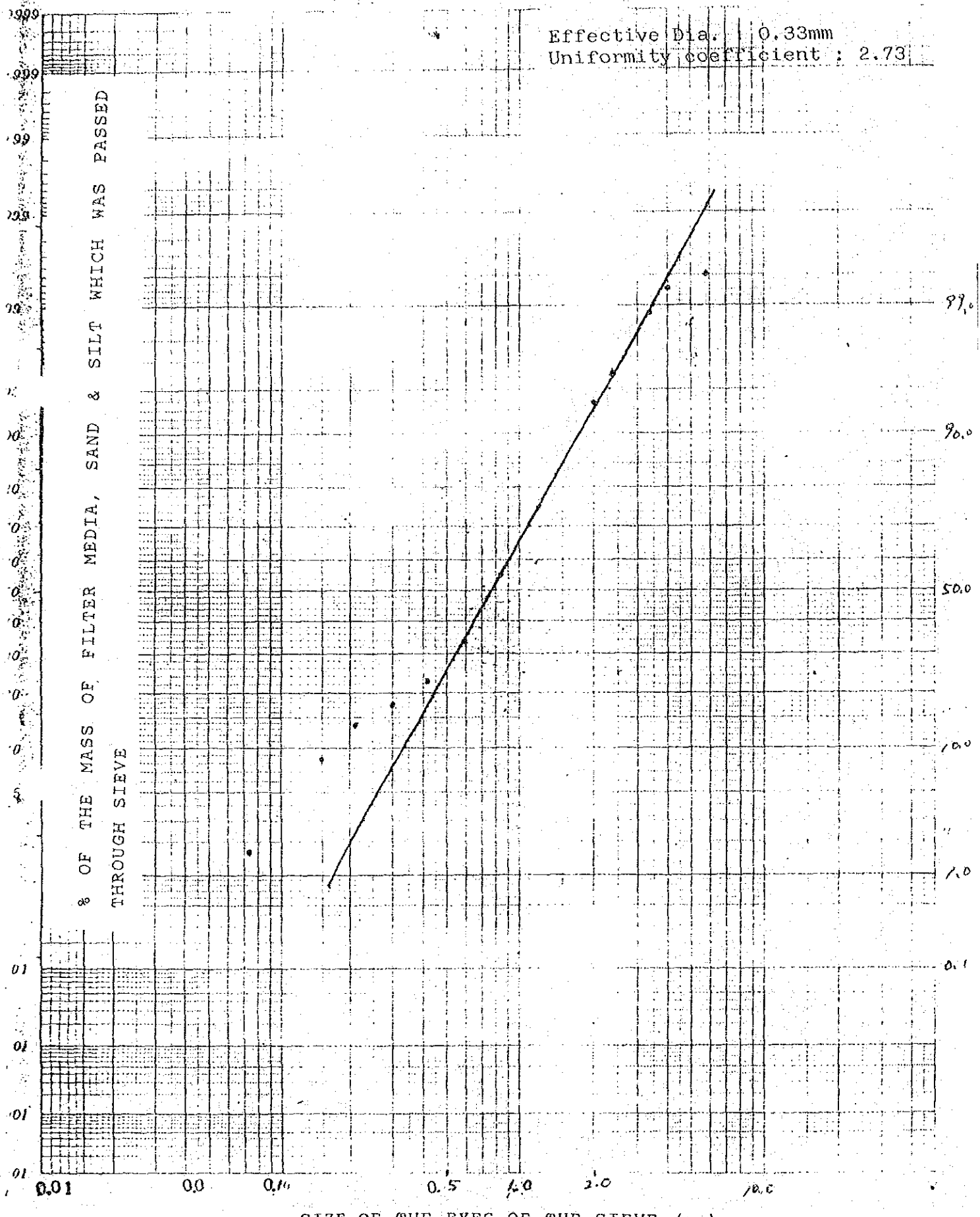
GRAIN SIZE DISTRIBUTION (B)



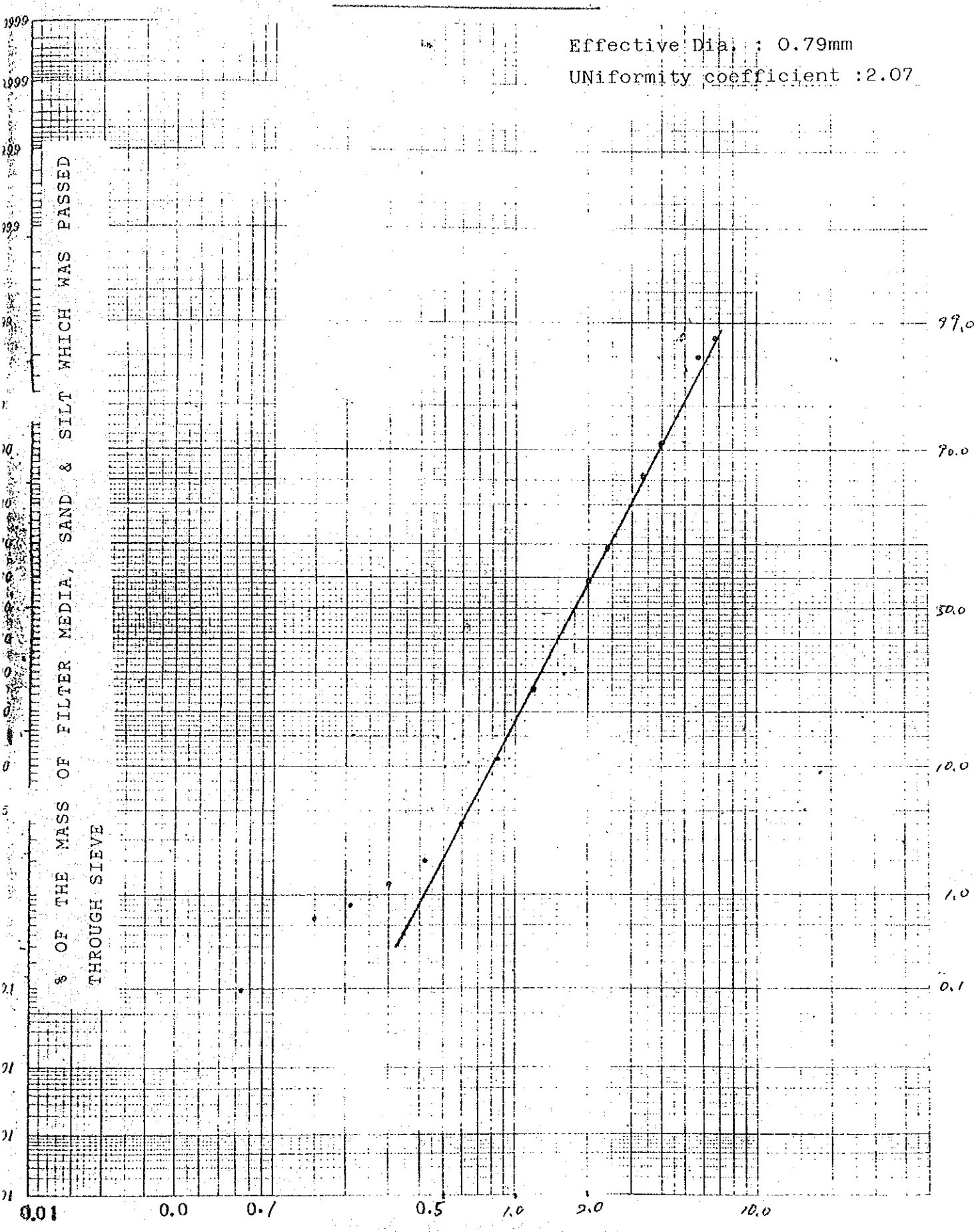
GRAIN SIZE DISTRIBUTION (C-1)



