2. Existing Pump Station Check List

Existing Pump Station Check List

Skuodas

Pump Station No.1 (Existing Pump Station)

Item	Contents	Remark
Year constructed	1973	
Type of structure	B. Circular/without housing	
Equipment 1) Screen Type Bar spacing Quantity	none	
2) Pump Type Capacity Quantity	horizontal shaft, centrifugal pump 80 m^3/hour x 7.5 kW 1 unit	
3) Others	floor drain pump	
Stand-by Generator	no	
Operation		
Disposal of screenings Method Frequency Amount	none	
Pump Operation Automatic on-off No. of unit operated Flow measurement	 automatic by water level in the pump well 1 unit none	
Discharge amount/flow	no record due to lack of flow meter	
Operator	circulating for inspection	
Existing problems	Equipment is old. Leaks in walls at pipe penetration	
Improvement in the Project	This pump station will be abandoned upon completion of a new pump station in the same premise. Structure of the new pump station has been completed. New pump units have been purchased.	

Existing Pump Station Check List

Skuodas

Pump Station No.1 (New Pump Station)

Item	Contents	Remark
Year constructed	To be completed, but not scheduled	
Type of structure	B. Circular/without housing	
Equipment 1) Screen Type Bar spacing Quantity	 caged screen unknown 1	
2) Pump Type Capacity Quantity	 submersible pump 58 m^3/hour x H15 m x 9 kW 2 units	
3) Others		
Stand-by Generator	no	
Operation		
Disposal of screenings Method Frequency Amount	 not operated yet	
Pump Operation Automatic on-off No. of unit operated Flow measurement	 automatic by water level in the pump well 1 unit none	
Discharge amount/flow		
Operator	circulating for inspection	
Existing problems	not applicable	
Improvement in the Project	Pump units have been purchased and should be installed.	

Existing Pump Station Check List

Skuodas

Pump Station No.2

Item	Contents	Remark
Year constructed	1976	
Type of structure	A. Circular/with upper housing	
Equipment		
1) Screen		
Type	manual bar screen	
Bar spacing	40 – 50 mm	
Quantity	1	
2) Pump		
Type	horizontal shaft, centrifugal pump	
Capacity	60 m^3/hour x 22 kW	
Quantity	2 units	
3) Others	hoist crane floor drain pump ventilation system	
Stand-by Generator	no	
Operation		
Disposal of screenings		
Method	container	
Frequency	every day	
Amount	little	
Pump Operation		
Automatic on-off	automatic by water level in the pump well	
No. of unit operated	1 unit	
Flow measurement	none	
Discharge amount/flow	no record due to lack of flow meter	
Operator	circulating for inspection	
Existing problems	Large amount of rainwater flows in. To prevent inundation, the inlet gate is throttled. Equipment is old. Leaks in walls at pipe penetration	
Improvement in the Project	Prevention of rainwater intrusion must be carried out with proper investigation. For the case of a large pumping amount, by-pass discharge will be installed at the proposed STP after the primary sedimentation tank. Repair of leaks should be included in the scope of this project.	

Existing Pump Station Check List

Skuodas

Pump Station No.3

Item	Contents	Remark
Year constructed	1976	
Type of structure	A. Circular/with upper housing	
Equipment		
1) Screen		
Type	manual	
Bar spacing	20 mm	
Quantity	1	
2) Pump		
Type	horizontal shaft, centrifugal pump	
Capacity	110 m^3/hour x 22 kW	
Quantity	2 units	
3) Others	hoist crane floor drain pump ventilation system	
Stand-by Generator	no	
Operation		
Disposal of screenings		
Method	by container	
Frequency	every day	
Amount	little	
Pump Operation		
Automatic on-off	automatic by water level in the pump well	
No. of unit operated	2 units (1 unit on at all time)	
Flow measurement	none	
Discharge amount/flow	no record due to lack of flow meter	
Operator	circulating for inspection	
Existing problems	Equipment is very old. Leaks in walls at pipe penetration	
Improvement in the Project	No need to replace the pump units immediately. Repair of cracks and leaks should be included in the project scope.	

Existing Pump Station Check List

Skuodas

Pump Station No.4 (Proposed at the Treatment Plant No.1)

Item	Contents	Remark
Year constructed	To be completed, but not scheduled	
Type of structure	B. Circular/without housing	
Equipment 1) Screen Type Bar spacing Quantity	 caged screen unknown 1	
2) Pump Type Capacity Quantity	 submersible pump 140 m^3/hour x 12 kW 3 units	
3) Others		
Stand-by Generator	no	
Operation		
Disposal of screenings Method Frequency Amount	 not operated yet	
Pump Operation Automatic on-off No. of unit operated Flow measurement	 automatic by water level in the pump well 2 units (1 unit on at all time) none	
Discharge amount/flow	no record due to lack of flow meter	
Operator	circulating for inspection	
Existing problems	not applicable	
Improvement in the Project	Pump units have been purchased and should be installed under this project. Only two units may be installed because the pump capacity is too big for the planned sewage amount.	

3. Comparison of Treatment Plant Alternatives

Appendix 3 Comparison of Treatment Plant Alternatives (Skuodas)

1. Design Criteria

1) Design Flow

Case-1 Oxidaion Ditch System with P.S.T.

Daily average : $Q_1 = 1{,}270\ m^3/day$
Daily maximum : $Q_2 = 1{,}600\ m^3/day$
Hourly maximum : $Q_3 = 3{,}200\ m^3/day$

Case-2 Oxidaion Ditch System without P.S.T.

Daily average : $Q_1 = 1{,}270\ m^3/day$
Daily maximum : $Q_2 = 1{,}600\ m^3/day$
Hourly maximum : $Q_3 = 3{,}200\ m^3/day$

Case-3 Sequencing Batch Reactor (SBR) System

Daily average : $Q_1 = 1{,}270\ m^3/day$
Daily maximum : $Q_2 = 1{,}600\ m^3/day$
Hourly maximum : $Q_3 = 3{,}200\ m^3/day$

2) Design Water Quality

Case-1 Oxidaion Ditch System with P.S.T.

	I.Q.	P.S.T. R.R.	P.S.T. E.Q.	S.T.F. R.R.	S.T.F. E.Q.	D.S. Ave.	D.S. Max.
	(mg/l)	(%)	(mg/l)	(%)	(mg/l)	(mg/l)	(mg/l)
BOD_5	490	30	343	96.2	13	13	21.7
BOD_7	560	30	392	96.2	15	15	25
SS	500	40	300	90	30	30	45
COD	1,000	30	700	90	70	75	120
T-N	70	10	63	70	18.9	20	35
T-P	12	10	10.8	*86.2	*1.5	1.5	2.5

Note) I.Q. : Influent Quality
P.S.T. : Primary Sedimemntation Tank
R.R. : Removal Rate
E.Q. : Effluent Quality
S.T.F. : Secondary Treatment Facility
D.S. : Discharge Standard
* : with Coagulant Treatment

Case-2 Oxidaion Ditch System without P.S.T.

	I.Q.	S.T.F. R.R.	S.T.F. E.Q.	D.S. Ave.	D.S. Max.
	(mg/l)	(%)	(mg/l)	(mg/l)	(mg/l)
BOD_5	490	97.4	13	13	21.7
BOD_7	560	97.4	15	15	25
SS	500	95	25	30	45
COD	1,000	92.5	70	75	120
T-N	70	70	21	20	35
T-P	12	*87.5	*1.5	1.5	2.5

Note) I.Q. : Influent Quality
S.T.F. : Secondary Treatment Facility
R.R. : Removal Rate
E.Q. : Effluent Quality
D.S. : Discharge Standard
* : with Coagulant Treatment

Case-3 Sequencing Batch Reactor (SBR) System

	I.Q.	S.T.F. R.R.	S.T.F. E.Q.	D.S. Ave.	D.S. Max.
	(mg/l)	(%)	(mg/l)	(mg/l)	(mg/l)
BOD_5	490	97.4	13	13	21.7
BOD_7	560	97.4	15	15	25
SS	500	95	25	30	45
COD	1,000	92.5	70	75	120
T-N	70	70	21	20	35
T-P	12	*87.5	*1.5	1.5	2.5

Note) I.Q. : Influent Quality
S.T.F. : Secondary Treatment Facility
R.R. : Removal Rate
E.Q. : Effluent Quality
D.S. : Discharge Standard
* : with Coagulant Treatment

3) Design Temperature

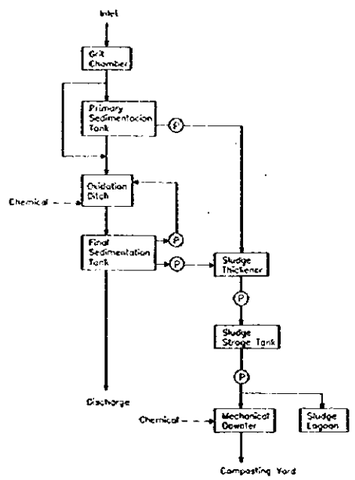
Case-1 7 degree C. at winter

Case-2 7 degree C. at winter

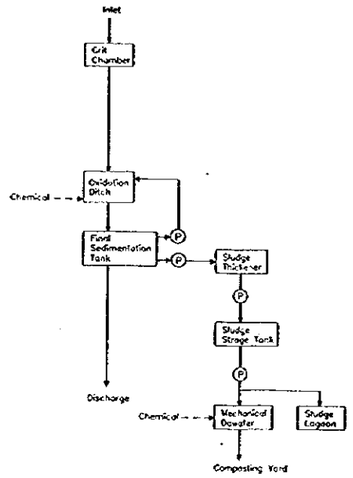
Case-3 7 degree C. at winter

2. Flow Chart

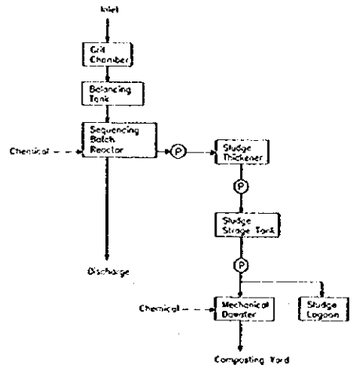
Case-1



Case-2



Case-3



Item	Case-1 Oxidaion Ditch System with P.S.T.	Case-2 Oxidaion Ditch System without P.S.T.	Case-3 Sequencing Batch Reactor (SBR) System	Remarks
3. Sludge (Q_{dmax})				
Primary Sludge	399 kgDS/day, 20 m^3/day, 98.0 %WT	------	------	
Excess Sludge	424 kgDS/day, 75 m^3/day, 99.4 %WT	701 kgDS/day, 121 m^3/day, 99.4 %WT	939 kgDS/day, 156 m^3/day, 99.4 %WT	
Thickened Sludge	658 kgDS/day, 26 m^3/day, 97.5 %WT	561 kgDS/day, 37 m^3/day, 98.5 %WT	751 kgDS/day, 50 m^3/day, 98.5 %WT	
Dewatered Sludge	625 kgDS/day, 3.9 m^3/day, 84 %WT	533 kgDS/day, 3.6 m^3/day, 85 %WT	713 kgDS/day, 4.8 m^3/day, 85 %WT	
4. Major Facility	1) Grit Chamber Gravity Type W 0.8 m x L 2.5 m x D 0.3 m x 1 unit Water Surface Load : 1,800 m^3/m^2 day Average Velocity : 0.15 m/s 2) Flow Measurement Parshall Flume Type W = 0.31 m x 1 unit 3) Primary Sedimentation Tank Rectangular Tank W 5.0 m x L 5.0 m x D 3.5 m x 1 unit Surface Load : 64 m^3/m^2 day Retention Time : 1.3 hrs 4) Reaction Tank Oxidation Ditch W 4.5 m x L 132.8 m x D 2.5 m x 2 units MLSS : 4,000 mg/l HRT : 43.2 hrs BOD-SS Load : 0.05 kg BOD/kg SS 5) Aeration Equipment Blower : 14.5 m3/min x 15 kw x 3 (1) unit Diffuser : Membrane Disc Aerator Submersible Mixer : 2.3 kw x 4 units 6) Final Sedimentation Tank Circular Tank with Center driven Sludge Collector Dia. 14.5 m x D 3.5 m x 2 units Surface Load : 5 m^3/m^2 day Retention Time : 17.3 hrs	1) Grit Chamber Same as Case-1 2) Flow Measurement Same as Case-1 3) Reaction Tank Oxidation Ditch W 4.5 m x L 192.8 m x D 3.5 m x 2 units MLSS : 4,000 mg/l HRT : 62.4 hrs BOD-SS Load : 0.05 kg BOD/kg SS 4) Aeration Equipment Same as Case-1 5) Final Sedimentation Tank Same as Case-1	1) Grit Chamber Same as Case-1 2) Flow Measurement Same as Case-1 3) Balancing Tank Rectangular Tank W 9.0 m x L 11.0 m x D 4.5 m x 1 unit Retention Time : 6 hrs 4) Reaction Tank Sequencing Batch Reactor W 12.0 m x L 30.0 m x D 5.5 m x 2 units MLSS : 2,000 - 3,000 mg/l BOD-SS Load : 0.13 - 0.2 kg BOD/kg SS Cycle Number : 3 Cycle Retention Time : 59.4 hrs 5) Aeration Equipment Blower : 23 m3/min x 45 kw x 2 (1) unit Aerator : 38 kg O_2/hr x7.5 kw x 4 units	Note) Considering the case of P.S.T.'s by-pass operation, oxygen requirement of Case-2 is also adopted to Case-1.

Item	Case-1 Oxidaion Ditch System with P.S.T.	Case-2 Oxidaion Ditch System without P.S.T.	Case-3 Sequencing Batch Reactor (SBR) System	Remarks
	7) Sludge Pumps Return Sludge Pumps : Max. Ratio 200 % 0.6 m^3/min x 1.5 kw x 4 units Excess Sludge Pumps : 6.5 m3/hr x 2.2 kv x 2 units Primary Sludge Pumps : 0.3 m3/in x 1.5 k x 1 unit	6) Sludge Pumps Return Sludge Pumps : Max. Ratio 200 % 0.6 m^3/min x 1.5 kw x 4 units Excess Sludge Pumps : 6.5 m^3/hr x 2.2 kv x 2 units	6) Sludge Pumps Excess Sludge Pumps : 0.4 m^3/min x 2.2 l x 4 (2) units	
	8) Sludge Thickener Rectangular Tank with Center driven Picket Fence Type Mixer W 5.0 m x L 5.0 m x D 4.0 m x 1 unit Dry Solid Surface Load : 40 kg DS/m^2 day Retention Time : 25 hrs	7) Sludge Thickener Rectangular Tank with Center driven Picket Fence Type Mixer W 5.0 m x L 5.0 m x D 4.0 m x 1 umit Dry Solid Surface Load : 30 kg DS/m^2 day Retention Time : 19.8 hrs	7) Sludge Thickener Rectangular Tank with Center driven Picket Fence Type Mixer W 6.0 m x L 6.0 m x D 4.0 m x 1 unit Dry Solid Surface Load : 30 kg DS/m^2 day Retention Time : 22 hrs	
	9) Sludge Storage Tank Rectangular Tank W 3.0 m x L 5.0 m x D 4.0 m x 1 unit Retention Time : 2.3 days	8) Sludge Storage Tank Rectangular Tank W 4.0 m x L 5.0 m x D 4.0 m x 1 unit Retention Time : 2.2 days	8) Sludge Storage Tank Rectangular Tank W 4.6 m x L 6.0 m x D 4.0 m x 1 unit Retention Time : 2.2 days	
	10) Sludge Dewatering Machine Centrifugal Dewatering Machine 5.0 m^3/hr x 22.2 kw x 1 unit Polymer : 1.3 % per DS	9) Sludge Dewatering Machine Centrifugal Dewatering Machine 8.0 m^3/hr x 27.5 kw x 1 unit Polymer : 1.5 % per DS	9) Sludge Dewatering Machine Centrifugal Dewatering Machine 10.0 m^3/hr x 44.5 kw x 1 unit Polymer : 1.5 % per DS	
	11) Sludge Composting Yard Stockpiling Yard W 9.0 m x L 36.0 m x 2 lines Storage Period : 6 months	10) Sludge Composting Yard Stockpiling Yard W 10.0 m x L 30.0 m x 2 lines Storage Period : 6 months	10) Sludge Composting Yard Stockpiling Yard W 11.0 m x L 36.0 m x 2 lines Storage Period : 6 months	
	12) Sludge Lagoon Open Cut W (top) 26 m - (bottom) 20 m x L (top) 26 m - (bottom) 20 m x D 1.5 m x 1 unit Storage Period : 1 month	11) Sludge Lagoon Open Cut W (top) 26 m - (bottom) 20 m x L (top) 36 m - (bottom) 30 m x D 1.5 m x 1 unit Storage Period : 1 month	11) Sludge Lagoon Open Cut W (top) 38 m - (bottom) 32 m x L (top) 32 m - (bottom) 26 m x D 1.5 m x 1 unit Storage Period : 1 month	
	13) Chemical Feeding Facility Alum-oxichloride Tank and Pumps Caustic Soda Tank and Pumps Polymer Tank and Pumps	12) Chemical Feeding Facility Same as Case-1	12) Chemical Feeding Facility Same as Case-1	
	14) Transformer 100 KVA x1 unit	13) Transformer 100 KVA x1 unit	13) Transformer 200 KVA x1 unit	

Item	Case-1 Oxidaion Ditch System with P.S.T.	Case-2 Oxidaion Ditch System without P.S.T.	Case-3 Sequencing Batch Reactor (SBR) System	Remarks
	15) Auxiliary Facilities Administration Building Single Story, W 12.0 m x L 18.0 m x 216 m^2 Sludge Building Single Story, W 9.0 m x L 11.0 m x 99 m^2 Sludge Pump Building Single Story, W 6.0 m x L 12.5 m x 75 m^2	14) Auxiliary Facilities Same as Case-1	14) Auxiliary Facilities Administration Building Single Story, W 12.0 m x L 18.0 m x 216 m^2 Sludge Building Single Story, W 9.0 m x L 11.0 m x 99 m^2	
5. Total Motor Power	90 kw	96 kw	166 kw	
6. Construction Cost	Civil/Arch. : 3,737,000 Mech./Elect. : 2,885,000 Total : 6,622,000	Civil/Arch. : 4,670,000 Mech./Elect. : 2,690,000 Total : 7,360,000	Civil/Arch. : 2,754,000 Mech./Elect. : 3,249,000 Total : 6,003,000	
7. O/M Cost				
1) Power Consumption	- Demand 177,000 kwH/year - Electricity Charge 177,000 x 0.204 = 36,000 Lts/year	- Demand 216,000 kwH/year - Electricity Charge 216,000 x 0.204 = 44,000 Lts/year	- Demand 255,000 kwH/year - Electricity Charge 255,000 x 0.204 = 52,000 Lts/year	Unit price 0.204 Lts/kwH (Aug. 1998)
2) Chemical Consumption	- Alum oxichloride : 38,600 kg/year 38,600 x 0.424 = 16,366 Lts/year Transportation 38.6 x 1/11 = 3.5 ..... 4 times 350 km x 4 x 1.3 = 1,820 Lts/year - Polymer : 1,340 kg/year 1,340 x 25 = 33,500 Lts/year Total 52,000 Lts/year	- Alum oxichloride : 50,800 kg/year 50,800 x 0.424 = 21,539 Lts/year Transportation 50.8 x 1/11 = 4.6 ..... 5 times 350 km x 5 x 1.3 = 2,275 Lts/year - Polymer : 1,370 kg/year 1,370 x 25 = 34,250 Lts/year Total 58,000 Lts/year	- Alum oxichloride : 18,400 kg/year 18,400 x 0.424 = 7,802 Lts/year Transportation 18.4 x 1/11 = 1.7 ..... 2 times 350 km x 2 x 1.3 = 910 Lts/year - Polymer : 1,830 kg/year 1,830 x 25 = 45,750 Lts/year Total 55,000 Lts/year	For annual average consumption Alum-oxichloride 0.424 Lts/kg Transportation 11 ton, 1.3 Lts/km (Aug. 1998) Polymer 25 Lts/kg including transportation (Aug. 1998)
3) Fuel	- 100 Lts/wk x 52 = 5,000 Lts/year	- 100 Lts/wk x 52 = 5,000 Lts/year	- 100 Lts/wk x 52 = 5,000 Lts/year	
4) Consumable Parts and Repairing	2,885,000 x 0.015 = 43,000 Lts/year	2,690,000 x 0.015 = 41,000 Lts/year	3,249,000 x 0.015 = 49,000 Lts/year	1.5 % of M/E construction cost
5) Total	136,000 Lts/year	148,000 Lts/year	161,000 Lts/year	

