5.4 Distribution Facility

5.4.1 Distribution Main to New Government Area

Akimat prepared the route plan of the distribution main pipeline, which connects the WTP with the new government area as shown on Figure 5.4.1.

In the initial plan, it reached to the new government area at the left bank of the Ishim River. Along a part of it, however, new road network has been under construction, and the pipeline is being constructed under the road. Because of this reason, Akimat requested the new distribution main with a diameter of 1000mm only for a total length of 5.6km starting from the water treatment plant.

5.4.2 Rehabilitation Sections

In the F/S, the rehabilitation pipeline length was proposed to be 99 km based on year of construction shown in the list of existing pipeline. However, ASA has rehabilitated many pipelines after the F/S, and some are scheduled to be replaced before implementation of the Project. Therefore, ASA prepared a new priority list for pipeline rehabilitation. Figure 5.4.2 shows location of pipes to be replaced and Table 5.4.1 summarizes the route length by pipe diameter to be rehabilitated.

Table 5.4.1 Distribution Pipeline Rehabilitation Route Length

Diameter (mm)	Length (m)*
100	448
150	1,606
200	9,603
250	1,571
300	29,693
400	24,364
500	5,258
600	12,897
700	8,300
800	3,882
900	2,258
1000	197
Total	100,077

*: Exclusive of parallel pipelines for crossing railways and rives

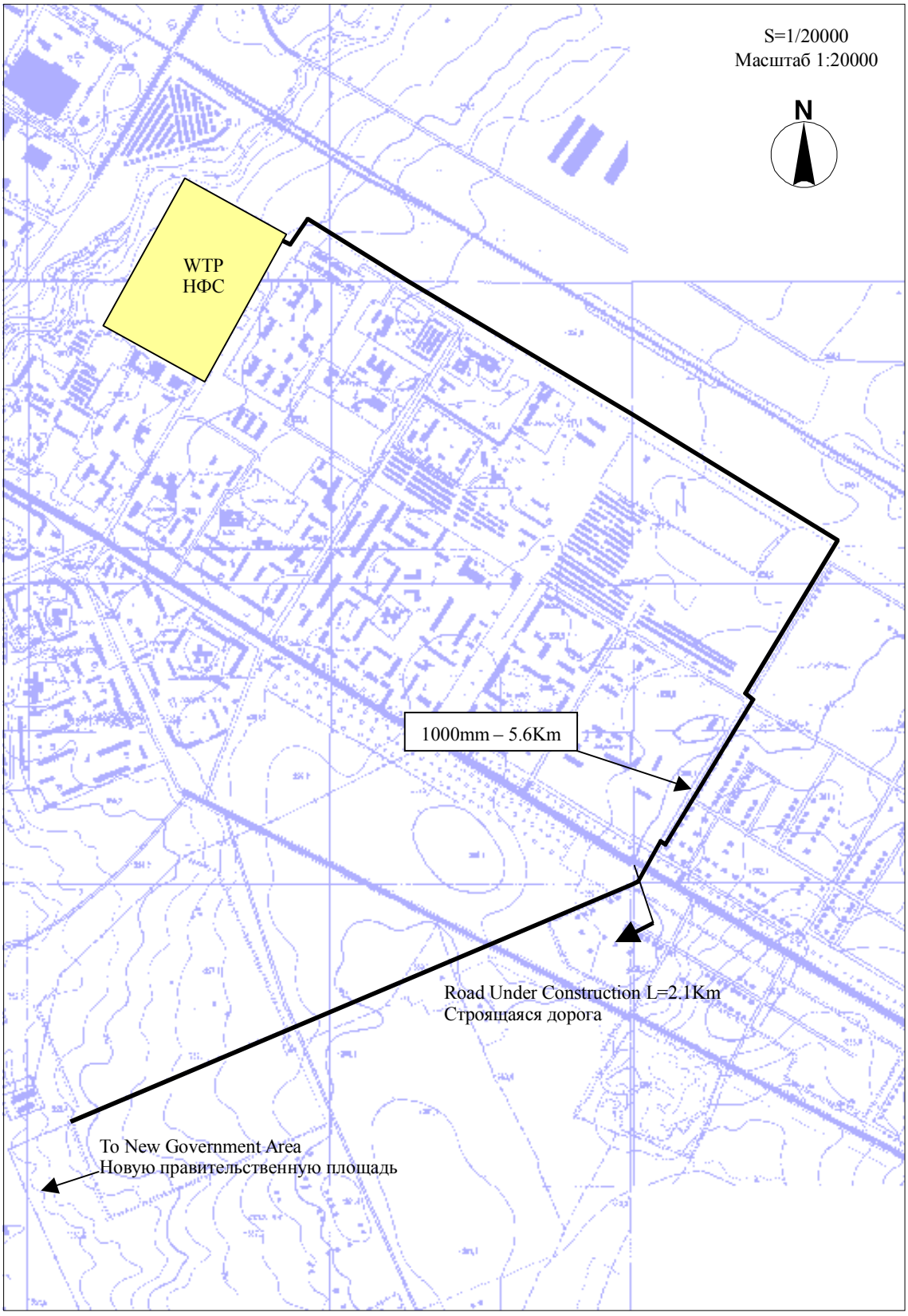


Figure 5.4.1 General Plan of the Distribution Main to New Government Area

Чертеж 5.4.1 Генеральный план Распределительного Водопровода Новой Правительственной Площади

Figure 5.4.2 Location of Pipes to be Replaced

Чертеж 5.4.2 Расположение труб, которые будут заменены

5.4.3 Design Criteria

With regard to design criteria, SNiP and International Standard were referred to and following design criteria are proposed to adopt in the design work.

(1) Hydraulic equation

The adopted equation for hydraulic calculation of pipeline is Hazen-Williams' formula, in which C value of 110 is applied.

(2) Effective pressure (based on SNiP: 4.01-02-2001)

In the F/S, it was recommended to supply water directly up to five-story buildings. Thus, water pressure of 26m is required based on the following calculation.

1st story (ground floor): more than 10m
Height of 1 story = +4m
Pressure on 5th floor: more than 10m + 4 x 4 m = more than 26m

(3) Maximum static pressure (based on SNiP: 4.01-02-2001)