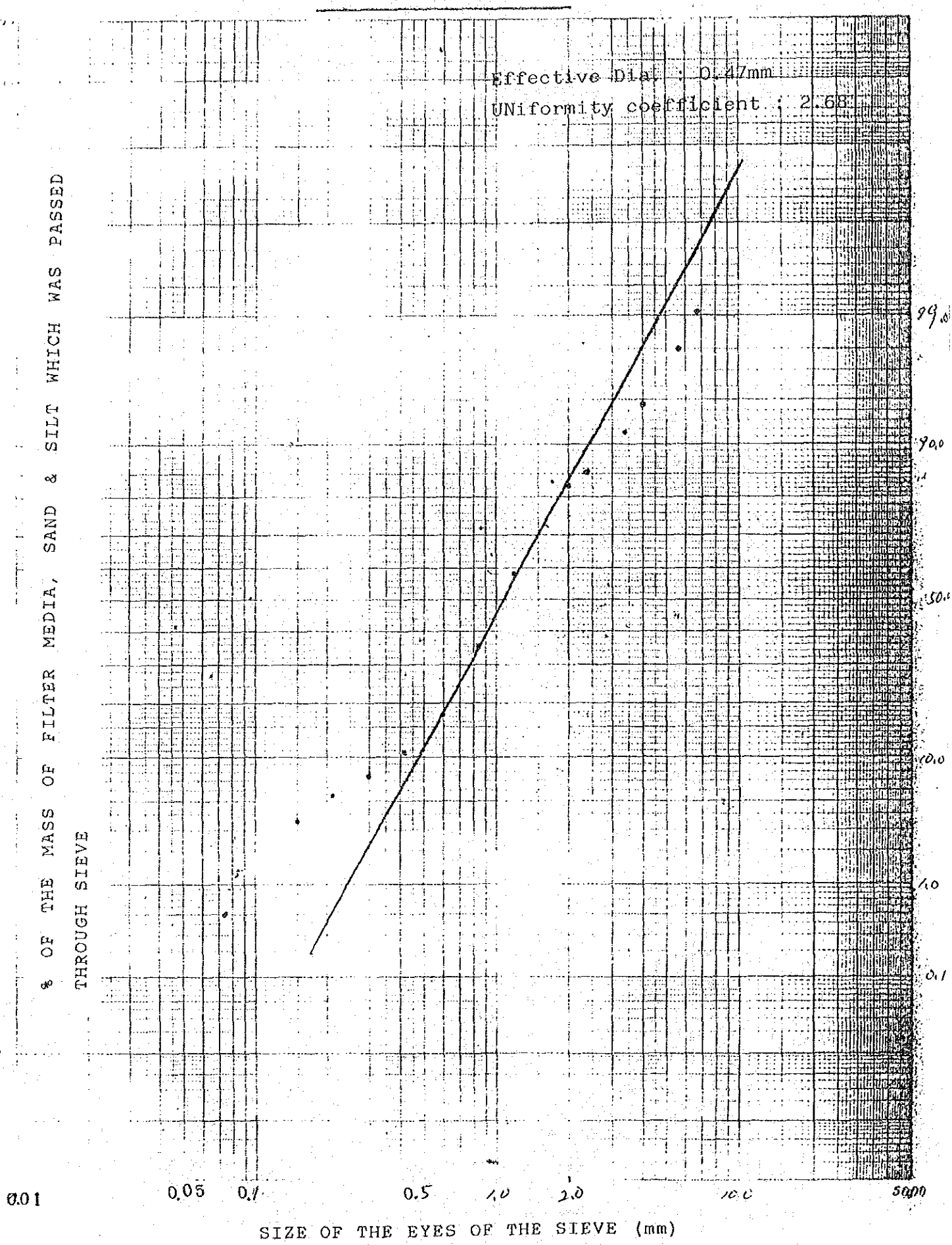
GRAIN SIZE DISTRIBUTION (C-2)



GRAIN SIZE DISTRIBUTION (C-3)



GRAIN SIZE DISTRIBUTION (C-4)



3. Water Analysis (Detail)

3.1. Test Method

In accordance with the following condition, sampling of the water was carried out on 17th and 18th Oct., 1988.
Water Quality Analysis was carried out 4th Nov., 1988 in Laboratory in Japan.

Sample No.	Sampling point
F-1	Low Water (Just before the aeration)
F-2	Just after the aeration
F-3	Rapid mixing basin (Just after the Alum Injection)
F-4	Just after the desludging channel
F-5	Just after Pulsator (Prior to the post lime injection point)
F-6	Just after the filter
F-7	Filtered water tank (Residual Chlorine : 1.5ppm)
F-8	Suction Chamber (Residual Chlorine : 2 ppm)

Please refer to the attached drawing (Dwg.No.001) for the sampling points.

3.2. Test Result

Test result is as per attached chart No.5.

WATER ANALYSIS (DETAIL)

Chart No.5 Date:4th Nov.1988

SAMPLE NO. / TEST ITEM	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8
pH(Temp.: 15°C)	6.80	6.59	6.67	6.60	5.90	5.82	6.20	6.40
Color(degree)	8	8	5	2	2	2	1	1
Turbidity(degree)	9	7	20	20	14	10	6	2
Electrical Conductibity(mg/ℓ)	49.2	49.5	55.7	57.5	54.5	54.0	58.5	61.3
NO2-N(mg/ℓ)	13	13	13	13	4	3	6	7
NO3-N(mg/ℓ)	0.002	0.002	0.003	0.001	0.003	0.002	<0.001	<0.001
Total Fe(mg/ℓ)	0.44	0.39	0.37	0.43	0.49	0.22	0.12	0.08
Coliform-bacteria(Lot/mℓ)	7	5	0	0	0	0	0	0

Remarks: 1). Above analysis was carried out in accordance with Japanese Standard.

Annex 9. The reasons why Tow-step pumping System has been adopted.

In general, intake pumping systems are divided into two categories: the single-step pumping system and the multi-step pumping system. It should be selected on the basis of analyses on the construction cost, operation and maintenance cost, and execution period of the construction. In this Project, a two-step pumping system has been adopted after consideration of the natural conditions in topography, geography, and flow of Mahaweli River as well, in addition to the views above mentioned. The reasons on it are described as follows:

1) The structure to have a function of separating sand from river water

The resource of water supply is Mahaweli River, which contains a lot of sand. The impeller and shaft of the existing pump has been rapidly worn out due to abrasion with sand mixed in the raw water. For this reason, countermeasures against the sand are the most important in this project. There are two ways for it. The one is construction of a grit chamber and the other is installation of a pump with anti-abrasion measures. It was assumed that to construct a grit chamber is the most dependable measure because mechanical way cannot be always free from abrasion sufficiently. Therefore, the construction of a grit chamber was proposed in this project. There are some differences on the construction manners for each pumping system as follows;

In case of the single-step pumping system, the following measures should be constructed additionally.

a. to excavate below water level of the river in order to construct a grit chamber due to its technical system
b. to make a coffer dam such as sheet-pile for the dry working during the long construction period.

In case of the 2-step pumping system, a slurry pump will be selected as the first-step pump, and it is possible to pump directly up the raw water which contains a lot of sand. In addition, the construction costs will be less than those for the said system because of its small scaled structure.

2) Estimated Construction period

In case of the 2-step pumping system, it will take about one year to complete the construction. On the other hand, in case of the single-step pumping system, it will take several years to complete by following reasons.

a. a large volume of rock excavation which needs a long time construction period;
b. Suspension of the construction time due to occasional floods;
c. Need for reconstruction due to the any damages because of floods.

This project should be completed as soon as possible in order to solve the water shortage in Kandy City. For these reasons, it is assumed that the 2-step pumping system is the most effective way to be selected.