4. Capacity Calculation for Skuodas Treatment Plant (Case 1)

Appendix 4 Capacity Calculation for Skoudas Sewage Treatment Plant (Case 1)
Case 1 : Oxidation Ditch System with Primary Sedimentation Tank

1. Design Criteria

1.1 Design Sewage Flow

$Q_{dave} = Q_1 = 1{,}270\ m^3/day$

$Q_{dmax} = Q_2 = 1{,}600\ m^3/day$

$Q_{hmax} = Q_3 = 3{,}200\ m^3/day$

1.2 Design Sewage Quality

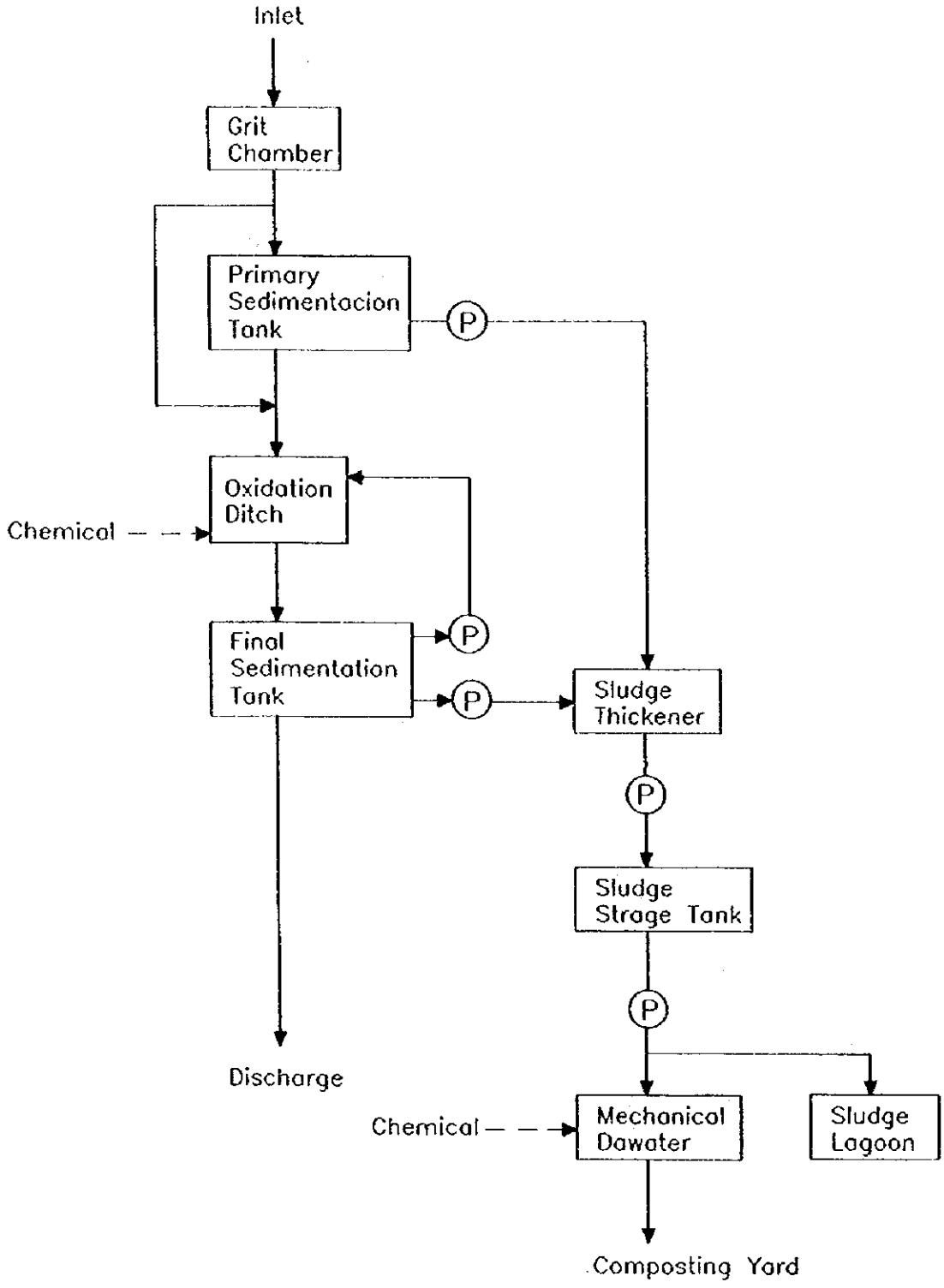
Item	Influent Quality (mg/l)	P.S.T.		S.T.F.		Discharge Standard	
		R.R. (%)	E.Q. (mg/l)	R.R. (%)	E.Q. (mg/l)	Average (mg/l)	Maximum (mg/l)
BOD_5	490	30	343	96.2	13	13	21.7
BOD_7	560	30	392	96.2	15	15	25
SS	500	40	300	90	30	30	45
COD_{Cr}	1,000	30	700	90	70	75	120
T-N	70	10	63	70	18.9	20	35
T-P	12	10	10.8	*86.2	1.5	1.5	2.5

P.S.T. : Primary Sedimentation Tank
R.R. : Removal Rate
E.Q. : Effluent Quality
S.T.F. : Secondary Treatment Facility
* : with coagulant treatment

1.3 Design Seage Temperature

In winter : 7 degree C.

2. Flow Chart


Inlet
Grit Chamber
Primary Sedimentacion Tank
P
Oxidation Ditch
Chemical
Final Sedimentation Tank
P
P
Sludge Thickener
P
Sludge Strage Tank
P
Discharge
Chemical
Mechanical Dawater
Sludge Lagoon
Composting Yard

MASS BALANCE IN OXIDATION DITCH SYSTEM

1. Design for Daily Maximum Flow

Design Flow		m3/day	m3/hour	m3/min	m3/sec
Daily Average	Qda	1,270	52.9	0.88	0.015
Daily Maximum	Qdm	1,600	66.7	1.11	0.019
Hourly Peak	Qhp	3,200	133.3	2.22	0.037

	Influent Quality	Effluent Quality
BOD7	560 mg/l	15 mg/l
BOD5	490 mg/l	13 mg/l
SS	500 mg/l	30 mg/l
COD	1,000 mg/l	75 mg/l
Total-N	70 mg/l	20 mg/l
Total-P	12 mg/l	1.5 mg/l

Inflow
Qdm 1,600 m3/day
BOD5 784 kg/day
SS 800 kg/day
COD 1,600 kg/day
Total-N 112 kg/day
Total-P 19 kg/day

Sedimentataion Tank Influent
Q 1,691 m3/day
BOD5 784 kg/day
SS 997 kg/day

Prim. Sedi. Tank
BOD Removal = 30 %
SS Removal = 40 %

Oxidation Ditch Influent
Q 1,671 m3/day
BOD5 549 kg/day
SS 598 kg/day

OD Design Criteria for Daily Maximum Flow
Design MLSS 4,000 mg/l
Design BOD/SS Ratio 0.05 Kg-BOD/kg-SS
Minimum HRT 2.0 days for Nitrification/Denitrification

Oxidation Ditch
V = 3,200 m3
HRT= 2.00 day
MLSS = 12,923 kg
= 4,039 mg/l
BOD/SS Ratio 0.042

Q 4,871 m3/day
BOD5 13 mg/l
= 64 kg/day
SS 4,039 mg/l
= 19,672 kg/day
(see SS Balance below)

Chemical Coagulent
7.4 mg/l for Influent Q
11.8 kg/day

Final Sedimentataion Tank

Effluent
Qdm 1,596 m3/day
BOD5 13 mg/l = 21 kg/day
SS 30 mg/l = 48 kg/day
COD 75 mg/l = 120 kg/day
Total-N 20 mg/l = 32 kg/day
Total-P 1.5 mg/l = 2.4 kg/day

Excess Sludge
Qe 75 m3/day
SS Water C. 99.4 %
SS 6,000 mg/l
= 424 kg/day

Primary Sludge
Qe 20 m3/day
SS Water C. 98.0 %
SS 20,000 mg/l
= 399 kg/day

Return Sludge
Return Ratio 200 % of Inflow
Qr 3,200 m3/day
Water Contents 99.4 %
SS 6,000 mg/l
= 19,200 kg/day

Sludge Thickener

Liquid Returned to Grit Chamber
Qr 69 m3/day
SS 165 kg/day
= 2,393 mg/l

SS Yield 80 %
Water Cont. 97.5 % water
SS 658 kg/day
Qs 26 m3/day

Sludge Dewatering

Liquid Returned to Grit Chamber
Qr 22 m3/day
SS 33 kg/day
= 1,468 mg/l

SS Yield 95 %
Water Cont. 84 % water
SS 625 kg/day

Sludge Volume
Qs 3.9 m3/day (wet base)

Oxidation Ditch Dimension
volume 3,200 m3
no. 2 units
unit vol. 1,600 m3/unit
depth 5.0 m
surface area 320 m2/unit
width 5.0 m
length 64 m/unit

SS Balance in Oxidation Ditch	
Influent SS	598 kg/day
Effluent SS	48 kg/day
SS removed	550 kg/day
Net reduction by endogeneous decay	75 % (including convert from BOD removed)
SS increase after decay	413 kg/day
SS increase by coagulant dosage	59 kg/day
SS in the Return Sludge	19,200 kg/day
Total SS	19,672 kg/day

<-- coagulant dosage rate
7.4 mg/l
SS production factor
5.0 kg-SS/kg-coagulant

4. Facility Capacity Calculation

4.1 Grit Chamber

Item	Sysmbol	Calculation	Remarks
Design flow (Hourly maximum)	Q_3	3,200 m^3/day = 133.3 m^3/hr = 2.22 m^3/min = 0.037 m^3/sec	
Type		Sand pit type	
Surface load	S_L	1,800 m^3/m^2.day	
Required surface area	A	$Q_3 \times 1/S_L$ = 1.78 m^2	
Effective depth	h	0.3 m	
Demensions		^{W} 0.8 m x ^{L} 2.5 m x Effective depth 0.3 m x 1 unit	
Check			
Surface area	A	0.8 x 2.5 = 2.0 m^2 > 1.78m^2 ... OK	
Average velocity	V	0.037 x 1/(0.8 x 0.3) = 0.15 m/s <0.3 m/s ... OK	
Retention time	T	0.8 x 2.5 x 0.3 x 1/0.037 = 16 sec	
Grit		(Daily Average) Assuming that sand volume contained in sewage is 0.01 m^3 per 1,000m^3 of sewage ; 1,270 m^3/day x 0.01/1,000 = 0.013 m^3/day	
Screenings		(Daily average) Equivalent to grit	

4.2 Primary Sedimentation Tank

Item	Sysmbol	Calculation	Remarks
Design flow (Daily maximum)	Q_2	1,600 m^3/day = 66.7 m^3/hr = 1.1 m^3/min	
Type		Radial Flow Rectangular Sedimentation Tank	
Surface load	S_1	70 m^3/m^2.day	
Required surface area	A_1	$Q_2 \times 1/S_1$ = 22.9 m^2	
Effective depth	H	3.5 m	
Overflow load		250 m^3/m/day	
Reqired weir length	l_1	1,600 x 1/250 = 6.4 m	
Demensions		W 5.0 m x L 5.0 m x 3.5 mH x 1 unit	
(Surface area)	A_2	5.0 x 5.0 = 25.0 m^2	
(Capacity)	V_2	25 x 3.5 = 87.5 m^3	
(Weir length)	l_2	5.0 x 4 = 20.0 m	
Check			
Surface load		1,600 x 1/25 = 64 m^3/m^2.day < 70 ... OK	
Retention time	T_2	87.5 x 1/1,600 x 24 =1.3 hrs	
Overflow load		1,600 x 1/20 = 80 m^3/m.day < 250 ... OK	

4.3 Oxidation Ditch

4.3.1 Oxidation Ditch

Item	Sysmbol	Calculation	Remarks
Design flow (Daily max.)	Q_2	1,600 m^3/day	
Type		Circulation Flow Channel Type	
Design sewage quality	S_C	BOD_5 : 343 mg/l	
	S_{SS}	SS : 392 mg/l	
	S_N	T-N : 63 mg/l	
MLSS	C_A	4,000 mg/l	
BOD-SS load	B_S	0.05 kg BOD/kg SS	
Return sludge density	Cr	6,000 mg/l	
Hydraulicretention time (HRT)	HRT	1.8 day = 43.2 hrs	
Reqired capacity	V	$V = HRT \times Q_2 = 2,880\ m^3$	
Dimension			
Channel width	B	4.5 m	
Length	L	132.8 m	
Effective depth	H	2.5 m	
No. of channel	N	2 units	
Effective capacity	V_2	3.0 % of capcity loss bt hunch shall be considered $V_2 = B \times L \times H \times N \times 0.97 = 2,898\ m^3$	
Check			
Aeration time	T_1	$V_2 \times 24/Q_2 = 43.5$ hrs	

Examination on Retention Time of Oxidation Ditch

Retention time will be calculated by the following three alternatives and largest value will be adopted.

A : Calculation by BOD-SS loading

B : Calculation by Required nitrification/denitrification zone capacity

C : Calculation by Required SRT

Inflow sewage flow per channel = Q_2 = 800 m^3/day

	A. BOD-SS loading	B. Nitrification/denitrification zone		C. Required SRT
		Summer	Winter	
O.D. capacity (m^3)	1,372	694	1,324	1,305
Retention time (day)	1.72	0.87	1.66	1.63

Thus, Hydraulic Retention Time (HRT) of Oxidation Dicth will be 1.8 days.

A. Calculation by BOD-SS load

$V = (Q_2 \times BOD_{in} \times 10^{-3})/(\text{BOD-SS load} \times MLSS \times 10^{-3})$

BOD-SS load : 0.05 kg BOD/kg SS day
MLSS : 4,000 mg/l

B. Calculation by required nitrification/denitrification zone capacity, when sewage temperature is 18 degree C. in summer and 7 degree C. in winter.

Nitrification ratio : 90 % in summer, 70 % in winter
Denitrification ratio : 80 % in summer, 80 % in winter
Nitrification velocity : $K_N = 0.159 \exp(0.0908T)$ (g-N/g MLSS day)
Denitrification velocity : $K_{DN} = 0.324 \exp(0.0634T)$ (g-N/g MLSS day)

C. Calculation by required SRT

Required SRT = $20.65 \exp(-0.0639T)$ = 13.2 days

T : Sewage temperature in winter (7 degree C.)

Required Oxidation Ditch volume was calculated based on above SRT.

4.3.2 Coagulation Facility

Item	Sysmbol	Calculation	Remarks
Dosing amount			
Design flow	Q	Q_1 = 1,270 m^3/day, Q_2 = 1,600 m^3/day	
Inflow T-P	$C_{TP\text{-}in}$	10.8 mg/l	
Inflow ST-P	$C_{STP\text{-}in}$	8.6 mg/l	
Coagulant		Alum-Oxichloride (Al_2O_3 content : 10 %)	
Dosing concentration	C_{AL}	$C_{STP\text{-}in}$/P x m x AL = 7.4 mg/l	
Atomic value of Phosphorous	P	31	
Dosing mole ratio	m	1.0	
Atomic value of Aluminium	AL	27	
Dosing amount (Max)	R_{AL}	C_{AL} x (O x 3 + AL x 2)/(AL x 2 x C_{ALL} x 10^{-2}) x Q x 10^{-3}	
Atomic value of Oxygen	O	16	
Al_2O_3 content	C_{ALL}	10%	
At Daily Maximum	R_{AL}	= 224 kg/day	
At Daily Average	R_{AL}	= 178 kg/day	
Anticipated consumption		Assuming that annual average inlet T-P is 10 mg/l. Posphorous removal at secondary treatment facility (30 %) shall also be considered.	
Target T-P	$C_{TP\text{-}in}$	10 x (1 - 0.1) x (1 - 0.3) = 6.3 mg/l	
Target ST-P	$C_{STP\text{-}in}$	5.0 mg/l	
Dosing concentration	C_{AL}	4.4 mg/l	
Dosing amount (Daily average)	R_{AL}	105.6 kg/day = 38,544 kg/year	

4.3.3 Aeration Equipment

Item	Sysmbol	Calculation	Remarks
Design sewage flow (Daily maximum)	Q_2	1,600 m^3/day	
Type		Submersible Propeller Mixer and Diffuser Type	
Oxygen Supply	SOR	Oxygen supply is supposed to be 2.1 kg O_2/kg BOD per unit inflow BOD. Further, aeration equipment shall be able to supply the required oxygen even in case of P.S.T.'s by-pass operation. = 1,600 m^3/day x 490 mg/l x 10^{-3} x 2.1 = 1,646 kg O_2/day	
Air supply	Qa	= SOR/(E x h x 10^{-3} x 24) E : Oxygen dissolution efficiency (18 g O_2/m^3 air.water depth) h : Deffuser depth = 2.2 m = 1,646/(18 x 2.2 x 10^{-3} x 24) = 1,732 m^3/hr = 28.9 m^3/min	
Aeration blower			
Type		Roots Blower	
Specification		Dia. 150 mm x 14.5 m^3/min x 3,200 mmAq x 15 kw	
Quantity		3 sets (1 set as stand-by)	
Diffuser			
Type		Membrane Disk Aerator	
Unit air flow		7 m^3/hr. 1 set	
Quantity		32 units/set x 4 sets/channel x 2 channel = 256 units	
Submersible mixer			
Type		Submersible Propeller Mixer	
Power reqirement	Lp	N x V x 10^{-3} = 2.9 kw/channel	

Item	Sysmbol	Calculation	Remarks
Unit power reqirement	N	2.0 w/m^3	
Ditch volume	V	2,898 m^3/channel x 1/2 channel = 1,449 m^3/channel	
Specification and quantity		Dia.1.6 m x 2.3 kw x 2 sets/channel x 2 channel	

4.4 Final Sedimentation Tank

Item	Sysmbol	Calculation	Remarks
Design flow (Daily maximum)	Q_2	1,600 m^3/day = 66.7 m^3/hr = 1.1 m^3/min	
Type		Radial Flow Circular Sedimentation Tank with Center driven Sludge Collector	
Surface load	S_L	5 m^3/m^2.day	
Required surface area	A_1	$Q_2 \times 1/S_L$ = 320 m^2	
Effective depth	H	3.5 m	
Overflow load	O_L	Less than 25 m^3/m day	
Weir length	l_1	Q_2/O_L = 64 m	
Demensions		Dia. 14.5 m x 3.5 mH x 2 units	
(Surface area)	A_2	π /4 x 14.5^2 = 165 m^2	
(Capacity)	V_2	165 x 3.5 = 577.5 m^3	
(Weir length)	l_2	π x (14.5 - 1.0) = 42.4 m	
Check			
Surface load	A	1,600 x 1/(165 x 2) = 4.8 m^3/m^2.day < 5.0 ... OK	
Retention time	T_2	577.5 x 2 x 1/66.7 =17.3 hrs	
Overflow load		1,600 x 1/(42.4 x 2) = 18.9 m^3/m^2.day < 25 ... OK	
Examination on Surface load			
Initial sedimentation verocity	v_0	$4.9 \times 10^6 \times T^{0.95} \times X_A^{-1.35} \times [SVI]^{-0.77}$ = 9.0 m/hr	
Sewage temperature	T	7 degree C.	
MLSS	X_A	4,000 mg/l	
SVI		150	