Maximum static pressure is set at 60 m.

(4) Invert Level

Pipeline invert level shall be the same as the one for raw transmission pipeline.

(5) Pipeline Material Selection

The use of Asbestos Cement pipe stopped in 1966 and polyethylene pipe has been used since 1998 for small diameter pipes. Generally, Steel pipe is used more than Ductile Cast Iron pipe because of easy assembling at construction site. However, in Japan and other developed countries, use of ductile cast iron pipe is more popular than steel pipe for medium-size diameter pipe for its reliability and durability.

Selection of pipe materials was made based on the comparative examination of several pipe materials as follows:

- DIP (Ductile Cast Iron Pipe) for pipes less than or equal to a diameter of 800mm
- SP (Steel Pipe) for pipes more than or equal to a diameter of 900mm

However, through the discussions with ASA at the beginning of D/D, ASA requested to con-

sider FRP pipe. As a result of the study, pipe materials are concluded as follows:

In accordance with SNiP 4.01-02-2001 8.21, pipe materials for water supply should be non-metal such as Reinforced Concrete Pipe (RCP), Asbestos Cement Pipe (ACP), and Plastic Pipes and if metal pipes are employed, necessity of metal pipes should be verified.

It is also stipulated that SP should be employed to pipes in case (i) of holding internal high pressure (1.5 MPa); (ii) of crossing rivers and railroads; and (iii) of intersecting sewers.

The above stipulation may be interpreted that metal pipes should be employed for important use and non-metal pipes for not important use because of higher price of metal pipes than those of non-metal pipes. In urban area, water supply pipes are installed under roads, thus metal pipes, i.e. Cast Iron Pipe (CIP) and SP are employed in consideration of importance of a public utility and infrastructure of the city. In fact, CIP and SP are mainly used for raw water transmission mains and distribution mains in Astana city. Therefore, it could be concluded that employing SP is not restricted by SNiP, however, verification for employing metal pipes in technical and economical respects should be made before decision of usage of metal pipes. Furthermore it could also be interpreted that metal pipes shall be employed in the particular cases stipulated in the SNiP. Contrary to the metal pipes, FRP pipe is rarely used for water supply because of its less reliability than the metal pipes.