3) The works to remove sand out of the grit chamber

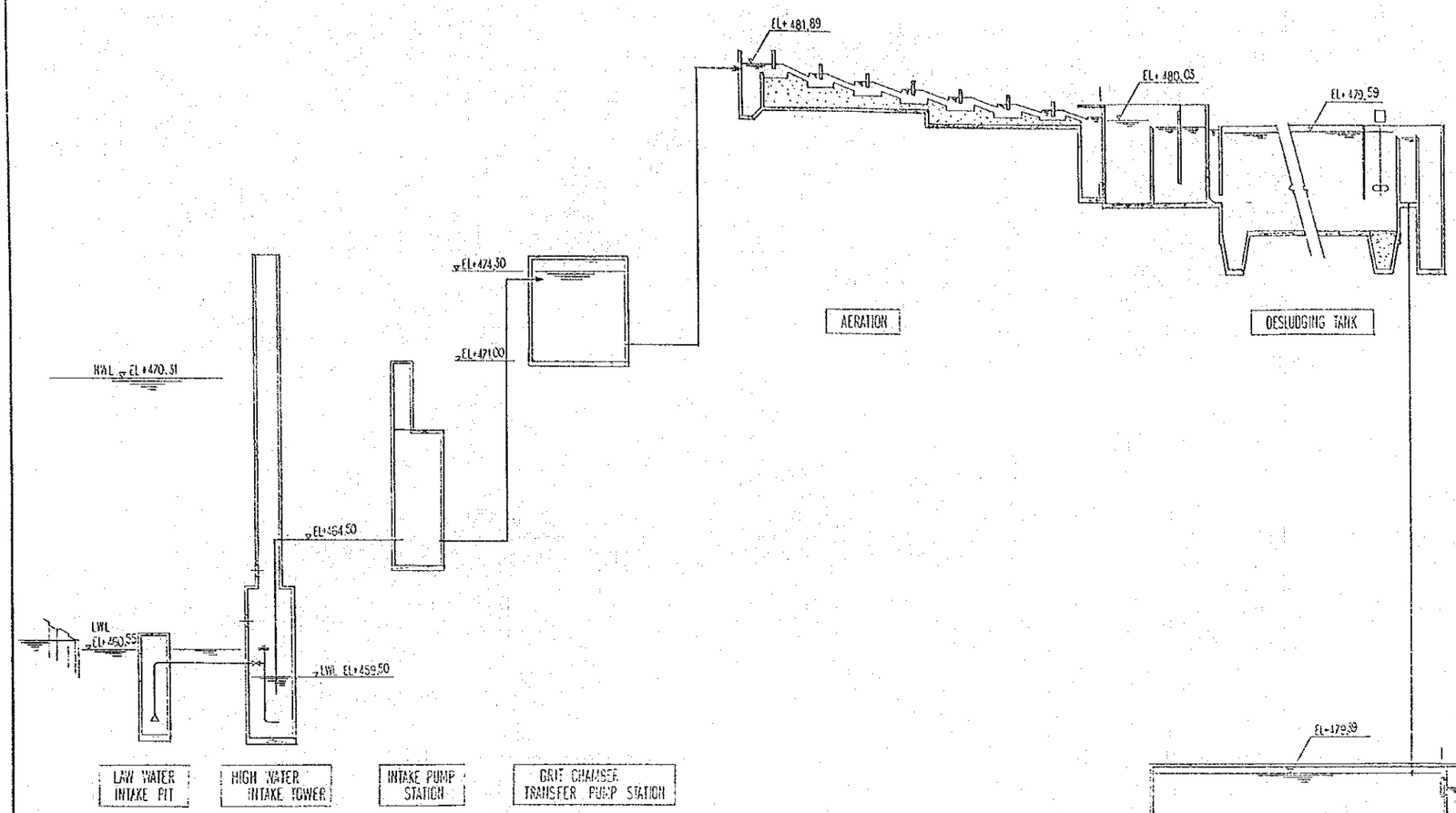
In case of the single-step pumping system, it will take much time and manpower to remove sand out of the grit chamber because of its depth. In case of the 2-step pumping system, it would not be difficult to remove sand off, because the grit chamber is rather shallow and is constructed at the above water level of the river.

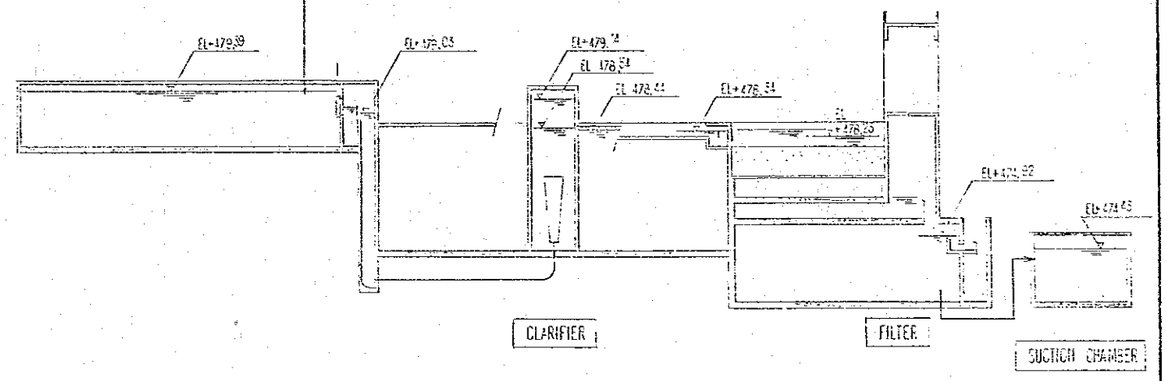
4) Maintenance & Operation

Generally, it can be said that the single-step pumping system is easy to operate compared with the 2-step pumping system. However, a long-shafted vertical pump will be applied by technical reasons in case of the single-step pumping system and it is difficult to maintain because of its complicated mechanical structure. On the other hand, a horizontal turbine pump will be applied in case of the 2-step pumping system, and it is easier to maintain because of its simple structure.

Generally, multi-step pumping systems consume more electricity than single-step pumping systems, however, 2-step pumping system recommended in this project consumes less electricity than the existing pumping system, because of its high efficiency.

BASIC DESIGN DRAWINGS





PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 1/11
Title : HYDRAULIC PROFILE