Item	Sysmbol	Calculation	Remarks
Surface load	S	$v_0/R = 4.5 \ldots 5.0\ m^3/m^2\ day$	
Fluctuation ratio	R	2	

4.5 Sludge Thickener

Item	Sysmbol	Calculation	Remarks
Design sludge volume	q_2	P.S.T. sludge : 20 m3/day, 399 kg/day	
(Daily maximum)		Excess sludge : 75 m^3/day, 424 kg/day	
		Total 95 m^3/day, 823 kg/day	
Type		Radial Flow Rectangular Sedimentation Tank with Picket Fence Mixer	
Solid load		40 kg DS/m^2.day	
Required surface area		823 x 1/40 = 20.6 m^2	
Effective depth		4.0 m	
Demensions		W 5.0 m x L 5.0 m x 4.0 mH x 1 unit	
(Surface area)	A_2	5.0 x 5.0 = 25.0 m^2	
(Capacity)	V_2	25 x 4.0 = 100 m^3	
Check			
Solid load		823 x 1/25 = 33 kg DS/m^2.day	
Thickening time	T	100 x 1/95 x 24 = 25 hrs	

4.6 Sludge Storage Tank

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Gravity thickened sludge : 26 m^3/day, 658 kg DS/day	
Type		Rectangular Tank	
Storage days	T_1	More than 2 day's sludge volume	
Storage capacity	V_1	26 x 2 = 52 m^3	
Demensions		3.0 m x 5.0m x 4.0 mH (effective depth)	
(Effective capacity)	V_2	3.0 x 5.0 x 4.0 = 60 m^3	
Check			
Storage days	T_2	60 x 1/26 = 2.3 days	

4.7 Sludge Dewater

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Gravity thickened sludge : 26 m^3/day, 658 kg DS/day (Mixed sludge)	
Type		Centrifugal Dewater Machine	
Operation time		6 days in week, 6 hrs/day	
Capacity requirement		26 m^3/day x 7/6 x 1/6 = 5.0 m^3/hr	
Specifications		5.0 m^3/hr x 18.5 kw/7.5 kw x 1 unit	
Polymer dosing ratio		Less than 1.3 % per DS	
Polymer consumption (Daily average)		Assuming that annual average inlet SS is 350 mg/l and average dosing ratio is 1.0 % ; 658 x 350/500 x 1,270/1,600 x 1.0 x 10^{-2} = 3.66 kg/day = 1,336 kg/year	

4.8 Composting Yard

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily average)	q_1	Target dewatered sludge volume is based on daily average sewage flow.	
Dewatered cake			
Solid weight	D_1	625 kg DS/dayx 0.8 = 500 kg DS/day	
Water content	wt_1	84 % (water content of dewatered cake : 97.5 %)	
Cake weight	V_1	500 x 100/(100 - 84) x 10^{-3} = 3.1 wt/day	
Bulk density	C_1	1.0 t/m^3	
Apparent volume	V_1'	3.1 wt /dayx 1/1.0 = 3.1 m^3/day	
Organic content		80%	
Organic digestion ratio		60%	
Digested organic		500 x 0.8 x 0.6 = 240 kg DS/day	
Compost products			
Solid weight	D_2	500 - 240 = 260 kg/day = 0.26 t/day	
Water content	wt_2	35%	
Product weight	V_2	0.26 x 100/(100 - 35) = 0.4 wt/day	
Bulk density	C_2	0.4 wt/m^3	
Apparent volume	V_2'	0.4 x 1/0.4 = 1.0 m^3/day	
Composting yard			
Storage days	T	180 days	
Deposit height	h	0.6 m	
Required area	A	(3.1 + 1.0) x 1/2 x 180 x 1/0.6 = more than 615 m^2	
Dimensions (Area)		9.0 m x 36.0 mL x 2 lines 9.0 x 36.0 x 2 = 648 m^2	

4.9 Sludge Lagoon

Item	Sysmbol	Calculation	Remarks
Design sewage flow (Thickened sludge)	Qd.ave	26 x 1,270/1,600 = 20.6 m^3/day	
Retention time	T	30 days	
Required volume	V	20.6 x 30 = 618 m^3	
Depth	D	1.5 m	
Surface area	A	618 x 1/1.5 = 412 m^2	
Dimension		W 20 m x 20 mL x 1.5 mH	

4.10 Transformer Capacity

Item	Sysmbol	Calculation	Remarks
Transformer capacity	TC	EC x (B x A)/(E x PF) = 84.3 KVA ... 100 KVA	
Electrical capacity	EC	90.2 kw	
Demand factor	B	0.65	
Allowance	A	1.1	
General Efficiency	E	0.85	
General power factor	PF	0.9	

5. Mechanical Equipment List

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-1	Mechanical Screen	Mechanical Bar Screen 800 W x 1,000 H Bar spacing : 5 mm	0.4	1	For main channel with screening cage
M-2	Bypass Screen	Bar Screen 800 W x 600 H Bar spacing : 20 mm	-	1	For bypass channel
M-3	Sand Pump	Submersible Sand Pump Dia. 80 mm x 0.3 m^3/min x 10 mH	3.7	1	
M-4	Raw Sludge Pump	Nonclog Centrifugal Sludge Pump Dia. 80 mm x 0.3 m^3/min x 5 mH	1.5	1	
M-5	Submersible Mixer	Submersible Propeller Mixer Dia.1.6 m x two blades Lifter Type	2.3	4	
M-6	Diffuser	Membrane Rubbrer Diffuser 7 m^3 air/hr set 32 sets/1 unit x 8 units	-	256	Oxygen supply efficiency 18 g O_2/m^3-air-m water depth
M-7	Aeration Blower	Roots Blower Dia. 150 mm x 14.5 m^3/min x 3,200 mmAq	15	2 + 1	Inverter control
M-8	Coagulant Tank	FRP Cyrindrical Tank 5.0 m^3 with Mixer	0.1	1	
M-9	Coagulant Feed Pump	Diaphram Pump 0.1 l/min x 20 m	0.2	2	Manual control
M-10	Caustic Soda Tank	FRP Cyrindrical Tank 4.0 m^3 with Mixer	0.1	1	
M-11	Caustic Soda Feed Pump	Diaphram Pump 0.1 l/min. x 20 m	0.2	2	Manual control

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-12	Bypass Gate	Rising Spindle Type Gate Dia. 400 mm	-	1	
M-13	Final Sedimentation Tank Sludge Collector	Center Drive Clarifier Dia. 14.5 m x 3.5 mH with Picket Fence	0.75	2	
M-14	Return Sludge Pump	Nonclog Centrifugal with Screw Type Sludge Pump Dia. 80mm x 0.6 m^3/min x 5 m	1.5	4	Hydrostal Type
M-15	Excess Sludge Pump	Progressive Cavity Pump Dia. 80mm x 6.5 m^3/hr x 10 m	2.2	2	
M-16	Plant Water Pump	Submersible Pump Dia. 65mm x 0.2 m^3/min x 30 m	2.2	1	
M-17	Sludge Thickening Mixer	Center Drive Picket Fence Type Mixer Dia. 1,500 mm	0.2	1	
M-18	Thickened Sludge Pump	Progressive Cavity Pump Dia. 80 mm x 7.5 m^3/hr x 20 m	2.2	1 + 1	
M-19	Sludge Storage Tank Mixing Blower	Roots Blower Dia. 50 mm x 0.2 m^3/min x 4,000 mm Aq	0.75	1	
M-20	Sludge Feed Pump	Progressive Cavity Pump Dia. 80 mm x 7.5 m^3/hr x 20 m	2.2	1	
M-21	Sludge Dewatering Unit	Cenrifugal Type Dewater 5.0 m^3/hr	18.5 + 3.7	1	
M-22	Sludge Cake Conveyer	Screw Conveyer 1.0 m^3/hr	0.75	1	
M-23	Polymer Tank	FRP Cylindrical Tank 5.0 m^3 with Mixer	0.1	1	

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-24	Polymer Feed Pump	Progressive Cavity Pump Dia. 25 mm x 0.9 m^3/hr x 20 mH	0.4	1	
M-25	Drain Pump	Submersible Non-clog Pump Dia. 80 mm x 0.3 m^3/min x 10 mH	1.5	1	
M-26	Flow Measurement Equipment	Parshall Flume Type W = 0.31 m	-	1	
M-27	Septage Transfer Pump	Submersible Non-clog Pump Dia. 80 mm x 0.3 m^3/min x 10 mH	1.5	1	

5. Capacity Calculation for Skuodas Treatment Plant (Case 2)

Appendix 5 Capacity Calculation for Skoudas Sewage Treatment Plant (Case 2)
Case 2 : Oxidation Ditch System without Primary Sedimentation Tank

1. Design Criteria

1.1 Design Sewage Flow

$Q_{dave} = Q_1 = 1,270\ m^3/day$

$Q_{dmax} = Q_2 = 1,600\ m^3/day$

$Q_{hmax} = Q_3 = 3,200\ m^3/day$

1.2 Design Sewage Quality

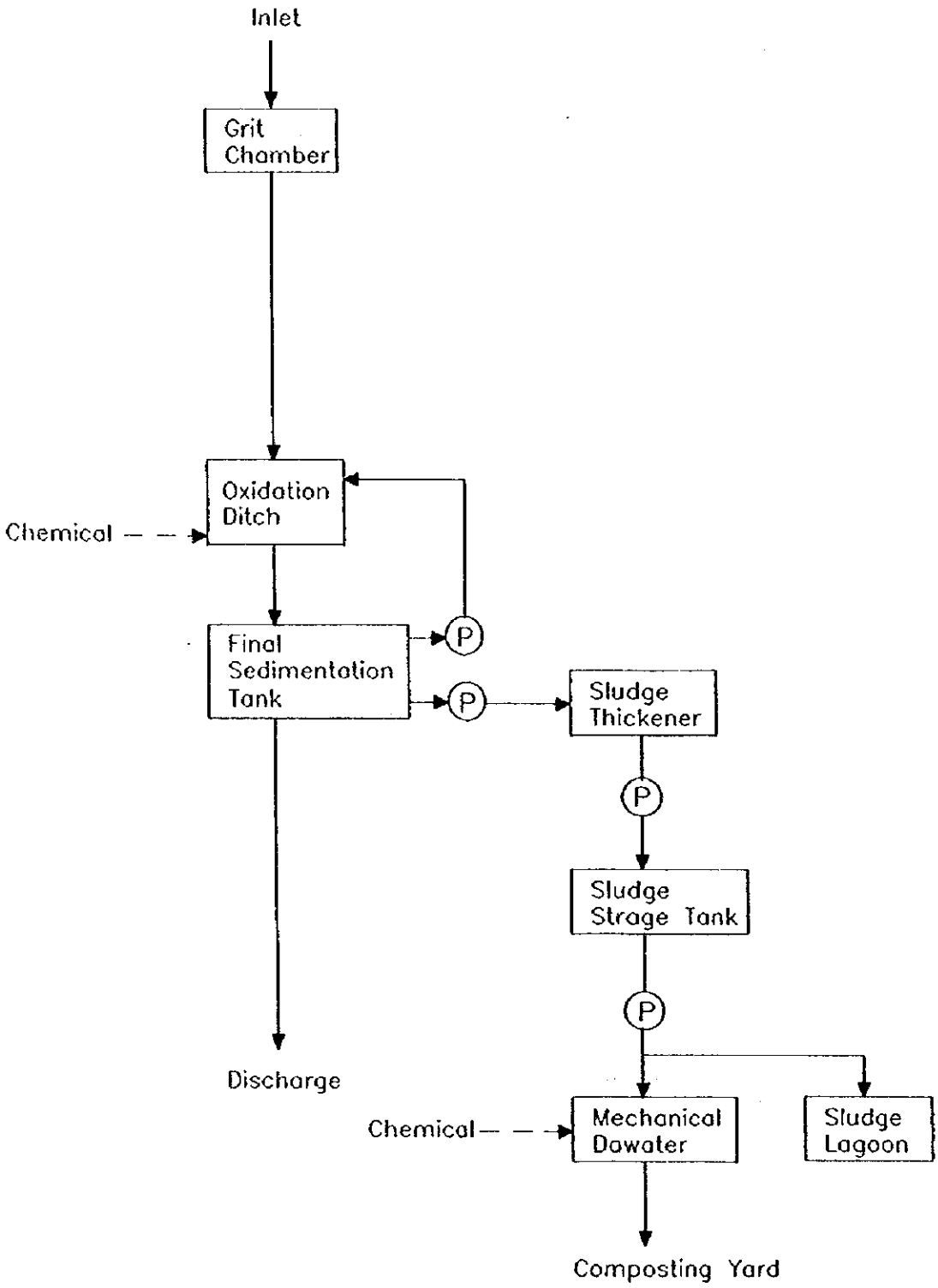
Item	Influent Quality (mg/l)	Secondary Tretment Facility		Discharge Standard		Remarks
		Removable Rates (%)	Effluent Quality (mg/l)	Average (mg/l)	Maximum (mg/l)	
BOD_5	490	97.4	13	13	21.7	
BOD_7	560	97.4	15	15	25	
SS	500	95	25	30	45	
COD_{Cr}	1,000	92.5	75	75	120	
T-N	70	70	21	20	35	
T-P	12	*87.5	1.5	1.5	2.5	

* : with coagulant treatment

1.3 Design Seage Temperature

In winter : 7 degree C.

2. Flow Chart


Inlet
Grit Chamber
Oxidation Ditch
Chemical
Final Sedimentation Tank
P
P
Sludge Thickener
P
Sludge Strage Tank
P
Discharge
Chemical
Mechanical Dewater
Sludge Lagoon
Composting Yard

MASS BALANCE IN OXIDATION DITCH SYSTEM

1. Design for Daily Maximum Flow
(without Primary Sedimentation Tank)

Design Flow		m3/day	m3/hour	m3/min	m3/sec
Daily Average	Qda	1,270	52.9	0.88	0.015
Daily Maximum	Qdm	1,600	66.7	1.11	0.019
Hourly Peak	Qhp	3,200	133.3	2.22	0.037

	Influent Quality	Effluent Quality
BOD7	560 mg/l	15 mg/l
BOD5	490 mg/l	13 mg/l
SS	500 mg/l	30 mg/l
COD	1,000 mg/l	75 mg/l
Total-N	70 mg/l	20 mg/l
Total-P	12 mg/l	1.5 mg/l

Inflow
- Qdm 1,600 m3/day
- BOD5 784 kg/day
- SS 800 kg/day
- COD 1,600 kg/day
- Total-N 112 kg/day
- Total-P 19 kg/day

OD Design Criteria for Daily Maximum Flow
- Design MLSS 4,000 mg/l
- Design BOD/SS Ratio 0.05 Kg-BOD/kg-SS
- Minimum HRT 2.0 days for Nitrification/Denitrification

Chemical Coagulant
7.4 mg/l for Influent Q
11.8 kg/day

Oxidation Ditch Influent
- Q 1,718 m3/day
- BOD5 784 kg/day
- SS 968 kg/day

Inflow → Grit Chamber → Oxidation Ditch

Oxidation Ditch
- V = ~~4,160~~ 3,920 m3
- HRT= ~~2.6~~ 2.45 day
- MLSS = 15,901 kg
- = 4,056 mg/l
- BOD/SS Ratio 0.049

Oxidation Ditch → Final Sedimentation Tank
- Q 4,918 m3/day
- BOD5 13 mg/l
- = 64 kg/day
- SS 4,056 mg/l
- = 19,949 kg/day
- (see SS Balance below)

Final Sedimentation Tank → Effluent
- Qdm 1,597 m3/day
- BOD5 13 mg/l = 21 kg/day
- SS 30 mg/l = 48 kg/day
- COD 75 mg/l = 120 kg/day
- Total-N 20 mg/l = 32 kg/day
- Total-P 1.5 mg/l = 2.4 kg/day

Return Sludge
- Return Ratio 200 % of Inflow
- Qr 3,200 m3/day
- Water Contents 99.4 %
- SS 6,000 mg/l
- = 19,200 kg/day

Excess Sludge
- Qe 121 m3/day
- SS Water C. 99.4 %
- SS 6,000 mg/l
- = 701 kg/day

Final Sedimentation Tank → Sludge Thickener

Liquid Returned to Grit Chamber
- Qr 84 m3/day
- SS 140 kg/day
- = 1,670 mg/l

Sludge Thickener
- SS Yield 80 %
- Water Cont. 98.5 % water
- SS 561 kg/day
- Qs 37 m3/day

Sludge Thickener → Sludge Dewatering

Liquid Returned to Grit Chamber
- Qr 34 m3/day
- SS 28 kg/day
- = 829 mg/l

Sludge Dewatering
- SS Yield 95 %
- Water Cont. 85 % water
- SS 533 kg/day

Sludge Volume
- Qs 3.6 m3/day (wet base)

Oxidation Ditch Dimension
- volume 3,920 m3
- no. 2 units
- unit vol. 1,960 m3/unit
- depth 5.0 m
- surface area 392 m2/unit
- width 5.0 m
- length 78 m/unit

SS Balance in Oxidation Ditch	
Influent SS	968 kg/day
Effluent SS	48 kg/day
SS removed	920 kg/day
Net reduction by endogeneous decay	75 % (including convert from BOD removed)
SS increase after decay	690 kg/day
SS increase by coagulant dosage	59 kg/day
SS in the Return Sludge	19,200 kg/day
Total SS	19,949 kg/day

<— coagulant dosage rate 7.4 mg/l
SS production factor 5.0 kg-SS/kg-coagulant

4. Facility Capacity Calculation

4.1 Grit Chamber

Item	Sysmbol	Calculation	Remarks
Design flow (Hourly maximum)	Q_3	3,200 m^3/day = 133.3 m^3/hr = 2.22 m^3/min = 0.037 m^3/sec	
Type		Sand pit type	
Surface load	S_L	1,800 m^3/m^2.day	
Required surface area	A	$Q_3 \times 1/S_L$ = 1.78 m^2	
Effective depth	h	0.3 m	
Demensions		^{W} 0.8 m x ^{L} 2.5 m x Effective depth 0.3 m x 1 unit	
Check			
Surface area	A	0.8 x 2.5 = 2.0 m^2 > 1.78m^2 ... OK	
Average velocity	V	0.037 x 1/(0.8 x 0.3) = 0.15 m/s <0.3 m/s ... OK	
Retention time	T	0.8 x 2.5 x 0.3 x 1/0.037 = 16 sec	
Grit		(Daily Average) Assuming that sand volume contained in sewage is 0.01 m^3 per 1,000m^3 of sewage ; 1,270 m^3/day x 0.01/1,000 = 0.013 m^3/day	
Screenings		(Daily average) Equivalent to grit	

4.2 Oxidation Ditch

4.2.1 Oxidation Ditch

Item	Sysmbol	Calculation	Remarks
Design flow (Daily max.)	Q_2	1,600 m^3/day	
Type		Circulation Flow Channel Type	
Design sewage quality	S_C	BOD_5 : 490 mg/l	
	S_{SS}	SS : 500 mg/l	
	S_N	T-N : 70 mg/l	
MLSS	C_A	4,000 mg/l	
BOD-SS load	B_S	0.05 kg BOD/kg SS	
Return sludge density	Cr	6,000 mg/l	
Hydraulicretention time (HRT)	HRT	2.6 day = 62.4 hrs	
Reqired capacity	V	$V = HRT \times Q_2 = 4,160\ m^3$	
Dimension			
Channel width	B	4.5 m	
Length	L	192.8 m	
Effective depth	H	2.5 m	
No. of channel	N	2 units	
Effective capacity	V_2	3.0 % of capcity loss bt hunch shall be considered $V_2 = B \times L \times H \times N \times 0.97 = 4,208\ m^3$	
Check			
Aeration time	T_1	$V_2 \times 24/Q_2 = 63.1$ hrs	

Examination on Retention Time of Oxidation Ditch

Retention time will be calculated by the following three alternatives and largest value will be adoptd.