CITY WATER

NAKE UP WATER TANK

VACUUM PUMP
2.8㎥/h × 690mmHg × 5.5KW

SEAL WATER TANK

SEAL WATER PUMP
50㎥/min × 30m × 22KW

CRANE-1

CRANE-2

GRIT CHAMBER-A

GRIT CHAMBER-B

TRANSFER PUMP
12.43㎥/min × 20.8m × 55KW

TO TREATMENT PLANT

INTAKE PUMP
12.43㎥/min × 18.5m × 55KW

TO DRAIN

TO DRAIN

DRAIN PUMP
50㎥/h × 10m × KW

RIVER WATER

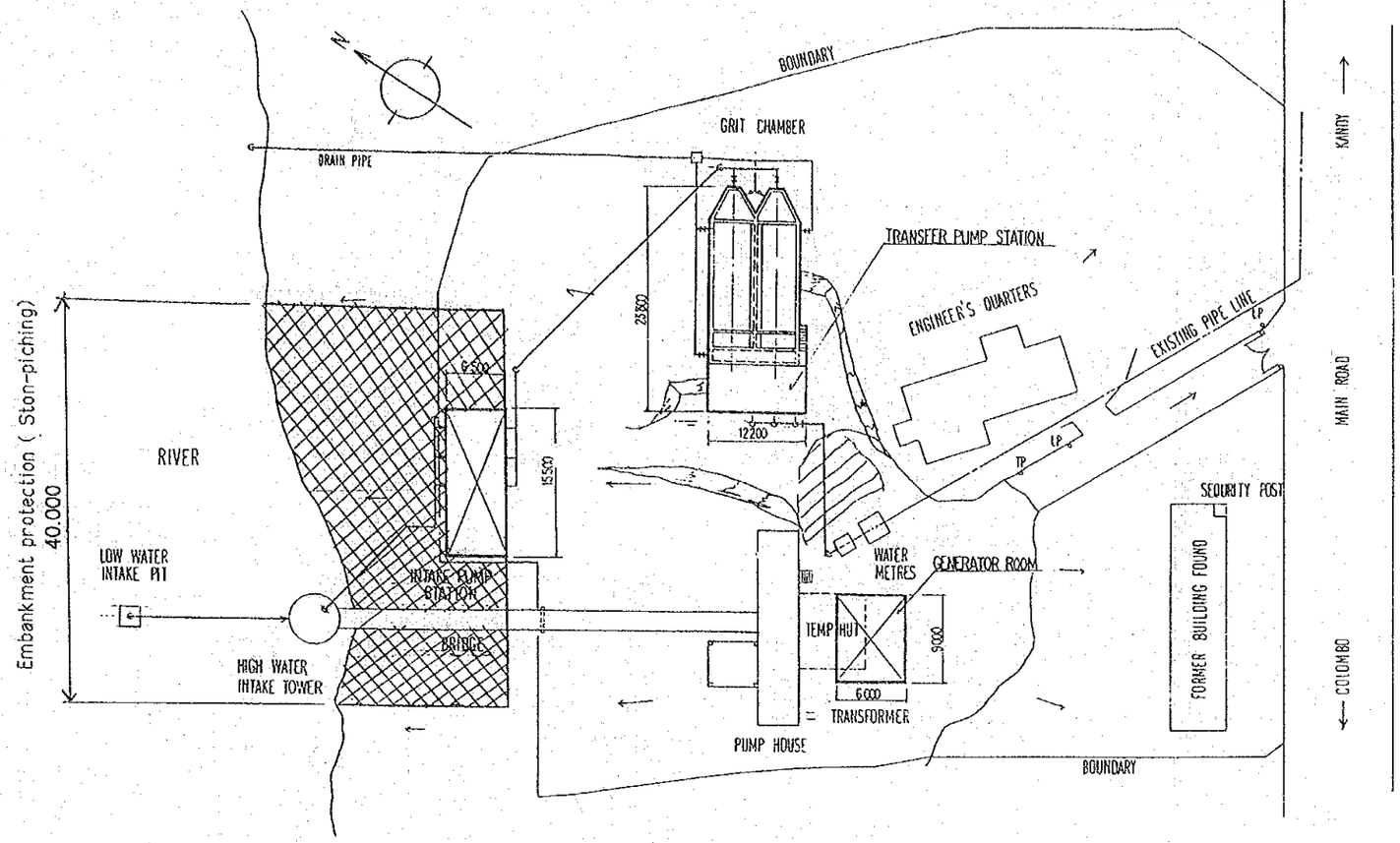
LOW WATER
INTAKE PIT

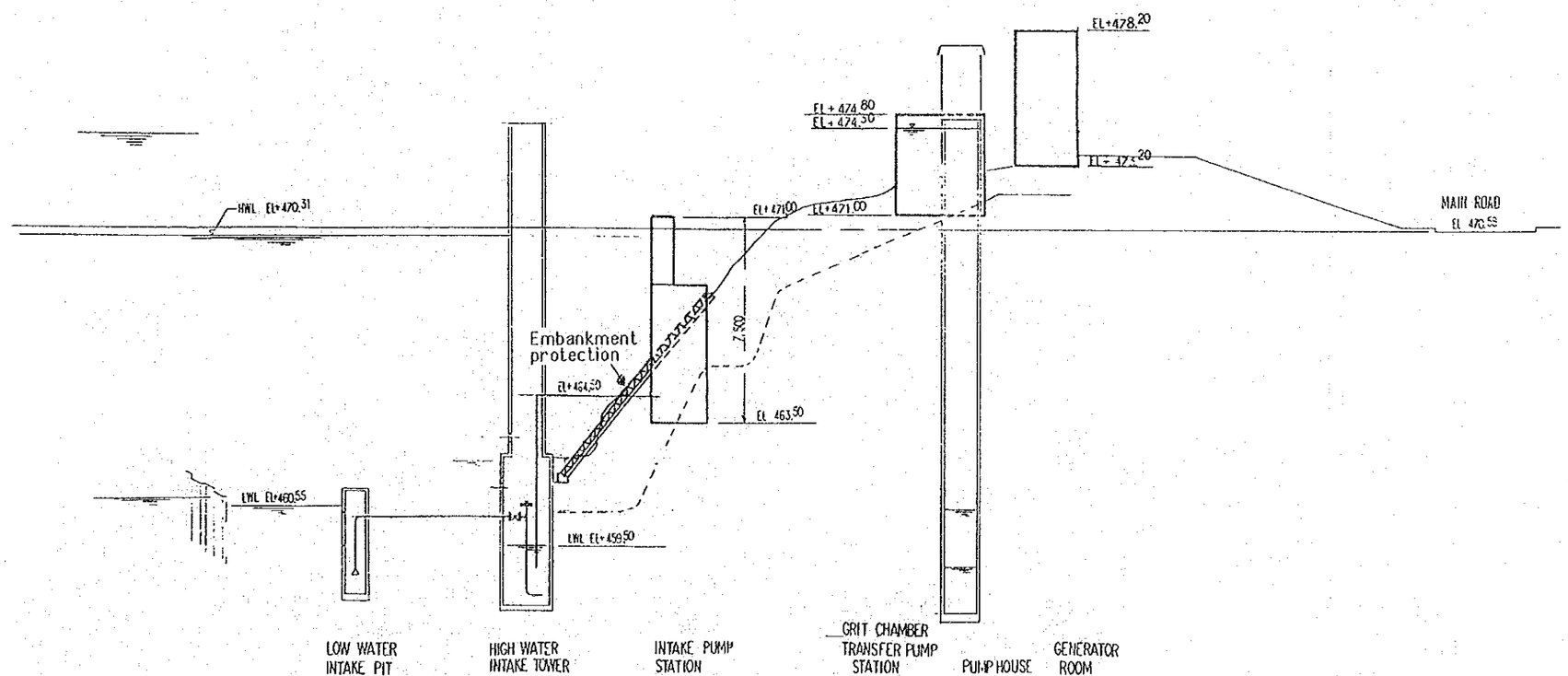
HIGH WATER
INTAKE TOWER

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 2／11
Title.:FLOW SHEET OF INTAKE PLANT

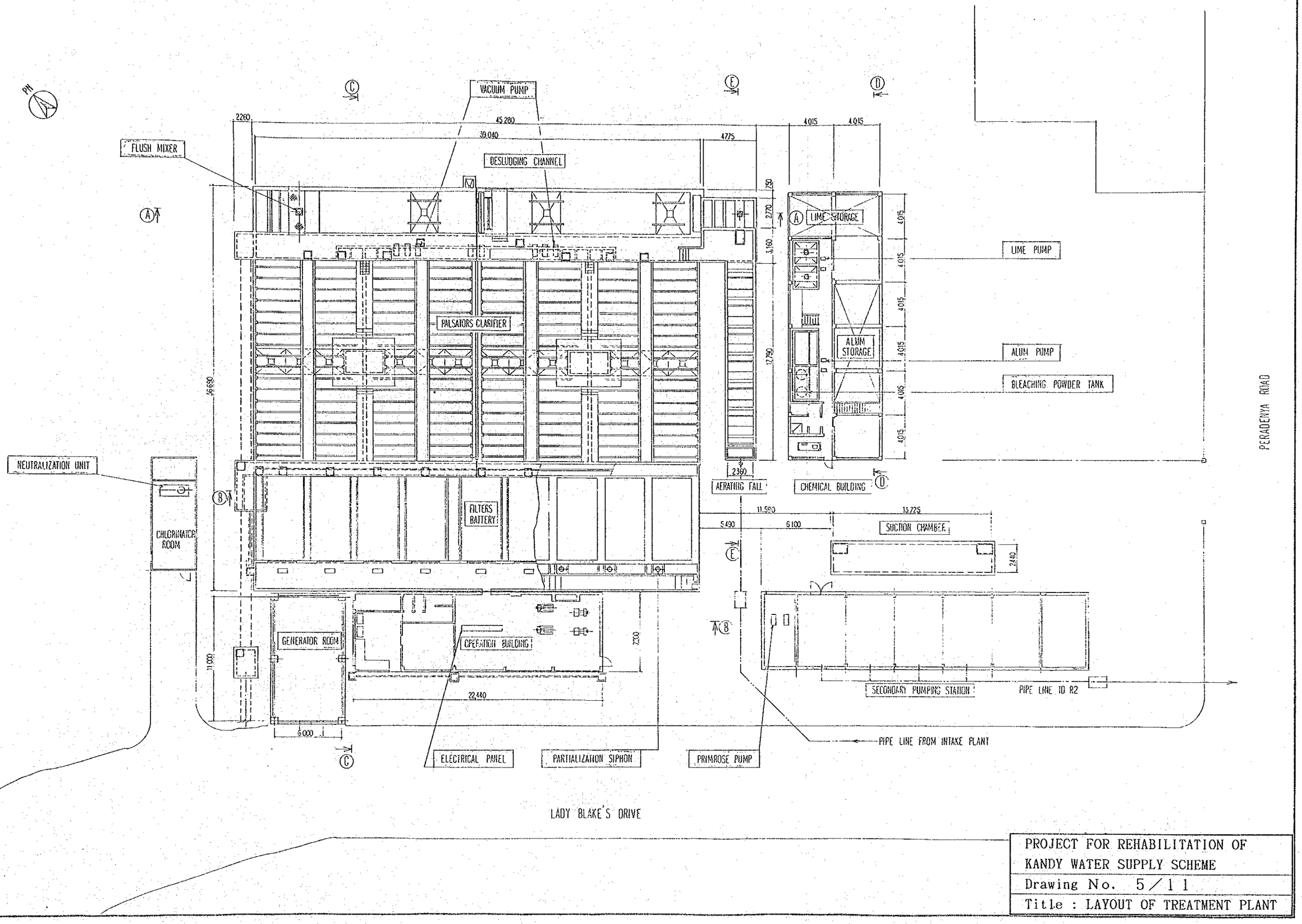
INDUSTRIAL WATER
BREACHING POWDER
ALUM BULK
LIME POWDER
LIME MIXER
LIME TANK
LIME PUMP
ALUM MIXER
ALUM PUMP
ALUM TANK
BLEACHING POWDER PUMP
BLEACHING POWDER TANK
INSTRUMENT AIR
COMPRESSOR
AIR TANK
BLOWER
CHLORINATOR
NEUTRALIZATION UNIT
TO PRIMROSE
PRIMROSE PUMP
TO R2 RESERVOIR
(OUT OF SCOPE)
BACK WASH PUMP
HIGH LIFT PUMP
AERATION
DESLUDGING CHANNEL
FLUSH MIXER
FROM INTAKE
DRAIN CHANNEL
BY-PASS
VACUUM PUMP
PULSATOR
FILTER
DRAIN

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 3/11
Title : FLOW SHEET OF TREATMENT PLANT

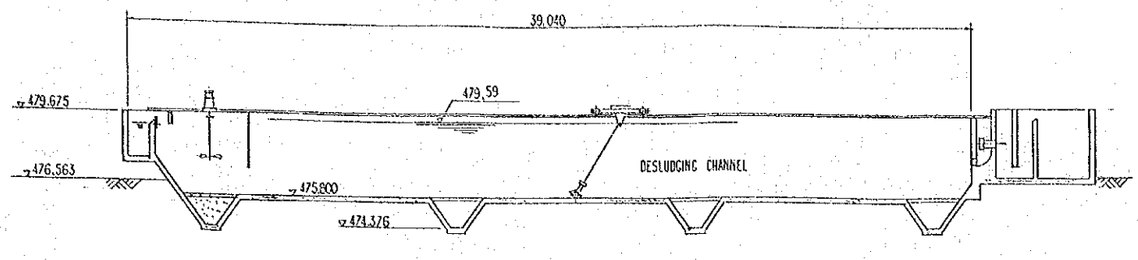




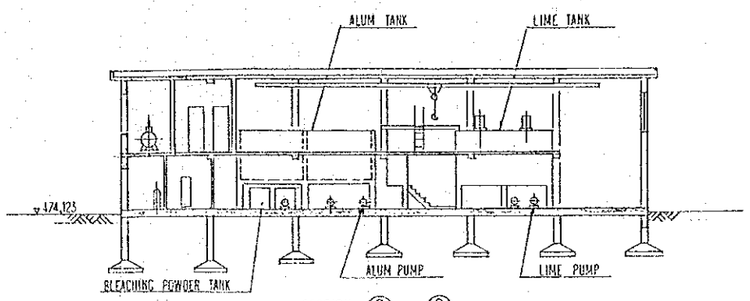
PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 4／11
Title : PLAN OF INTAKE PLANT



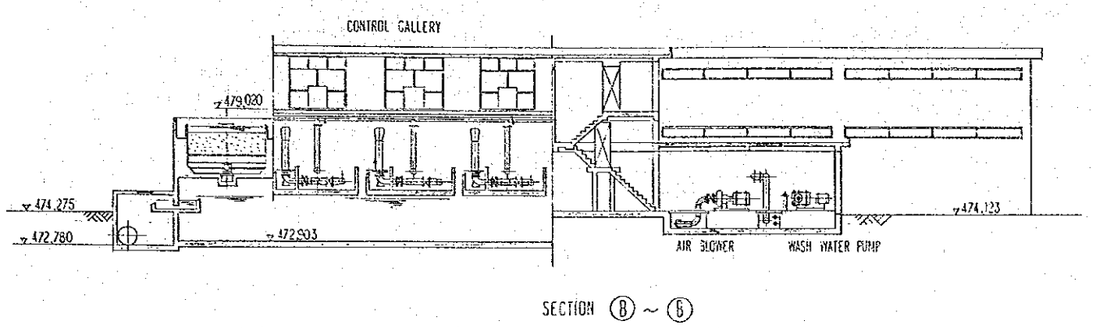
PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 5／11
Title : LAYOUT OF TREATMENT PLANT



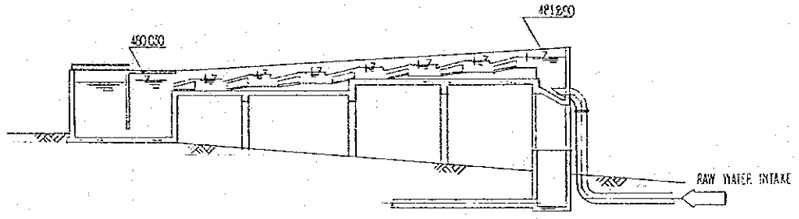
SECTION Ⓐ ~ Ⓐ



SECTION Ⓓ ~ Ⓓ



SECTION Ⓑ ~ Ⓑ



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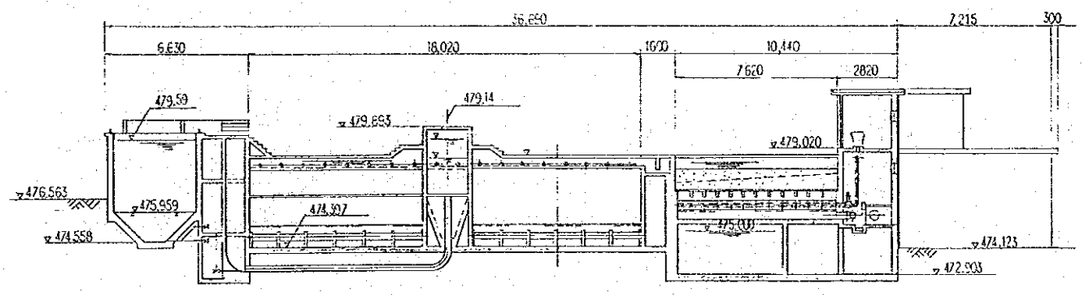
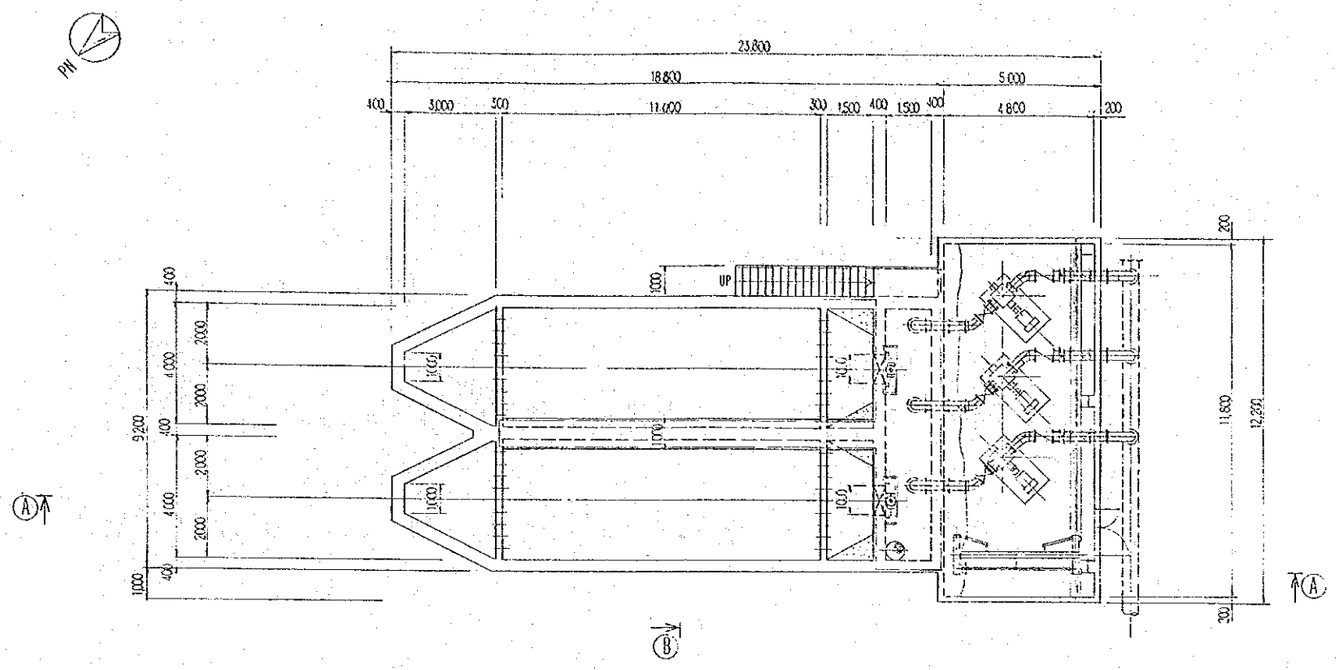
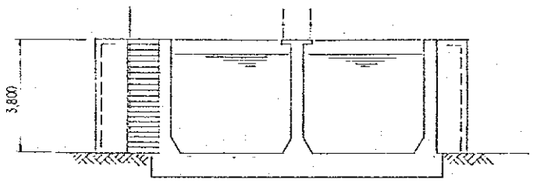