A : Calculation by BOD-SS loading

B : Calculation by Required nitrification/denitrification zone capacity

C : Calculation by Required SRT

Inflow sewage flow per channel = Q_2 = 800 m^3/day

	A. BOD-SS loading	B. Nitrification/denitrification zone		C. Required SRT
		Summer	Winter	
O.D. capacity (m^3)	1,960	694	1,324	2,063
Retention time (day)	2.45	0.87	1.66	2.58

Thus, Hydraulic Retention Time (HRT) of Oxidation Ditch will be 2.6 days.

A. Calculation by BOD-SS load

$V = (Q_2 \times BOD_{in} \times 10^{-3})/(\text{BOD-SS load} \times MLSS \times 10^{-3})$

BOD-SS load : 0.05 kg BOD/kg SS day
MLSS : 4,000 mg/l

B. Calculation by required nitrification/denitrification zone capacity, when sewage temperature is 18 degree C. in summer and 7 degree C. in winter.

Nitrification ratio : 90 % in summer, 70 % in winter
Denitrification ratio : 80 % in summer, 80 % in winter
Nitrification velocity : $K_N = 0.159 \exp(0.0908T)$ (g-N/g MLSS day)
Denitrification velocity : $K_{DN} = 0.324 \exp(0.0634T)$ (g-N/g MLSS day)

C. Calculation by required SRT

Required SRT = 20.65 exp (-0.0639T) = 13.2 days

T : Sewage temperature in winter (7 degree C.)

Required Oxidation Ditch volume was calculated based on above SRT.

4.2.2 Coagulation Facility

Item	Sysmbol	Calculation	Remarks
Dosing amount			
Design flow	Q	Q_1 = 1,270 m^3/day, Q_2 = 1,600 m^3/day	
Inflow T-P	$C_{TP\text{-}in}$	12.0 mg/l	
Inflow ST-P	$C_{STP\text{-}in}$	9.6 mg/l	
Coagulant		Alum-Oxichloride (Al_2O_3 content : 10 %)	
Dosing concentration	C_{AL}	$C_{STP\text{-}in}$/P x m x AL = 8.4 mg/l	
Atomic value of Phosphorous	P	31	
Dosing mole ratio	m	1.0	
Atomic value of Aluminium	AL	27	
Dosing amount (Max)	R_{AL}	C_{AL} x (O x 3 + AL x 2)/(AL x 2 x C_{AlL} x 10^{-2}) x Q x 10^{-3}	
Atomic value of Oxygen	O	16	
Al_2O_3 content	C_{ALL}	10%	
At Daily Maximum	R_{AL}	= 254 kg/day	
At Daily Average	R_{AL}	= 202 kg/day	
Anticipated consumption		Assuming that annual average inlet T-P is 10 mg/l. Posphorous removal at secondary treatment facility (30 %) shall also be considered.	
Target T-P	$C_{TP\text{-}in}$	12 x (1 - 0.3) = 8.4 mg/l	
Target ST-P	$C_{STP\text{-}in}$	6.7 mg/l	
Dosing concentration	C_{AL}	5.8 mg/l	
Dosing amount (Daily average)	R_{AL}	139.2 kg/day = 50,808 kg/year	

4.2.3 Aeration Equipment

Item	Sysmbol	Calculation	Remarks
Design sewage flow (Daily maximum)	Q_2	1,600 m^3/day	
Type		Submersible Propeller Mixer and Diffuser Type	
Oxygen Supply	SOR	Oxygen supply is supposed to be 2.1 kg O_2/kg BOD per unit inflow BOD. Further, aeration equipment shall be able to supply the required oxygen even in case of P.S.T.'s by-pass operation. = 1,600 m^3/day x 490 mg/l x 10^{-3} x 2.1 = 1,646 kg O_2/day	
Air supply	Qa	= SOR/(E x h x 10^{-3} x 24) E : Oxygen dissolution efficiency (18 g O_2/m^3 air.water depth) h : Deffuser depth = 2.2 m = 1,646/(18 x 2.2 x 10^{-3} x 24) = 1,732 m^3/hr = 28.9 m^3/min	
Aeration blower			
Type		Roots Blower	
Specification		Dia. 150 mm x 14.5 m^3/min x 3,200 mmAq x 15 kw	
Quantity		3 sets (1 set as stand-by)	
Diffuser			
Type		Membrane Disk Aerator	
Unit air flow		7 m^3/hr. 1 set	
Quantity		32 units/set x 4 sets/channel x 2 channel = 256 units	
Submersible mixer			
Type		Submersible Propeller Mixer	
Power reqirement	Lp	N x V x 10^{-3} = 4.2 kw/channel	

Item	Sysmbol	Calculation	Remarks
Unit power reqirement	N	2.0 w/m^3	
Ditch volume	V	4,208 m^3/channel x 1/2 channel = 2,104 m^3/channel	
Specification and quantity		Dia.1.6 m x 2.3 kw x 2 sets/channel x 2 channel	

4.3 Final Sedimentation Tank

Item	Sysmbol	Calculation	Remarks
Design flow (Daily maximum)	Q_2	1,600 m^3/day = 66.7 m^3/hr = 1.1 m^3/min	
Type		Radial Flow Circular Sedimentation Tank with Cnter driven Sludge Collector	
Surface load	S_L	5 m^3/m^2.day	
Required surface area	A_1	$Q_2 \times 1/S_L$ = 320 m^2	
Effective depth	H	3.5 m	
Overflow load	O_L	Less than 25 m^3/m day	
Weir length	l_1	Q_2/O_L = 64 m	
Demensions		Dia. 14.5 m x 3.5 mH x 2 units	
(Surface area)	A_2	$\pi/4 \times 14.5^2$ = 165 m^2	
(Capacity)	V_2	165 x 3.5 = 577.5 m^3	
(Weir length)	l_2	π x (14.5 - 1.0) = 42.4 m	
Check			
Surface load	A	1,600 x 1/(165 x 2) = 4.8 m^3/m^2.day < 5.0 ... OK	
Retention time	T_2	577.5 x 2 x 1/66.7 = 17.3 hrs	
Overflow load		1,600 x 1/(42.4 x 2) = 18.9 m^3/m^2.day < 25 ... OK	
Examination on Surface load			
Initial sedimentation verocity	v_0	$4.9 \times 10^6 \times T^{0.95} \times X_A^{-1.35} \times [SVI]^{-0.77}$ = 9.0 m/hr	
Sewage temperature	T	7 degree C.	
SVI		150	
Surface load	S	v_0/R = 4.5 ... 5.0 m^3/m^2 day	
Fluctuation ratio	R	2	

4.4 Sludge Thickener

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Excess sludge : 121 m^3/day, 701 kg/day	
Type		Radial Flow Rectangular Sedimentation Tank with Picket Fence Mixer	
Solid load		30 kg DS/m^2.day	
Required surface area		701 x 1/40 = 23.4 m^2	
Effective depth		4.0 m	
Demensions		W 5.0 m x L 5.0 m x 4.0 mH x 1 unit	
(Surface area)	A_2	5.0 x 5.0 = 25.0 m^2	
(Capacity)	V_2	25 x 4.0 = 100 m^3	
Check			
Solid load		701 x 1/25 = 28 kg DS/m^2.day	
Thickening time	T	100 x 1/121 x 24 = 19.8 hrs	

4.5 Sludge Storage Tank

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Gravity thickened sludge : 37 m^3/day, 561 kg DS/day	
Type		Rectangular Tank	
Storage days	T_1	More than 2 day's sludge volume	
Storage capacity	V_1	37 x 2 = 74 m^3	
Demensions		4.0 m x 5.0m x 4.0 mH (effective depth)	
(Effective capacity)	V_2	4.0 x 5.0 x 4.0 = 80 m^3	
Check			
Storage days	T_2	80 x 1/37 = 2.2 days	

4.6 Sludge Dewater

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Gravity thickened sludge : 37 m^3/day, 561 kg DS/day (Excess sludge only)	
Type		Centrifugal Dewater Machine	
Operation time		6 days in week, 6 hrs/day	
Capacity requirement		37 m^3/day x 7/6 x 1/6 = 7.2 m^3/hr	
Specifications		8.0 m^3/hr x 22 kw/5.5 kw x 1 unit	
Polymer dosing ratio		Less than 1.5 % per DS	
Polymer consumption (Daily average)		Assuming that annual average inlet SS is 350 mg/l and average dosing ratio is 1.2 % ; 561 x 350/500 x 1,270/1,600 x 1.2 x 10^{-2} = 3.74 kg/day = 1,365 kg/year	

4.7 Composting Yard

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily average)	q_1	Target dewatered sludge volume is based on daily average sewage flow.	
Dewatered cake			
Solid weight	D_1	533 kg DS/dayx 0.8 = 426 kg DS/day	
Water content	wt_1	85 % (water content of dewatered cake : 98.5 %)	
Cake weight	V_1	426 x 100/(100 - 85) x 10^{-3} = 2.8 wt/day	
Bulk density	C_1	1.0 t/m^3	
Apparent volume	V_1'	2.8 wt /dayx 1/1.0 = 2.8 m^3/day	
Organic content		70%	
Organic digestion ratio		60%	
Digested organic		426 x 0.7 x 0.6 = 179 kg DS/day	
Compost products			
Solid weight	D_2	426 - 179 = 247 kg/day = 0.25 t/day	
Water content	wt_2	35%	
Product weight	V_2	0.25 x 100/(100 - 35) = 0.38 wt/day	
Bulk density	C_2	0.4 wt/m^3	
Apparent volume	V_2'	0.38 x 1/0.4 = 0.95 m^3/day	
Composting Yard			
Storage days	T	180 days	
Deposit height	h	0.6 m	
Required area	A	(2.8 + 0.95) x 1/2 x 180 x 1/0.6 = more than 563 m^2	
Dimensions		10.0 m x 30.0 mL x 2 lines	
(Area)		10.0 x 30.0 x 2 = 600 m^2	

4.8 Sludge Lagoon

Item	Sysmbol	Calculation	Remarks
Design sewage flow (Thickened sludge)	Qd.ave	37 x 1,270/1,600 = 29.4 m^3/day	
Retention time	T	30 days	
Required volume	V	29.4 x 30 = 882 m^3	
Depth	D	1.5 m	
Surface area	A	882 x 1/1.5 = 588 m^2	
Dimension		W 20 m x 30 mL x 1.5 mH	

4.9 Transformer Capacity

Item	Sysmbol	Calculation	Remarks
Transformer capacity	TC	EC x (B x A)/(E x PF) = 89.3 KVA ... 100 KVA	
Electrical capacity	EC	95.5 kw	
Demand factor	B	0.65	
Allowance	A	1.1	
General Efficiency	E	0.85	
General power factor	PF	0.9	

5. Mechanical Equipment List

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-1	Mechanical Screen	Mechanical Bar Screen 800 W x 1,000 H Bar spacing : 5 mm	0.4	1	For main channel with screening cage
M-2	Bypass Screen	Bar Screen 800 W x 600 H Bar spacing : 20 mm	-	1	For bypass channel
M-3	Sand Pump	Submersible Sand Pump Dia. 80 mm x 0.3 m^3/min x 10 mH	3.7	1	
M-4	Submersible Mixer	Submersible Propeller Mixer Dia.1.6 m x two blades Lifter Type	2.3	4	
M-5	Diffuser	Membrane Rubbrer Diffuser 7 m^3 air/hr set 32 sets/1 unit x 8 units	-	256	Oxygen supply efficiency 18 g O_2/m^3-air-m water depth
M-6	Aeration Blower	Roots Blower Dia. 150 mm x 14.5 m^3/min x 3,200 mmAq	15	2 + 1	Inverter control
M-7	Coagulant Tank	FRP Cyrindrical Tank 5.0 m^3 with Mixer	0.1	1	
M-8	Coagulant Feed Pump	Diaphram Pump 0.1 l/min x 20 m	0.2	2	Manual control
M-9	Caustic Soda Tank	FRP Cyrindrical Tank 4.0 m^3 with Mixer	0.1	1	
M-10	Caustic Soda Feed Pump	Diaphram Pump 0.1 l/min. x 20 m	0.2	2	Manual control
M-11	Bypass Gate	Rising Spindle Type Gate Dia. 400 mm	-	1	

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-12	Final Sedimentation Tank Sludge Collector	Center Drive Clarifier Dia. 14.5 m x 3.5 mH with Picket Fence	0.75	2	
M-13	Return Sludge Pump	Nonclog Centrifugal with Screw Type Sludge Pump Dia. 80mm x 0.6 m^3/min x 5 m	1.5	4	Hydrostal Type
M-14	Excess Sludge Pump	Progressive Cavity Pump Dia. 80mm x 6.5 m^3/hr x 10 m	2.2	2	
M-15	Plant Water Pump	Submersible Pump Dia. 65mm x 0.2 m^3/min x 30 m	2.2	1	
M-16	Sludge Thickening Mixer	Center Drive Picket Fence Type Mixer Dia. 1,500 mm	0.2	1	
M-17	Thickened Sludge Pump	Progressive Cavity Pump Dia. 80 mm x 7.5 m^3/hr x 20 m	2.2	1 + 1	
M-18	Sludge Storage Tank Mixing Blower	Roots Blower Dia. 50 mm x 0.2 m^3/min x 4,000 mm Aq	0.75	1	
M-19	Sludge Feed Pump	Progressive Cavity Pump Dia. 100 mm x 12 m^3/hr x 20 m	3.7	1	
M-20	Sludge Dewatering Unit	Centrifugal Type Dewater 8.0 m^3/hr	22 + 5.5	1	
M-21	Sludge Cake Conveyer	Screw Conveyer 1.0 m^3/hr	0.75	1	
M-22	Polymer Tank	FRP Cylindrical Tank 5.0 m^3 with Mixer	0.1	1	
M-23	Polymer Feed Pump	Progressive Cavity Pump Dia. 25 mm x 1.3 m^3/hr x 20 mH	0.4	1	

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-24	Drain Pump	Nonclog Submersible Pump Dia. 80 mm x 0.3 m^3/min x 10 mH	1.5	1	
M-25	Flow Measurement Equipment	Parshall Flume Type W = 0.31 m	-	1	

6. Capacity Calculation for Skuodas Treatment Plant (Case 3)

Appendix 6 Capacity Calculation for Skoudas Sewage Treatment Plant (Case 3)
Case 3 : Sequencing Batch Reactor System

1. Design Criteria

1.1 Design Sewage Flow

$Q_{dave} = Q_1$ = 1,270 m^3/day

$Q_{dmax} = Q_2$ = 1,600 m^3/day

$Q_{hmax} = Q_3$ = 3,200 m^3/day

1.2 Design Sewage Quality

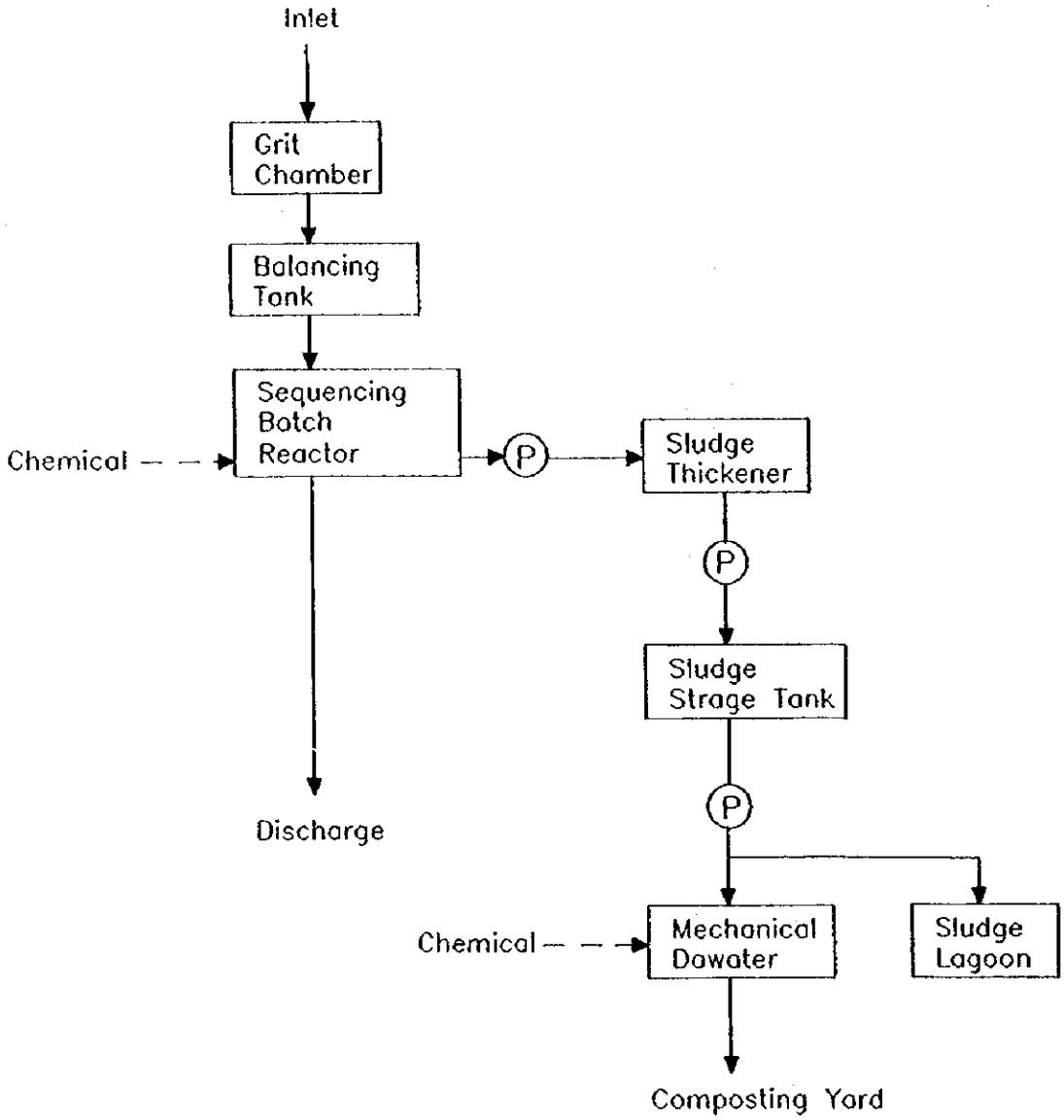
Item	Influent Quality (mg/l)	Secondary Tretment Facility		Discharge Standard		Remarks
		Removable Rates (%)	Effluent Quality (mg/l)	Average (mg/l)	Maximum (mg/l)	
BOD_5	490	97.4	13	13	21.7	
BOD_7	560	97.4	15	15	25	
SS	500	95	25	30	45	
COD_{Cr}	1,000	92.5	75	75	120	
T-N	70	70	21	20	35	
T-P	12	*87.5	1.5	1.5	2.5	

* : with coagulant treatment

1.3 Design Seage Temperature

In winter : 7 degree C.