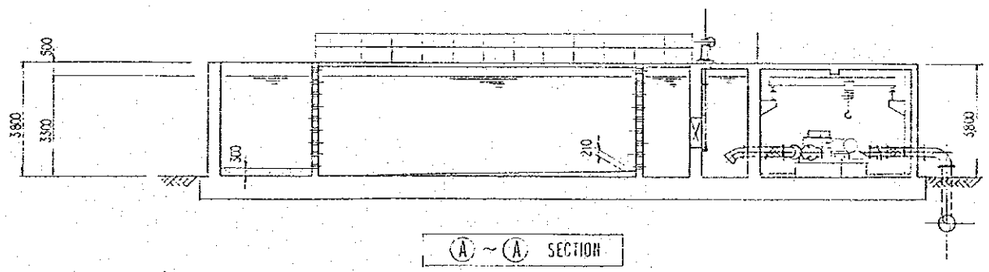
SECTION Ⓒ ~ Ⓒ

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 6／11
Title : SECTION OF TREATMENT PLANT



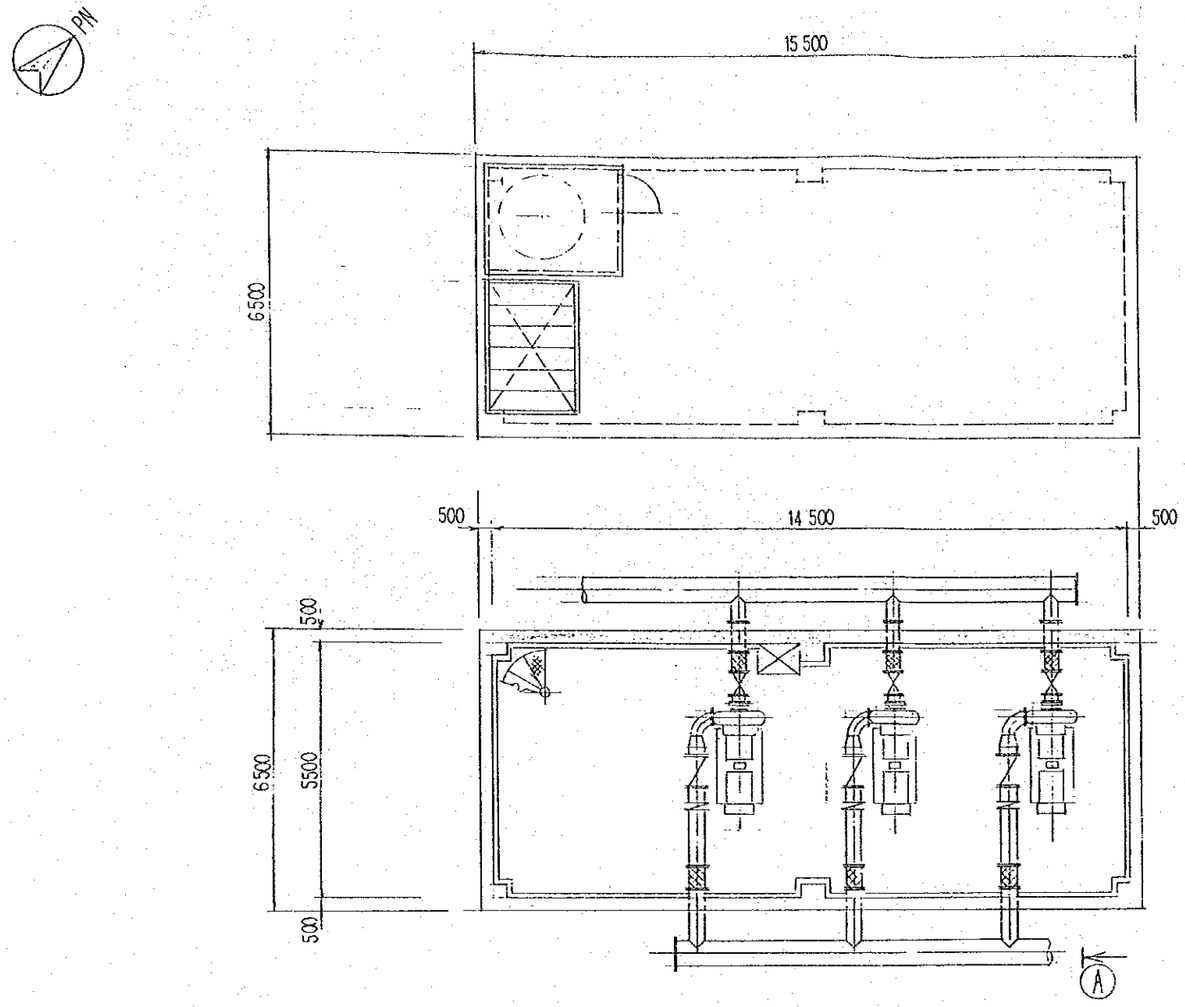


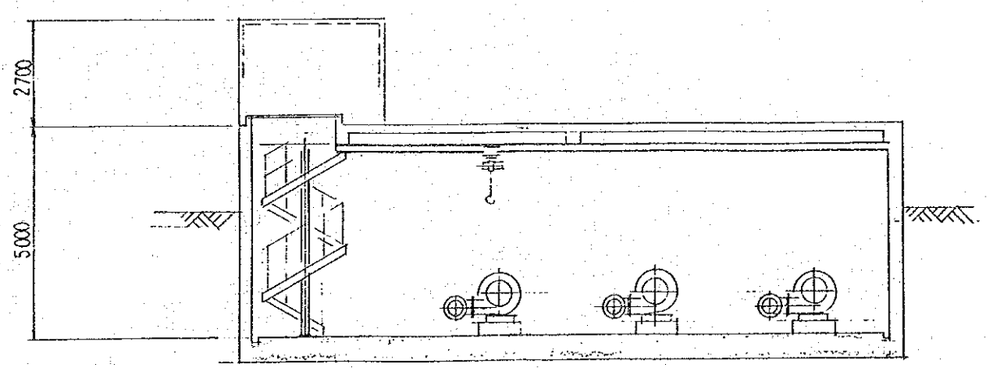
Ⓑ SECTION

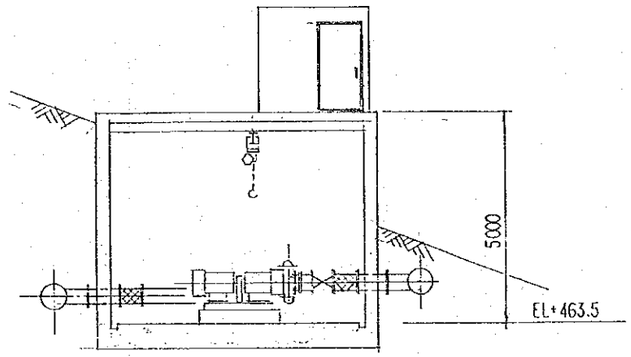


Ⓐ ~ Ⓐ SECTION

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 7／11
Title : GRIT CHAMBER & TRANSFER PUMP STATION