2. Flow Chart


Inlet
Grit Chamber
Balancing Tank
Sequencing Botch Reactor
Chemical
P
Sludge Thickener
P
Sludge Strage Tank
P
Discharge
Chemical
Mechanical Dowater
Sludge Lagoon
Composting Yard

MASS BALANCE IN SBR SYSTEM

1. Design for Daily Maximum Flow

Design Flow		m3/day	m3/hour	m3/min	m3/sec
Daily Average	Qda	1,270	52.9	0.88	0.015
Daily Maximum	Qdm	1,600	66.7	1.11	0.019
Hourly Peak	Qhp	3,200	133.3	2.22	0.037

	Influent Quality	Effluent Quality
BOD7	560 mg/l	15 mg/l
BOD5	490 mg/l	13 mg/l
SS	500 mg/l	30 mg/l
COD	1,000 mg/l	75 mg/l
Total-N	70 mg/l	20 mg/l
Total-P	12 mg/l	1.5 mg/l

Inflow

Qdm	1,600 m3/day
BOD5	784 kg/day
SS	800 kg/day
COD	1,600 kg/day
Total-N	112 kg/day
Total-P	19 kg/day

SBR Design Criteria for Daily Maximum Flow

Design MLSS 2,000 mg/l

Design BOD/SS Ratio 0.2 Kg-BOD/kg-SS

Minimum HRT 2.0 days for Nitrification/Denitrification

SBR Influent

Q	1,752 m3/day
BOD5	784 kg/day
SS	1,025 kg/day

Inflow → Grit Chamber → Oxidation Ditch → Effluent

Oxidation Ditch

V =	4,000 m3
HRT=	2.50 day
MLSS =	2,000 mg/l
=	8,000 kg
BOD/SS Ratio	0.20

Effluent

Q	1,596 m3/day
BOD5	13 mg/l
=	21 kg/day
SS	30 mg/l
=	48 kg/day

Chemical Coagulant

7.4 mg/l for influent Q

11.8 kg/day

Excess Sludge

Qe	156 m3/day
SS Water C.	99.4 %
SS	6,000 mg/l
=	939 kg/day

(see SS Balance below)

Sludge Thickener

Liquid Returned to Grit Chamber

Qr	106 m3/day
SS	188 kg/day
=	1,765 mg/l

SS Yield	80 %
Water Cont.	98.5 % water
SS	751 kg/day
Qs	50 m3/day

Sludge Dewatering

Liquid Returned to Grit Chamber

Qr	45 m3/day
SS	38 kg/day
=	829 mg/l

SS Yield	95 %
Water Cont.	85 % water
SS	713 kg/day

Sludge Volume

Qs 4.8 m3/day (wet base)

SS Balance	
Influent SS	1,025 kg/day
Effluent SS	48 kg/day
SS removed	977 kg/day
Net reduction by endogenous decay	90 % (including convert from BOD removed)
SS increase after decay	879 kg/day
SS increase by coagulant dosage	59 kg/day
Total SS	939 kg/day

<— coagulant dosage rate 7.4 mg/l

SS production factor 5.0 kg-SS/kg-coagulant

4. Facility Capacity Calculation

4.1 Grit Chamber

Item	Sysmbol	Calculation	Remarks
Design flow (Hourly maximum)	Q_3	3,200 m^3/day = 133.3 m^3/hr = 2.22 m^3/min = 0.037 m^3/sec	
Type		Sand pit type	
Surface load	S_L	1,800 m^3/m^2.day	
Required surface area	A	$Q_3 \times 1/S_L$ = 1.78 m^2	
Effective depth	h	0.3 m	
Demensions		W 0.8 m x L 2.5 m x Effective depth 0.3 m x 1 unit	
Check			
Surface area	A	0.8 x 2.5 = 2.0 m^2 > 1.78m^2 ... OK	
Average velocity	V	0.037 x 1/(0.8 x 0.3) = 0.15 m/s <0.3 m/s ... OK	
Retention time	T	0.8 x 2.5 x 0.3 x 1/0.037 = 16 sec	
Grit		(Daily Average) Assuming that sand volume contained in sewage is 0.01 m^3 per 1,000m^3 of sewage ; 1,270 m^3/day x 0.01/1,000 = 0.013 m^3/day	
Screenings		(Daily average) Equivalent to grit	

4.2 Balancing Tank

Item	Sysmbol	Calculation	Remarks
Design flow (Daily maximum)	Q_2	1,600 m^3/day	
Type		Recutangular Tank	
Retention time	T	6 hrs	
Required capacity	V	Q_2 x T x 1/24 = 400 m^3	
Demensions		9.0 m x 11.0 m x 4.5 mH (effective depth)	
(Capacity)	V'	9.0 x 11.0 x 4.5H = 446 m^3	

4.3 SBR Reaction Tank

4.3.1 Reaction Tank

Item	Sysmbol	Calculation	Remarks
Design flow (Daily max.)	Q_2	1,600 m^3/day	
Type		Sequencing Batch System Reaction Tank (Dual Tank)	
BOD-SS load	L_B	0.2 kg/kg day	
Tank capacity	V	$Q_2 \times S_{in} \times 10^{-3}/(T_A \times n/24 \times L_B \times M_S \times 10^{-3})$	
		= 3,920 m^3	
Inflow BOD	S_{in}	490 mg/l	
Aeration time	T_A	4 hrs/1 cycle	
Number of cycle	n	3 cycle/day (1 cycle 8 hrs)	
MLSS	M_S	2,000 mg/l (BOD-SS load is 0.13 kg/kg day, when MLSS is 3,000 mg/l)	
Dimension		12.0 mW x 30.0 mL x 5.5 mH x 2 tanks	
(Capacity)	V'	12.0 x 30.0 x 5.5 x 2 = 3,960 m^3	
Retention time	T	3,960 x 1/1,600 x 24 = 59.4 hrs	
Withdrawal ratio	1/m	24/(T x n) = 1/7.4 ... 1/7	
Operation schedule (Plan)		8 hrs/cycle No.1 Tank 1 2 3 4 5 6 7 8 Inflow (4 hrs) Mixing (1 hr) Acration (4 hrs) Sedimantation (2 hrs) Withdraw (1 hr) NO.2 Tank Inflow Mixing Acration Sedimantation Withdraw	

4.3.2 Coagulation Facility

Item	Sysmbol	Calculation	Remarks
Dosing amount			
Design flow	Q	Q_1 = 1,270 m^3/day, Q_2 = 1,600 m^3/day	
Inflow T-P	$C_{TP\text{-}in}$	12.0 mg/l	
Inflow ST-P	$C_{STP\text{-}in}$	9.6 mg/l	
Coagulant		Alum-Oxichloride (Al_2O_3 content : 10 %)	
Dosing concentration	C_{AL}	$C_{STP\text{-}in}$/P x m x AL = 8.4 mg/l	
Atomic value of Phosphorous	P	31	
Dosing mole ratio	m	1.0	
Atomic value of Aluminium	AL	27	
Dosing amount (Max)	R_{AL}	C_{AL} x (O x 3 + AL x 2)/(AL x 2 x C_{ALL} x 10^{-2}) x Q x 10^{-3}	
Atomic value of Oxygen	O	16	
Al_2O_3 content	C_{ALL}	10%	
At Daily Maximum	R_{AL}	= 254 kg/day	
At Daily Average	R_{AL}	= 202 kg/day	
Anticipated consumption		Assuming that annual average inlet T-P is 10 mg/l. Posphorous removal at secondary treatment facility (70 %) shall also be considered.	
Target T-P	$C_{TP\text{-}in}$	10 x (1 - 0.7) = 3.0 mg/l	
Target ST-P	$C_{STP\text{-}in}$	2.4 mg/l	
Dosing concentration	C_{AL}	2.1 mg/l	
Dosing amount (Daily average)	R_{AL}	50.4 kg/day = 18,396 kg/year	

4.3.3 Aeration Equipment

Item	Sysmbol	Calculation	Remarks
Type		Submersible Mechanical Aerator	
Oxygen Supply	SOR	$Q \times (S_{in} - S_{out}) \times 10^{-3} \times A$ $= 1,596$ kg O_2/day $= 66.5$ kg O_2/hr	
Sewage inflow	Q	$= Q_2 = 1,600$ m^3/day	
Inflow BOD	S_{in}	490 mg/l	
Effluent BOD	S_{out}	15 mg/l	
Required oxygen per unit BOD removal	A	2.1 kg O_2/kg BOD	
Air supply	Qa	$= SOR/(G_S \times 10^{-2} \times E \times O_W) \times (273 + T)/273 \times 1/60 \times A$ $= 22.1$ m^3/min	
Oxygen transfer efficiency against clear water	G_S	20 % (Submergible Mechanical Aerator)	
Air density	E	1.2923 kg air/N m^3	
Air temperature	T	15 degree C.	
Surplus ratio	A	1.15	
Aeration blower			
Type		Roots Blower	
Specification		Dia. 200 mm x 23 m^3/min x 6,000 mmAq x 55 kw	
Quantity		2 sets (1 set as stand-by)	
Aeration equipment			
Type		Submersible Type Mechanical Aerator	
Specification		38 kg O_2/hr x 11 kw x 4 sets	

4.4 Sludge Thickener

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Excess sludge : 156 m^3/day, 939 kg/day	
Type		Radial Flow Rectangular Sedimentation Tank with Picket Fence Mixer	
Solid load		30 kg DS/m^2.day	
Required surface area		939 x 1/30 = 31.3 m^2	
Effective depth		4.0 m	
Demensions		W 6.0 m x L 6.0 m x 4.0 mH x 1 unit	
(Surface area)	A_2	6.0 x 6.0 = 36.0 m^2	
(Capacity)	V_2	36 x 4.0 = 144 m^3	
Check			
Solid load		939 x 1/36 = 26.1 kg DS/m^2.day	
Thickening time	T	144 x 1/156 x 24 = 22 hrs	

4.5 Sludge Storage Tank

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Gravity thickened sludge : 50 m^3/day, 751 kg DS/day	
Type		Rectangular Tank	
Storage days	T_1	More than 2 day's sludge volume	
Storage capacity	V_1	50 x 2 = 100 m^3	
Demensions		5.0 m x 5.5m x 4.0 mH (effective depth)	
(Effective capacity)	V_2	5.0 x 5.5 x 4.0 = 110 m^3	
Check			
Storage days	T_2	110 x 1/50 = 2.2 days	

4.6 Sludge Dewater

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily maximum)	q_2	Gravity thickened sludge : 50 m^3/day, 751 kg DS/day (Excess sludge only)	
Type		Centrifugal Dewater Machine	
Operation time		6 days in week, 6 hrs/day	
Capacity requirement		50 m^3/day x 7/6 x 1/6 = 9.7 m^3/hr	
Specifications		10 m^3/hr x 1 unit	
Polymer dosing ratio		Less than 1.5 % per DS	
Polymer consumption (Daily average)		Assuming that annual average inlet SS is 350 mg/l and average dosing ratio is 1.2 % ; 751 x 350/500 x 1,270/1,600 x 1.2 x 10^{-2} = 5.01 kg/day = 1,829 kg/year	

4.7 Composting Yard

Item	Sysmbol	Calculation	Remarks
Design sludge volume (Daily average)	q_t	Target dewatered sludge volume is based on daily average sewage flow.	
Dewatered cake			
Solid weight	D_t	713 kg DS/dayx 0.8 = 570 kg DS/day	
Water content	wt_t	85%	
Cake weight	V_t	570 x 100/(100 - 85) x 10^{-3} = 3.8 wt/day	
Bulk density	C_t	1.0 t/m^3	
Apparent volume	V_t'	3.8 wt /dayx 1/1.0 = 3.8 m^3/day	
Organic content		80%	
Organic digestion ratio		60%	
Digested organic		570 x 0.8 x 0.6 = 274 kg DS/day	
Compost products			
Solid weight	D_2	570 - 274 = 296 kg/day = 0.29 t/day	
Water content	wt_2	35%	
Product weight	V_2	0.29 x 100/(100 - 35) = 0.44 wt/day	
Bulk density	C_2	0.4 wt/m^3	
Apparent volume	V_2'	0.44 x 1/0.4 = 1.1 m^3/day	
Composting yard			
Storage days	T	180 days	
Deposit height	h	0.6 m	
Required area	A	(3.8 + 1.1) x 1/2 x 180 x 1/0.6 = more than 735 m^2	
Dimensions		11.0 m x 36.0 mL x 2 lines	
(Area)		11.0 x 36.0 x 2 = 792 m^2	

4.8 Sludge Lagoon

Item	Sysmbol	Calculation	Remarks
Design sewage flow (Thickened sludge)	Qd.ave	50 x 1,270/1,600 = 39.7 m^3/day	
Retention time	T	30 days	
Required volume	V	39.7 x 30 = 1,191 m^3	
Depth	D	1.5 m	
Surface area	A	1,191 x 1/1.5 = 794 m^2	
Dimension		W 26 m x 32 mL x 1.5 mH	

4.9 Transformer Capacity

Item	Sysmbol	Calculation	Remarks
Transformer capacity	TC	EC x (B x A)/(E x PF) = 155 KVA ... 200 KVA	
Electrical capacity	EC	166.25 kw	
Demand factor	B	0.65	
Allowance	A	1.1	
General Efficiency	E	0.85	
General power factor	PF	0.9	

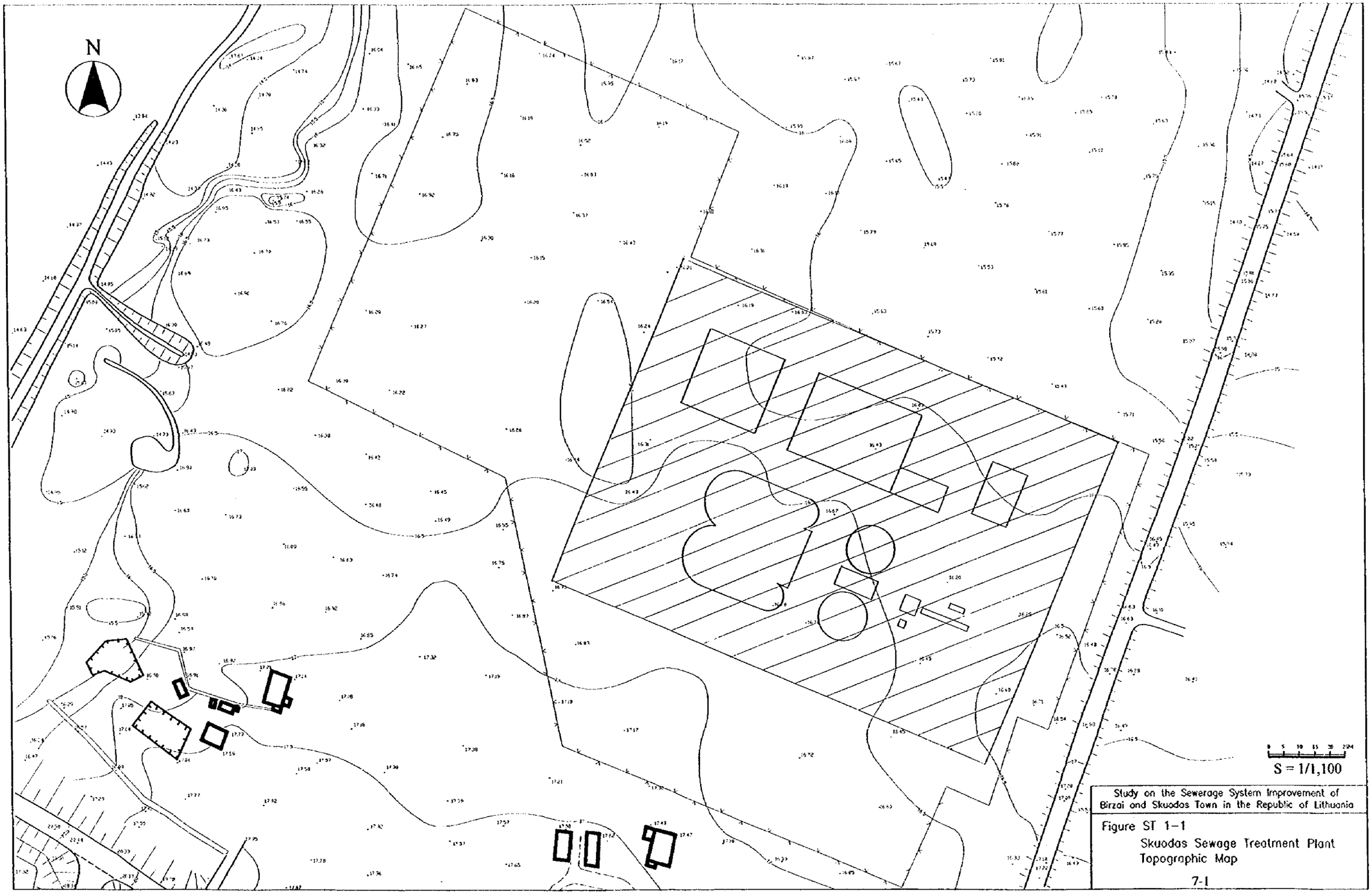
5. Mechanical Equipment List

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-1	Mechanical Screen	Mechanical Bar Screen 800 W x 1,000 H Bar spacing : 5 mm	0.4	1	For main channel with screening cage
M-2	Bypass Screen	Bar Screen 800 W x 600 H Bar spacing : 20 mm	-	1	For bypass channel
M-3	Sand Pump	Submersible Sand Pump Dia. 80 mm x 0.3 m^3/min x 10 mH	3.7	1	
M-4	Mixing Pump	Submersible Pup with Ejector Dia.80 mm	5.5	2	
M-5	Lift Pump	Submersible Non-clog Pump Dia. 100 mm x 1.33 m^3/min x 10 m	5.5	1 + 1	
M-6	Aerator	Submersible Mechanical Aerator Lifter Type, 38 kg O_2/hr	7.5	4	
M-7	Aeration Blower	Roots Blower Dia. 200 mm x 23 m^3/min x 6,000 mmAq	45	1 + 1	Inverter control
M-8	Outlet Equipment	Float-arm Type 4.0 mL	0.75	2	
M-9	Coagulant Tank	FRP Cyrindrical Tank 5.0 m^3 with Mixer	0.1	1	
M-10	Coagulant Feed Pump	Diaphram Pump 0.1 l/min x 20 m	0.2	2	Manual control
M-11	Caustic Soda Tank	FRP Cyrindrical Tank 4.0 m^3 with Mixer	0.1	1	
M-12	Caustic Soda Feed Pump	Diaphram Pump 0.1 l/min. x 20 m	0.2	2	Manual control