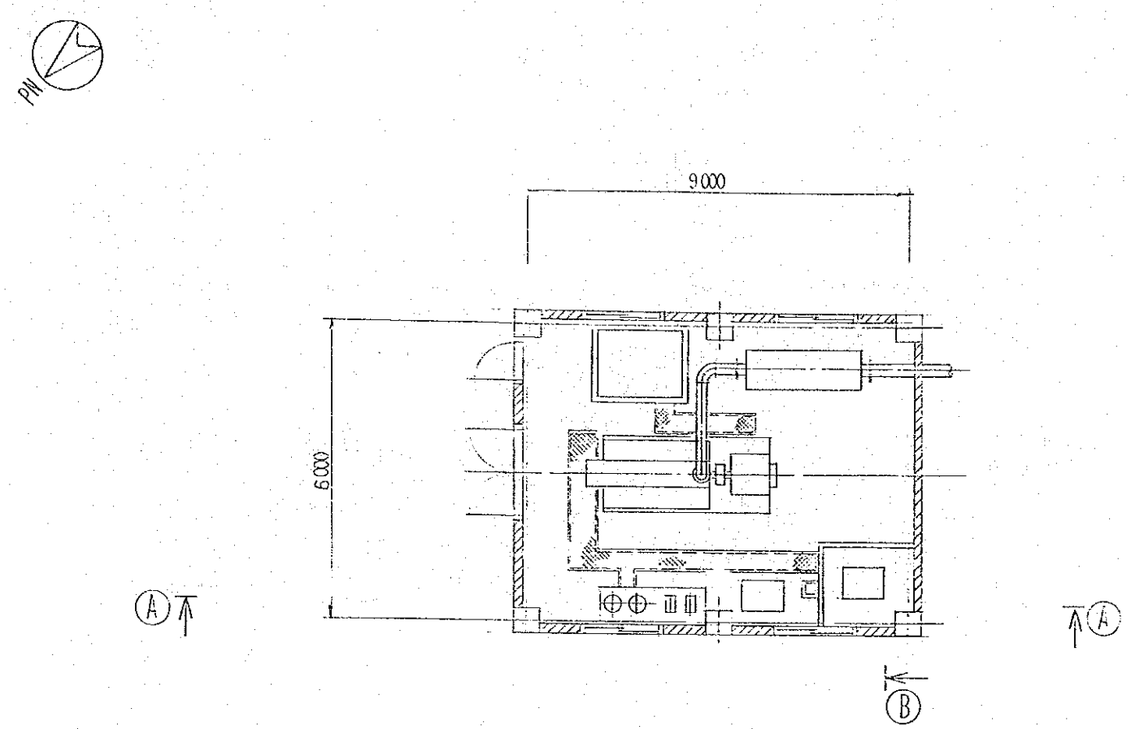


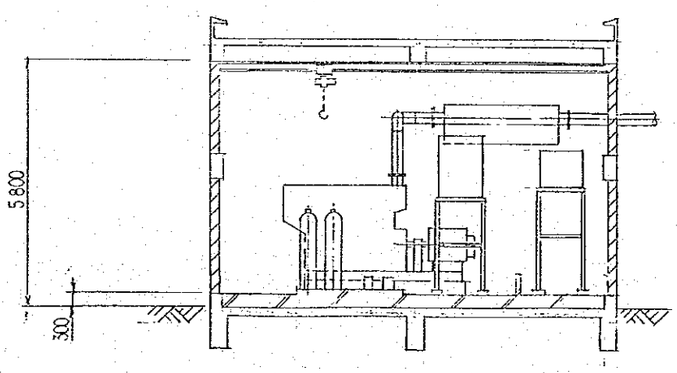




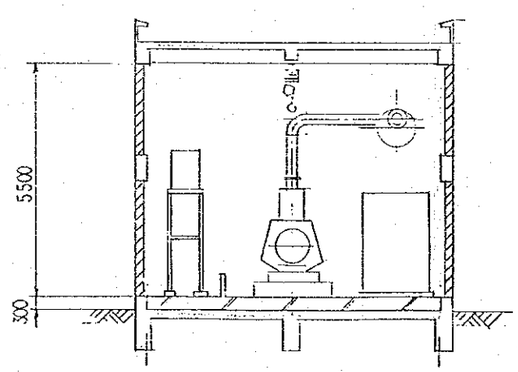
Ⓐ ~ SECTION

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 8／11
Title : INTAKE PUMP STATION



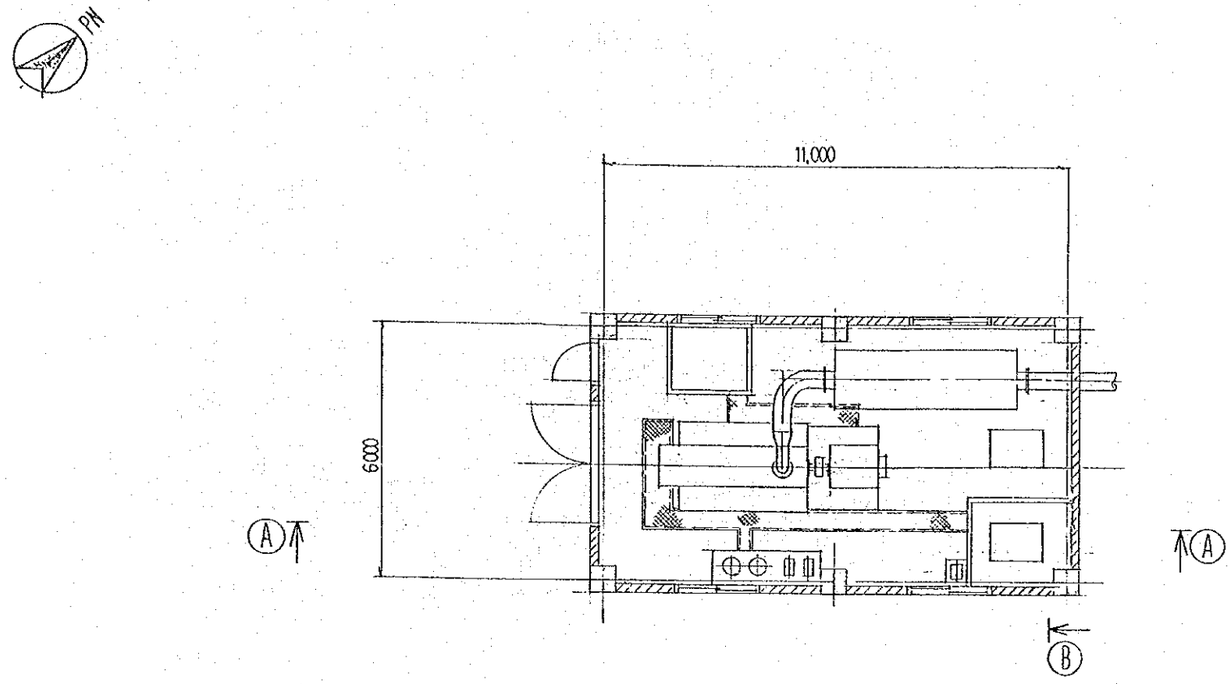


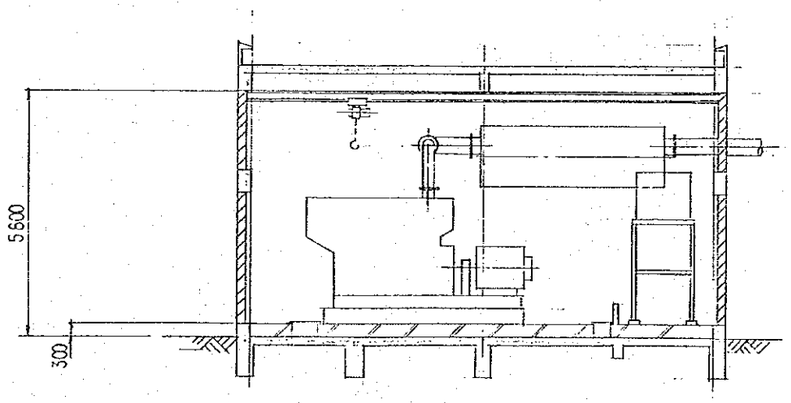
Ⓐ ~ Ⓐ SECTION



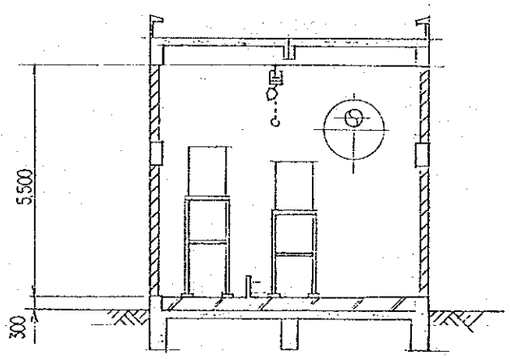
Ⓑ ~ SECTION

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 9／11
Title :. GENERATOR ROOM, INTAKE PLANT



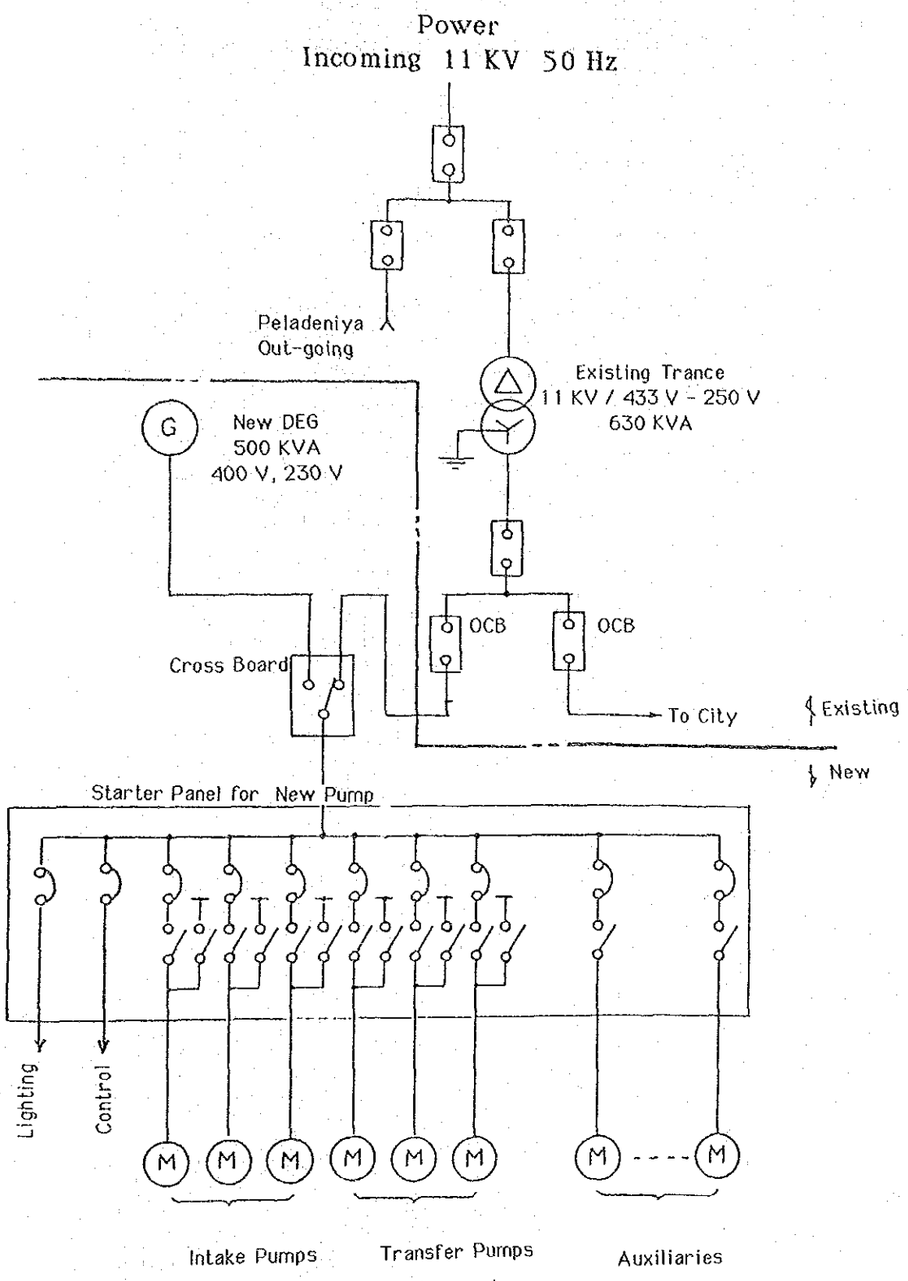


Ⓐ ~ Ⓐ SECTION

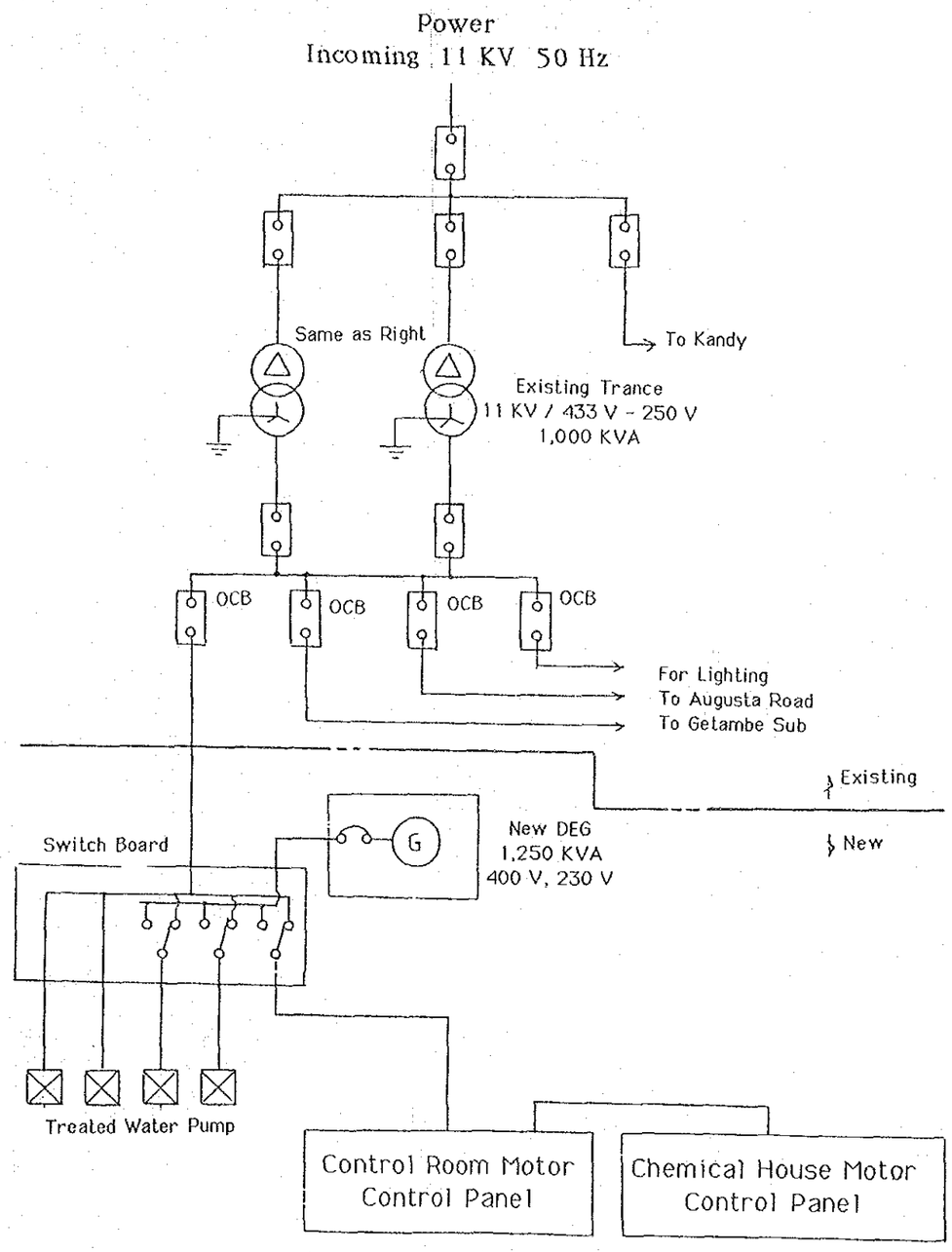


Ⓑ ~SECTION

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 10／11
Title : GENERATOR ROOM, TREATMENT PLANT



Single Line Diagram for Water Intake Facilities



Single Line Diagram for Water Treatment Facilities

PROJECT FOR REHABILITATION OF KANDY WATER SUPPLY SCHEME
Drawing No. 11/11
Title : ELECTRICITY SEQUENCE