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-13	Scum Removal Equipment	Trough Skimer FRP, 150W x 7,000L	0.2	2	
M-14	Motor Valve	Motorized Butterfly Valve Dia. 200 mm	0.1	4	
M-15	Excess Sludge Pump	Submersible Non-clog Pump Dia. 80mm x 0.4 m^3/min x 10 m	2.2	4	
M-16	Plant Water Pump	Submersible Pump Dia. 65mm x 0.2 m^3/min x 30 m	2.2	1	
M-17	Sludge Thickening Mixer	Center Drive Picket Fence Type Mixer Dia. 1,500 mm	0.2	1	
M-18	Thickened Sludge Pump	Progressive Cavity Pump Dia. 80 mm x 7.5 m^3/hr x 20 m	2.2	1 + 1	
M-19	Sludge Storage Tank Mixing Blower	Roots Blower Dia. 50 mm x 0.2 m^3/min x 4,000 mm Aq	0.75	1	
M-20	Sludge Feed Pump	Progressive Cavity Pump Dia. 125 mm x 15 m^3/hr x 20 m	5.5	1	
M-21	Sludge Dewatering Unit	Cenrifugal Type Dewater 10 m^3/hr	37 + 7.5	1	
M-22	Sludge Cake Conveyer	Screw Conveyer 1.0 m^3/hr	0.75	1	
M-23	Polymer Tank	FRP Cylindrical Tank 8.0 m^3 with Mixer	0.2	1	
M-24	Polymer Feed Pump	Progressive Cavity Pump Dia. 32 mm x 1.8 m^3/hr x 20 mH	0.75	1	
M-25	Drain Pump	Submersible Non-clog Pump Dia. 80 mm x 0.3 m^3/min x 10 mH	1.5	1	

No.	Equipment Name	Specification	Motor Output (kw)	Quantity	Remarks
M-26	Flow Measurement Equipment	Parshall Flume Type W = 0.31 m	-	1	

7. Topographic Survey Map

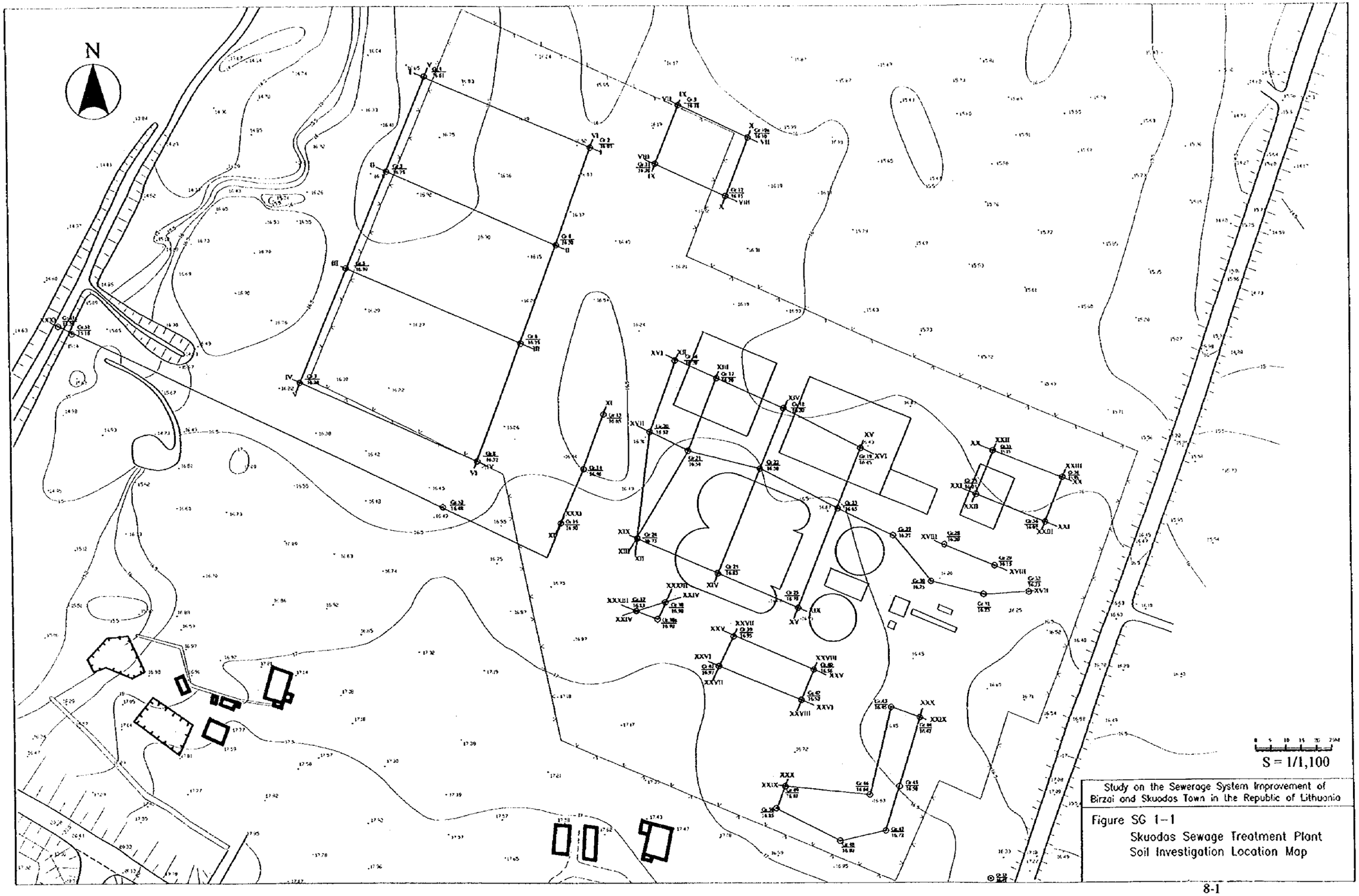


Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure ST 1-1
Skuodas Sewage Treatment Plant
Topographic Map

7-1

8. Soil Investigation Result



Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

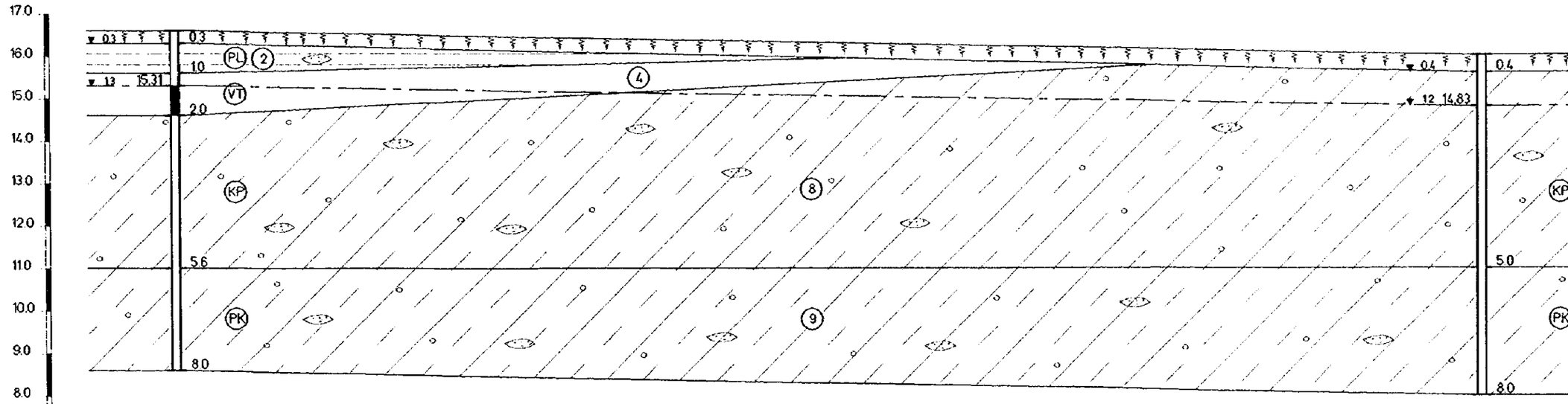
Figure SG 1-1
Skuodas Sewage Treatment Plant
Soil Investigation Location Map

No.	Description of soil	Symbol	Unit Volume Weight (kg/cm³)	Adhesion (kPa)	Friction Angle (degree)	Def. Modulus (MPa)	Strength (kPa)	Soil Clasific. Number
1	Poured soil		1.760	-	-	-	80	10b
2	Plastic sandy soil	PL	2.050	15	26	10	180	10a
3	Fine sand, loose	P	1.620	-	29	5	100	10a
4	Fine sand, medium density	VT	1.660	2	32	24	300 (200)	10a
5	Loamy soil, solidly plastic	KP	2.010	28	22	22	250	10b
6	Gravel		1.900	1	40	40	500	10d
7	Clay, solidly plastic	KP	1.920	43	16	13	250	10v
8	Moraine loamy soil	KP	2.240	39	24	23	300	10ž
9	Moraine loamy soil, solidly plastic	PK	2.260	47	26	40	300	10ž
10	Moraine sandy soil, solid	K	2.250	21	30	45	300	10ž

Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

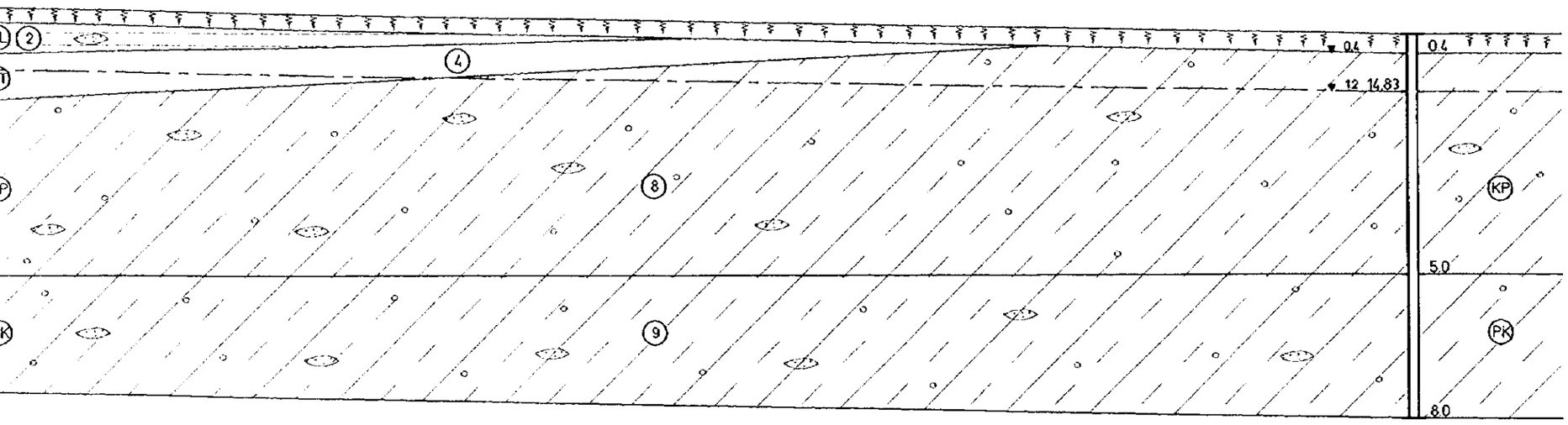
Table SG 2-1
Skuodas Sewage Treatment Plant
Geological Symbols and
Characteristic of Soils

I – I



Boring No.	GR.1	GR 2
Ground Level	16.61	16.03
Section Length (m)	61.50	

I - I

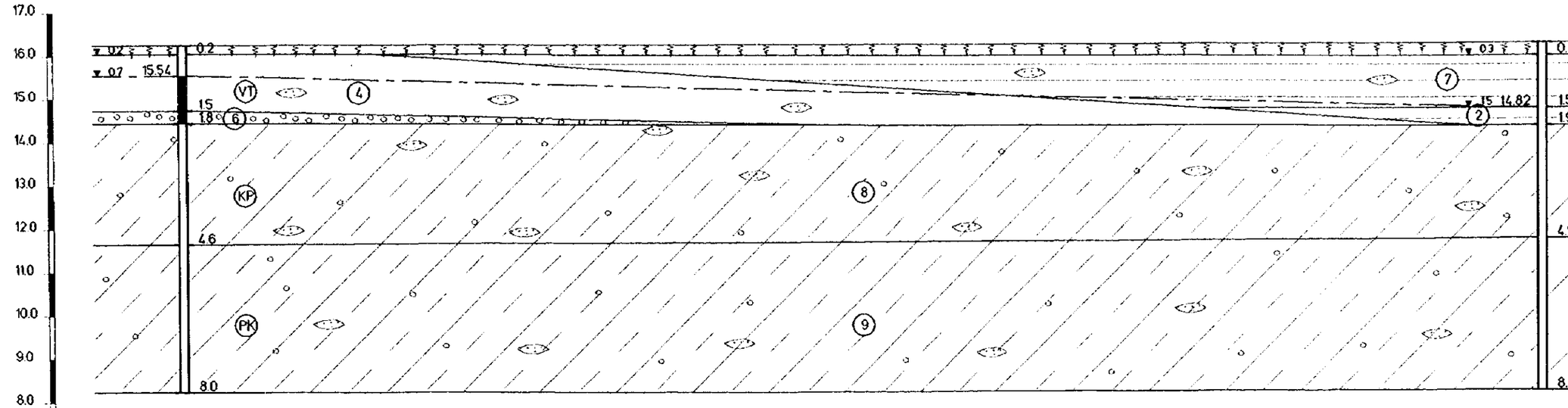


Scale V : 1/100
H : 1/200

Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

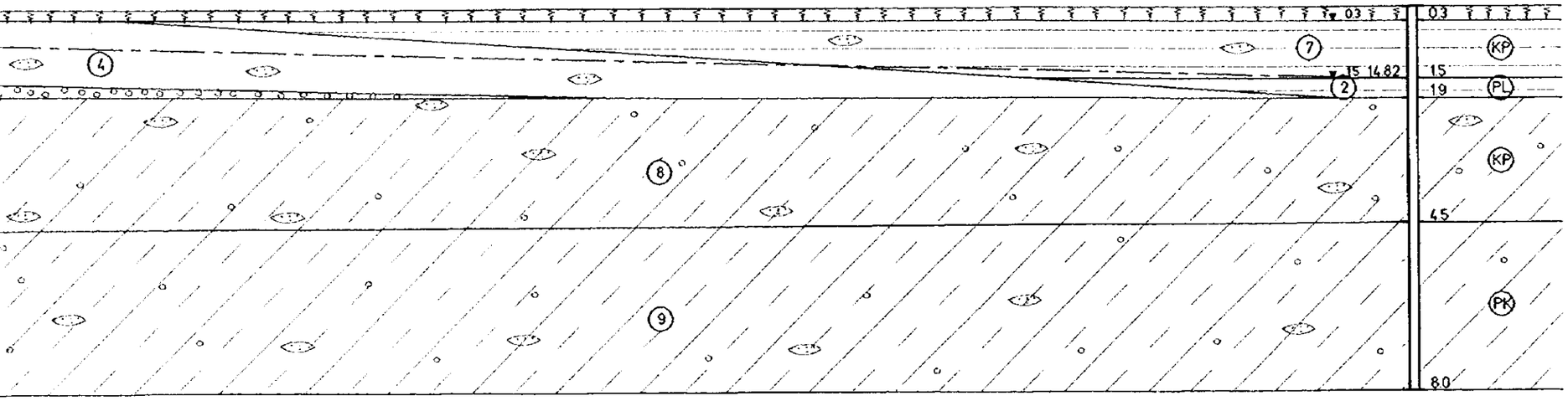
Figure SG 2-1
Skuodas Sewage Treatment Plant
Geological Section (I-I)

IV - IV



Boring No.	GR.7	GR.8
Ground Level	16.24	16.32
Section Length (m)	63.00	

IV - IV

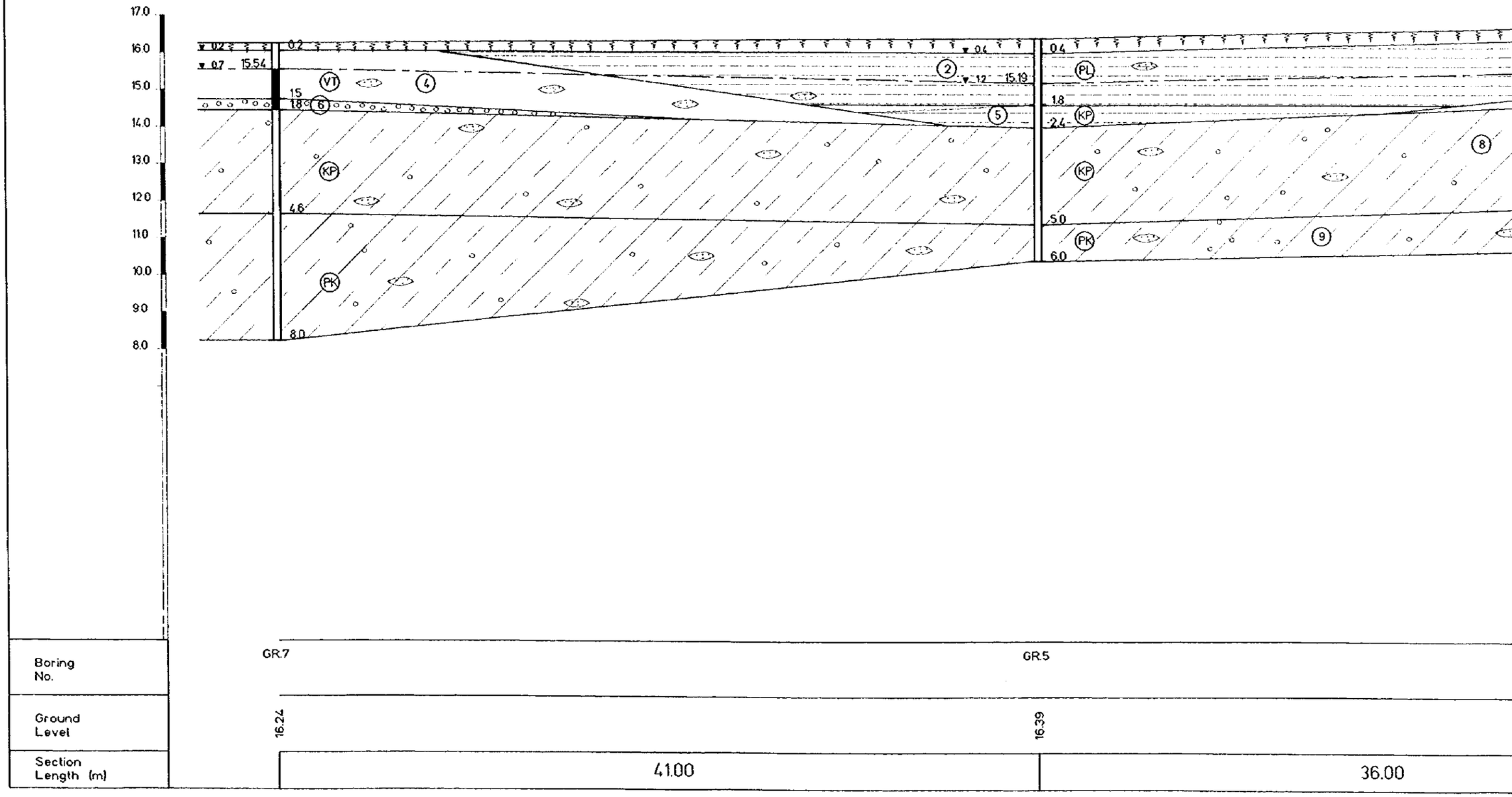


Scale V : 1/100
H : 1/200

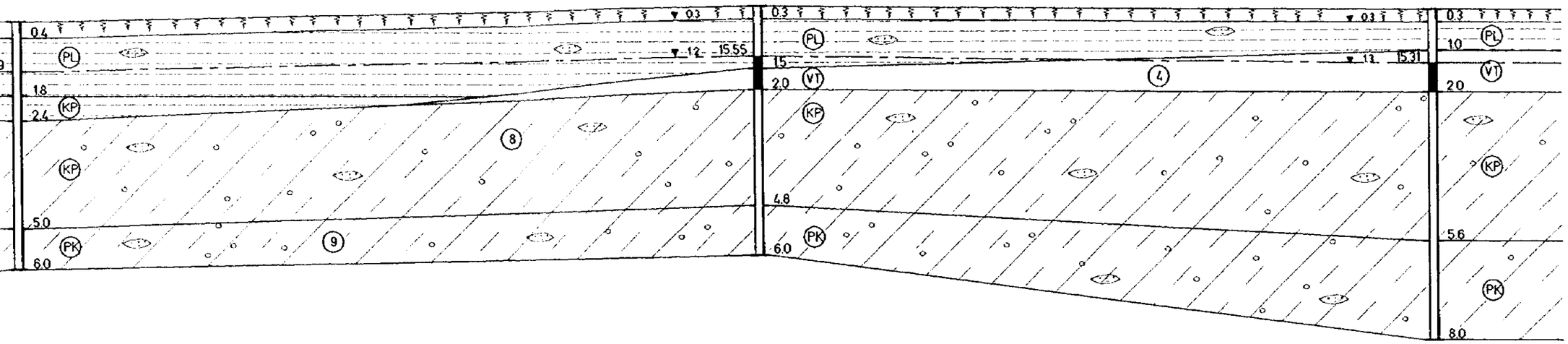
Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure SG 2-2
Skuodas Sewage Treatment Plant
Geological Section (IV-IV)

V - V


17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
0.2
0.7
15.54
VT
4
1.5
1.8
6
KP
4.6
PK
8.0
0.4
1.2
15.19
2
5
0.4
PL
1.8
2.4
KP
KP
8
5.0
PK
9
6.0
Boring No.
GR.7
GR.5
Ground Level
16.24
16.39
Section Length (m)
41.00
36.00

V - V



GR.5 GR.3 GR.1

16.39 16.75 16.61

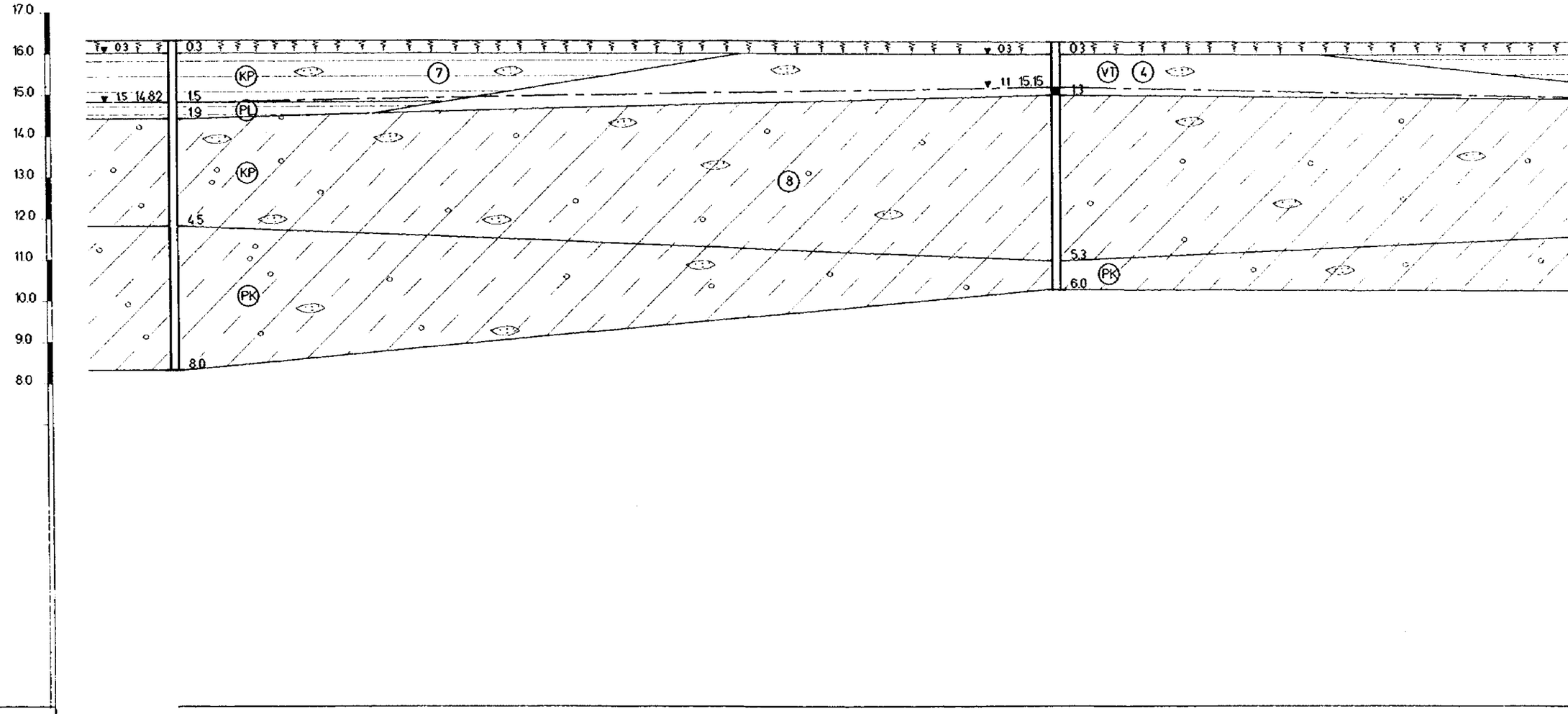
36.00 32.50

Scale V : 1/100
H : 1/200

Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

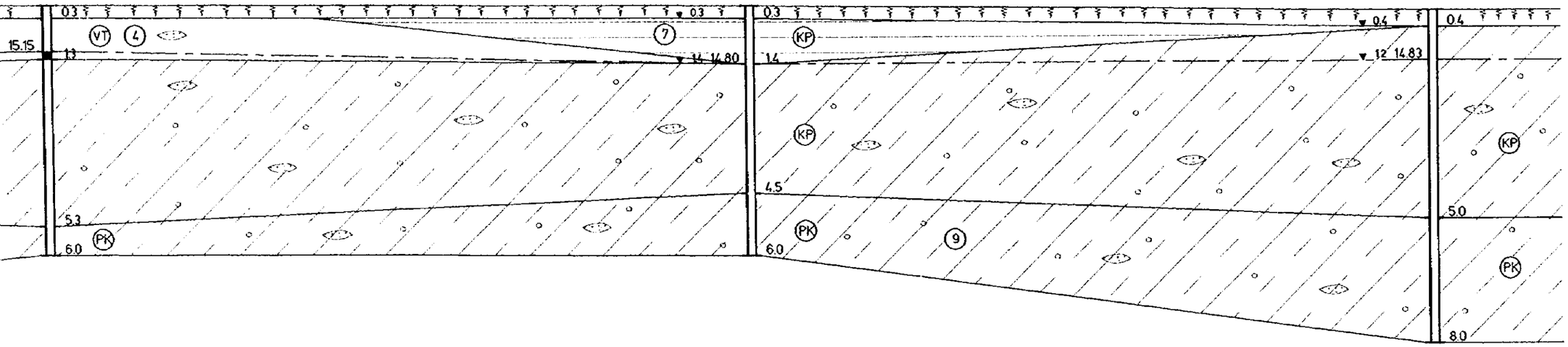
Figure SG 2-3
Skuodas Sewage Treatment Plant
Geological Section (V-V)

VI - VI



Boring No.	GR.8	GR.6
Ground Level	16.32	16.25
Section Length (m)	43.00	34.00

VI - VI



Scale V : 1/100
H : 1/200

GR.6 GR.4 GR.2

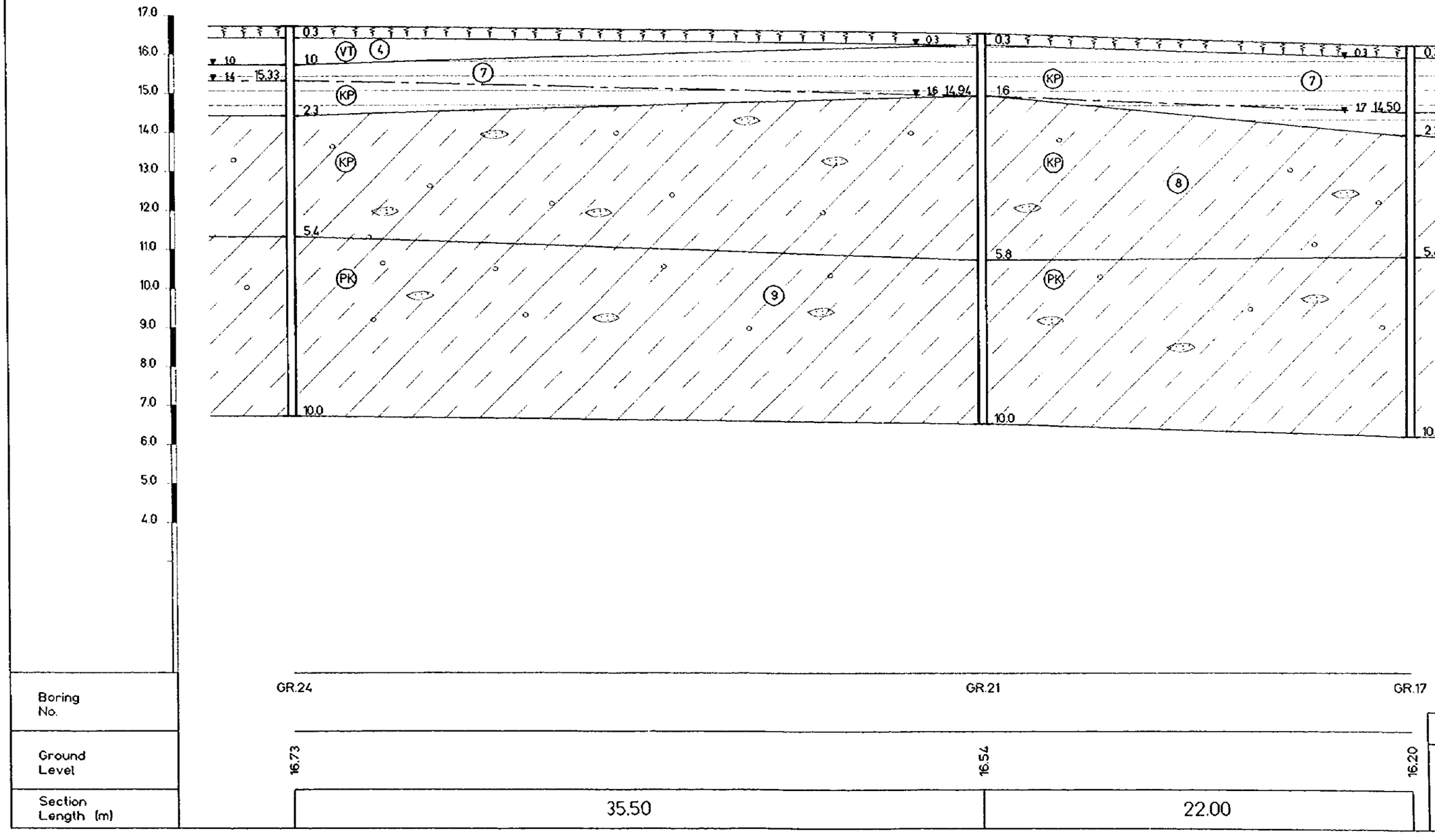
16.25 16.20 16.03

34.00 33.00

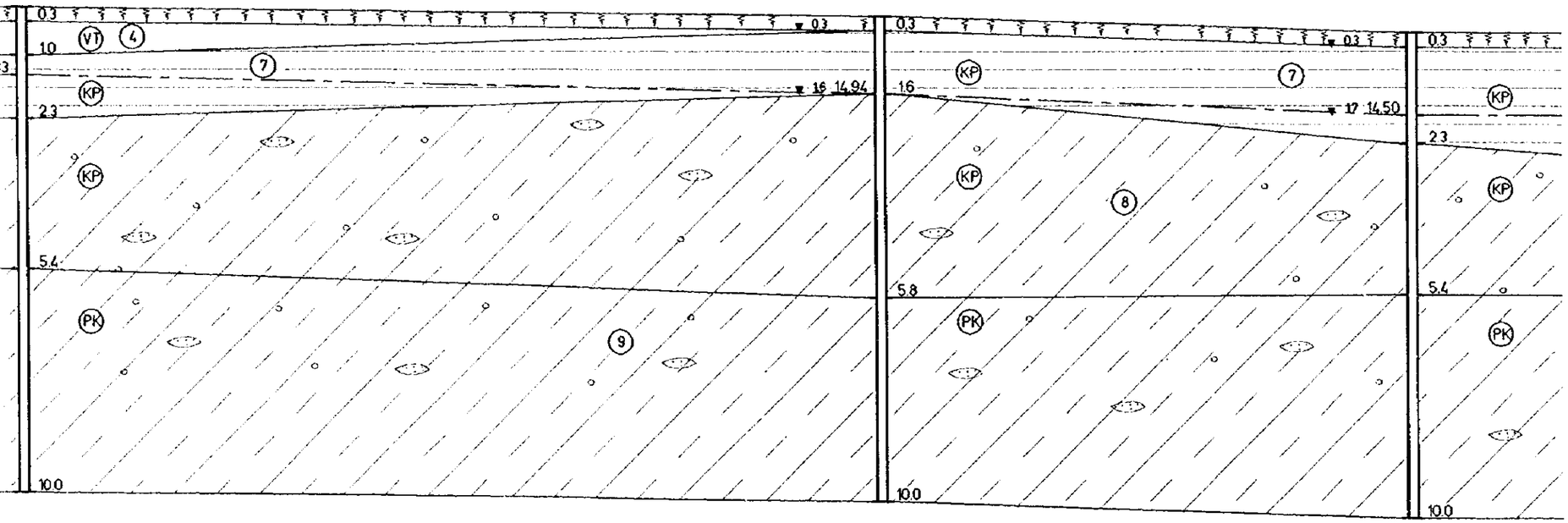
Study on the Seweroge System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure SG 2-4
Skuodas Sewage Treatment Plant
Geological Section (VI-VI)

XIII - XIII


17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
0.3
10
14 15.33
2.3
5.4
10.0
VT
4
7
KP
PK
9
16 14.94
16
17 14.50
5.8
8
GR.24
GR.21
GR.17
Boring No.
Ground Level
Section Length (m)
16.73
16.54
16.20
35.50
22.00

XIII - XIII



Scale V : 1/100
H : 1/200

GR.24 GR.21 GR.17

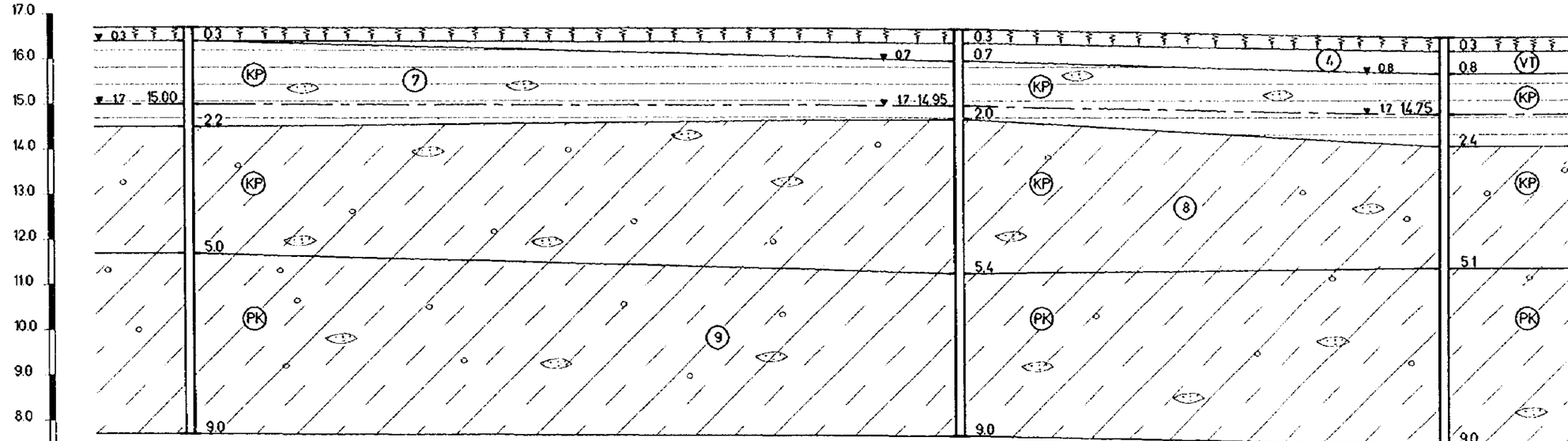
16.73 16.54 16.20

35.50 22.00

Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure SG 2-5
Skuodas Sewage Treatment Plant
Geological Section (XIII-XIII)

XV - XV

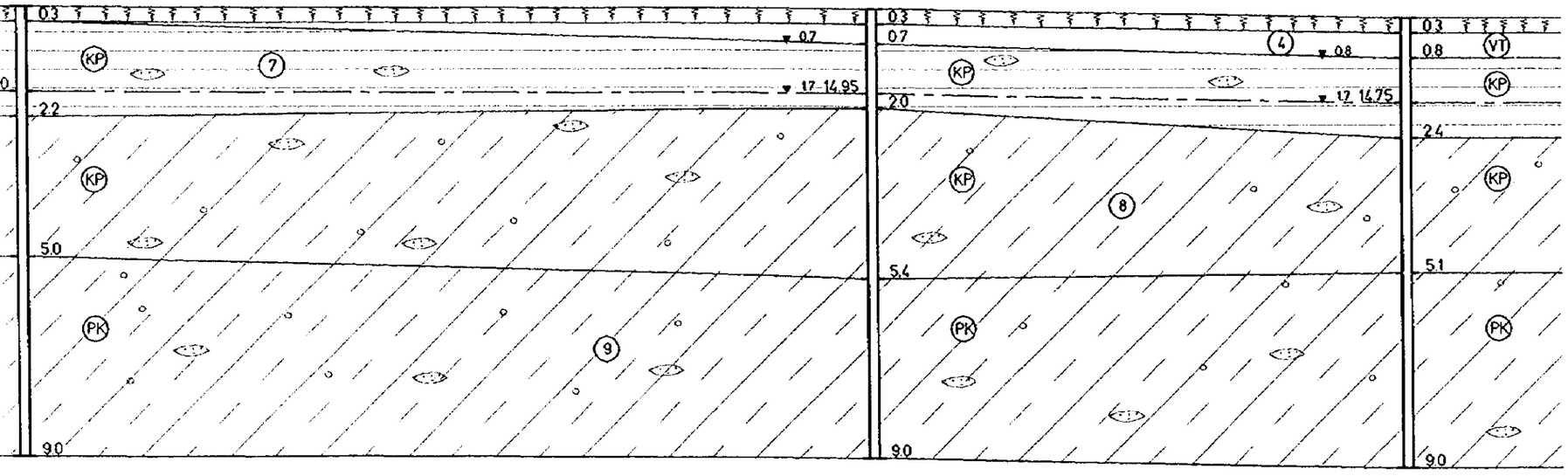


Boring No.	GR.26	GR.23	GR.19
Ground Level	16.70	16.65	16.45
Section Length (m)	34.00	21.50	

Study on th
Birzai and Sku

Figure SG 2
Skuo
Geolo

XV - XV



Scale V : 1/100
H : 1/200

GR.26 GR.23 GR.19

16.70 16.65 16.45

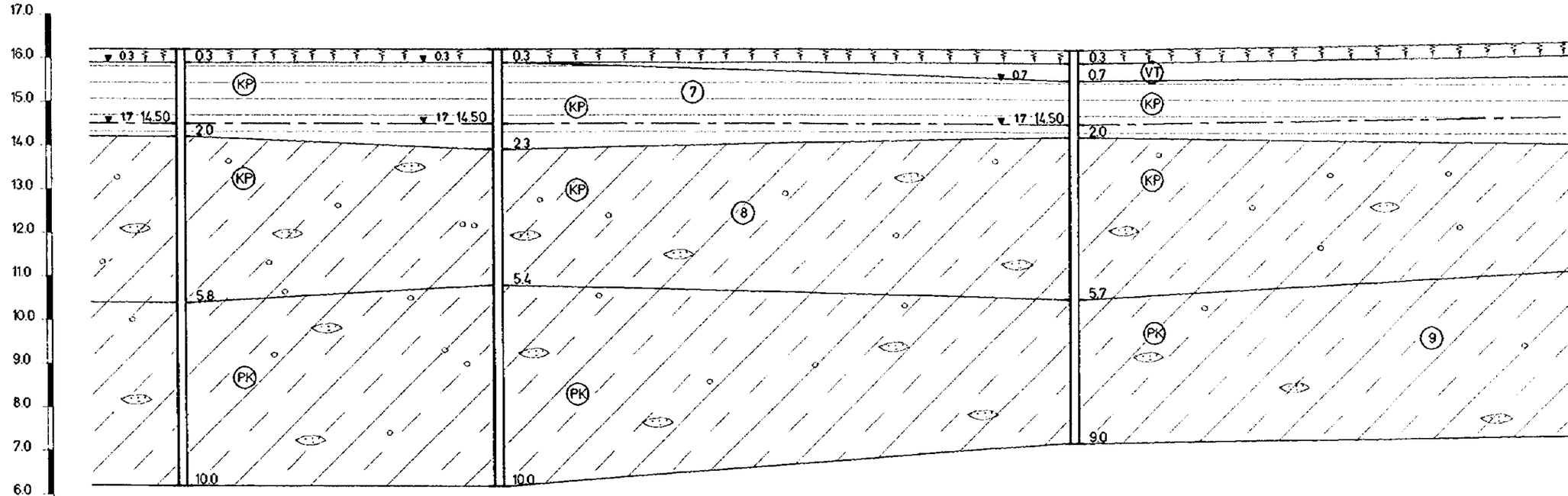
34.00 21.50

Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure SG 2-6
Skuodas Sewage Treatment Plant
Geological Section (XV-XV)

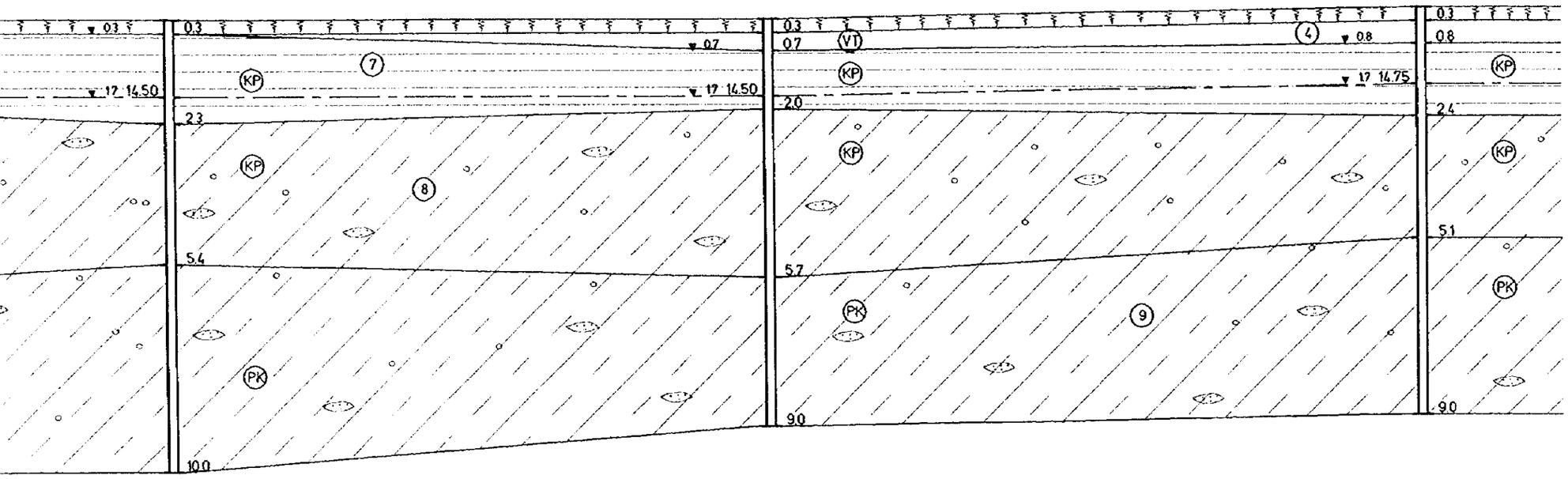
8-8

XVI - XVI



Boring No.	GR.16	GR.17	GR.18
Ground Level	16.20	16.20	16.20
Section Length (m)	14.50	26.50	29.00

XVI - XVI



GR.17 GR.18 GR.19

16.20 16.20 16.45

14.50 | 26.50 | 29.00

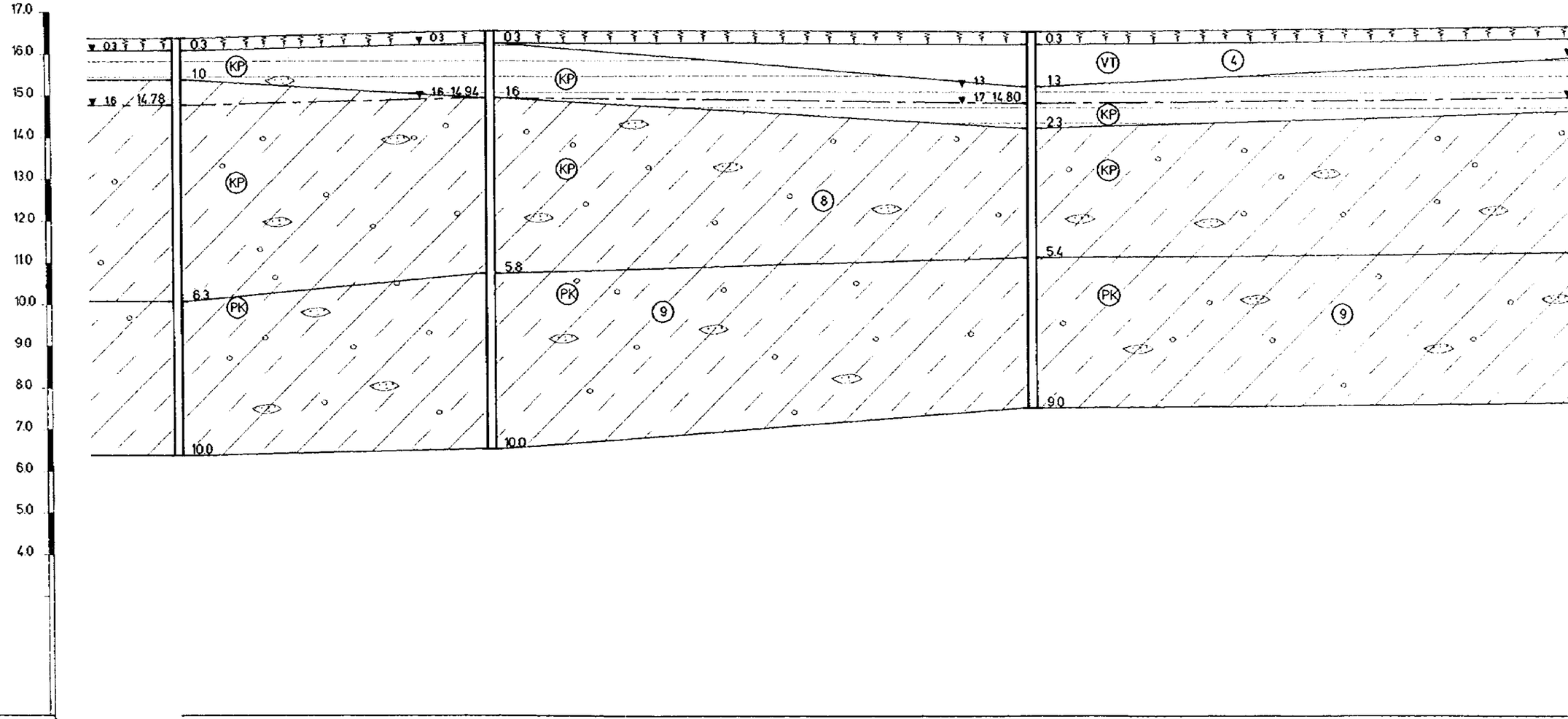
Scale V : 1/100
H : 1/200

Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure SG 2-7
Skuodas Sewage Treatment Plant
Geological Section (XVI-XVI)

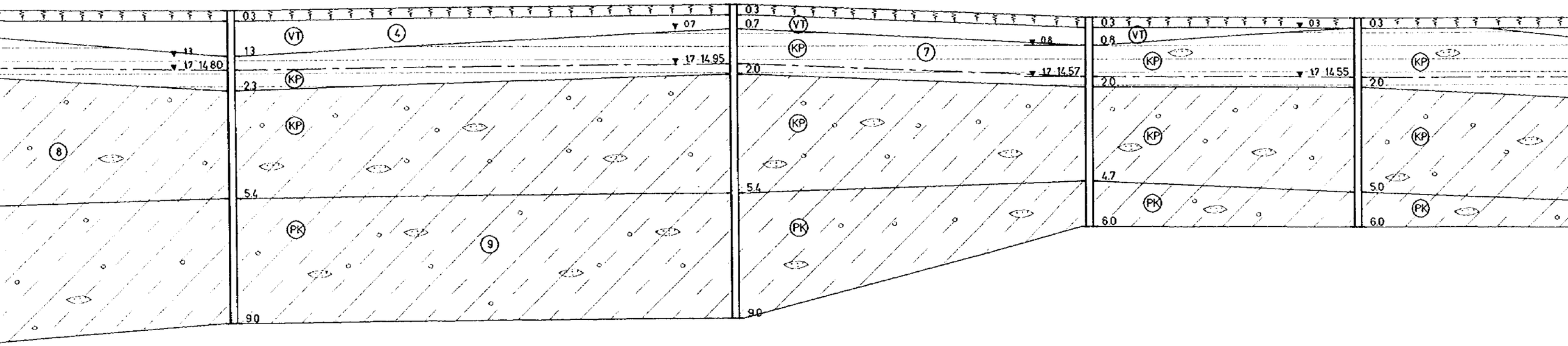
8-9

XV

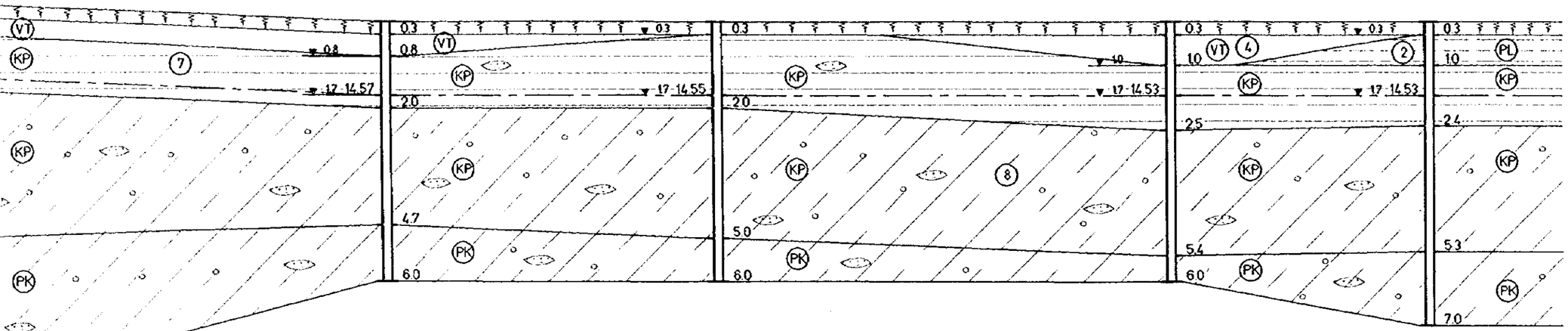


Boring No.	GR.20	GR.21	GR.22
Ground Level	16.32	16.54	16.50
Section Length (m)	15.00	26.00	29.00

XVII - XVII



	GR 22	GR 23	GR 27	GR 30
	16.50	16.65	16.27	16.25
26.00	29.00	20.50	15.50	21.0



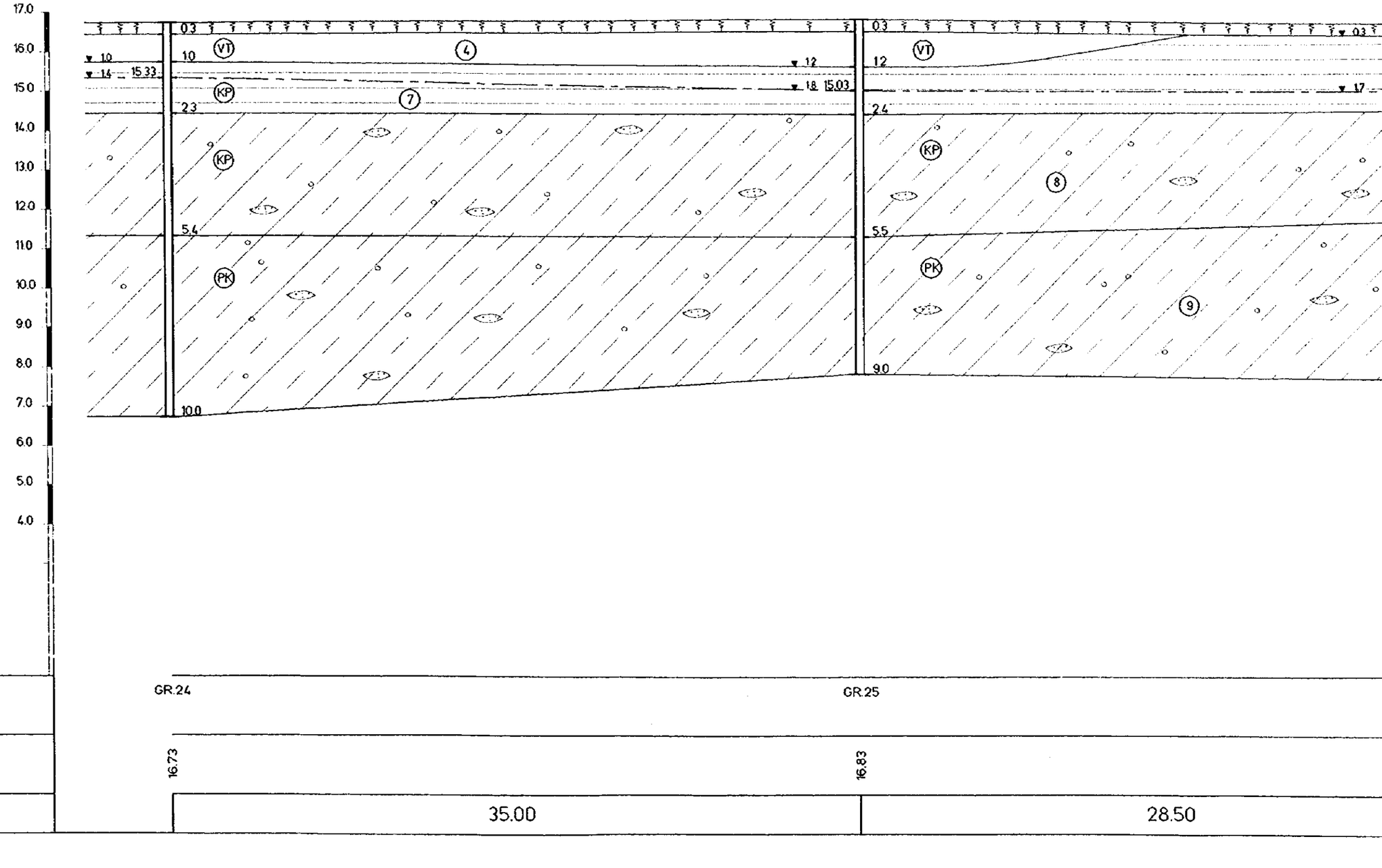
Scale V : 1/100
H : 1/200

	GR.27	GR.30	GR.31	GR.32
	16.27	16.25	16.23	16.23
	20.50	15.50	21.00	12.00

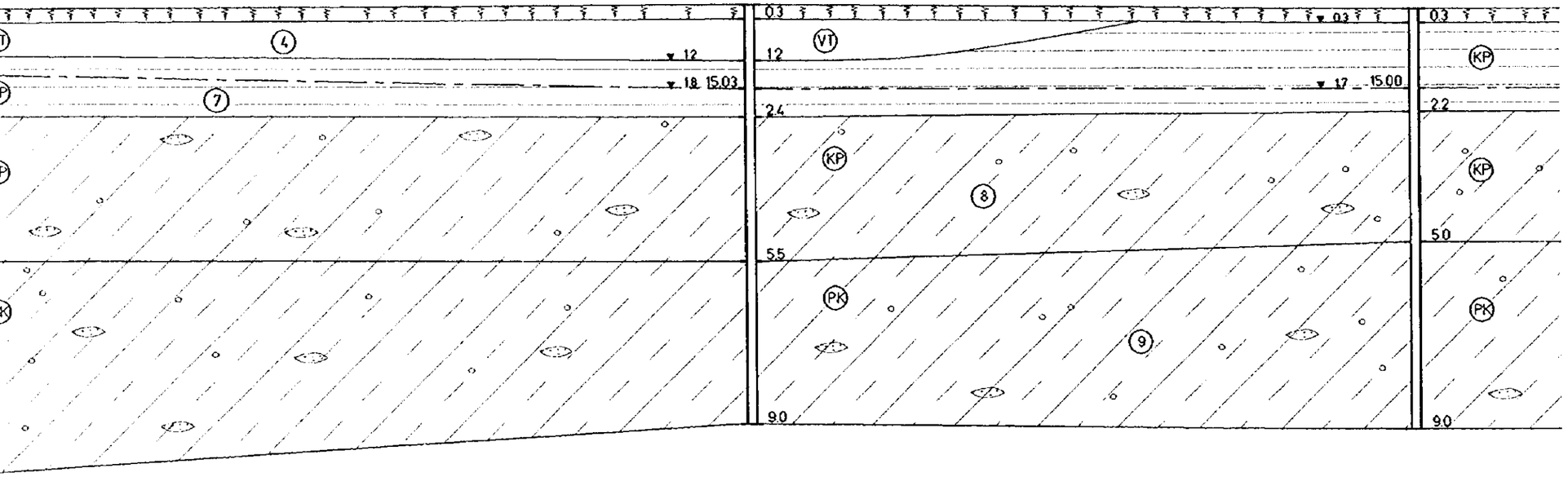
Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure SG 2-8
Skuodas Sewage Treatment Plant
Geological Section (XVII–XVII)

XIX - XIX


17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
0.3
1.0
VT
4
1.0
1.2
1.4
15.33
KP
7
1.8
15.03
2.3
KP
5.4
PK
10.0
0.3
VT
1.2
1.7
2.4
KP
8
5.5
PK
9
9.0
Boring No.
GR.24
GR.25
Ground Level
16.73
16.83
Section Length (m)
35.00
28.50

XIX - XIX



GR 25 GR 26

16.83 16.70

35.00 28.50

Scale V : 1/100
H : 1/200

Study on the Sewerage System Improvement of Birzai and Skuodas Town in the Republic of Lithuania

Figure SG 2-9
Skuodas Sewage Treatment Plant
Geological Section (XIX-XIX)