Taking result of the examination about pipeline materials conducted in the F/S, it is proposed that main pipe materials in this project is DIP, however, SP is employed for pipes with diameter 900 mm and larger in consideration of technical and economic respects as conformed to the requirement of the SNiP.

(6) River Crossing

Inverted Siphon, i.e. pipe bridge, is applicable structure for River Crossing rather than exposed structure in consideration of cold climate in Astana. Main pipes are installed in concrete casings, which will be installed by the open-cut method.

(7) Railway Crossing

Main pipes are installed into case pipes, which will be installed by the jacking method prior to crossing pipe installation. The both pipes i.e. main and case pipes are of steel pipe as conformed to the SNiP.

After discussion with the Railway Department, it was concluded that there are two construction methods for case pipes; (i) pipe jacking method and (ii) open-cut method.

(8) Appurtenant pipeline Structure

1) Isolation Valve

Applicable types of isolation valve are Sluice type and Butterfly type valve.

Feature of a sluice valve and a butterfly valve employed as isolation purpose is as follows:

- Sluice valves are most commonly used for on-off service, since they are relatively inexpensive and provide relatively positive shutoff. Larger size of sluice vale, even at low pressure, is subjected to large forces when they are in the closed position. Geared operators and small bypass valves may be used in such cases.
- Butterfly valves are widely used in both low and high-pressure applications. In large sizes, they are substantially cheaper, more compact, easier to operate, and less subject to wear than sluice valves. They are not suitable for liquids that contain solid materials, which might prevent their complete closure.
- Regarding face to face dimensions and height, butterfly valves are shorter in the both dimensions. Required space for butterfly valves in structure such as valve manhole or chamber is smaller than those for sluice valves consequently.
- Price concerns, prices of gate valves in diameter 300 mm and larger are generally higher than those of butterfly valves.

In consideration with the above, it is concluded that isolation valves in diameter 300 mm and larger are of butterfly valves, however, gate valves are employed in diameter less than 300 mm.

2) Air Valve

Air Valve is required at high point in longitudinal profile of the pipeline to release separated and collected air from water and to eliminate the air when the pipeline is filled with water. Furthermore, it functions as air suction device when water in a pipeline is drained in the necessity of construction or other work.

There are two types of air valves generally used for water supply such as single orifice type and double orifice type. Selection of type should be based on pipe diameter and purpose of the air valve as mentioned above, however, recommended type of air valves for the distribution networks are as follows:

- Diameter of main pipes are 300 mm and larger: Double Orifice Type

- Diameter of main pipes are less than 300 mm: Single Orifice Type

3) Drainage Facility

To drain water from pipeline, the pipeline is equipped with blow-off branch at the low point in longitudinal profile. Drainage facilities are provided to the distribution pipelines in conformity to the ASA standards as follows:

Main Pipe Diameter (mm)	Drainage Pipe Diameter (mm)
100 to 150	50
200 to 250	80
300 to 400	100
500 and larger	150

5.4.4 Installation of Pipeline

(1) Pipe Materials

Pipe material selection and proposed pipe materials are described in Section 5.4.3 (5). As a result, the following is proposed:

- DIP (Ductile Cast Iron Pipe) for pipes less than or equal to a diameter of 800mm
- SP (Steel Pipe) for pipes more than or equal to a diameter of 900mm

(2) Pipe Jointing

(i) Ductile Iron Pipe (DIP)

There are three types of joint for DIP, push-on, mechanical and flange type which are commonly used. Push-on and mechanical joint type has similar jointing mechanism, inserting a spigot end into a socket end with rubber gasket, except tightening gland for the mechanical joint. Mechanical joint type is superior to push on type joint in securing water tightness against failure caused during jointing i.e. setting rubber gasket and tightening gland bolts, as well adjusting pipeline alignment, however, push on type pipe joint is commonly used in worldwide. If compared with mechanical joint, push on joint requires less jointing time and cost including pipe material and installation. Mechanical joint type pipe costs approximately 10% more than push-on joint pipe. On the other hand, most leakages from DIP were detected at joint those were caused by failing of tightening bolts of gland since trenching or dewatering or installation was made with lack of workmanship. In addition, a depth of

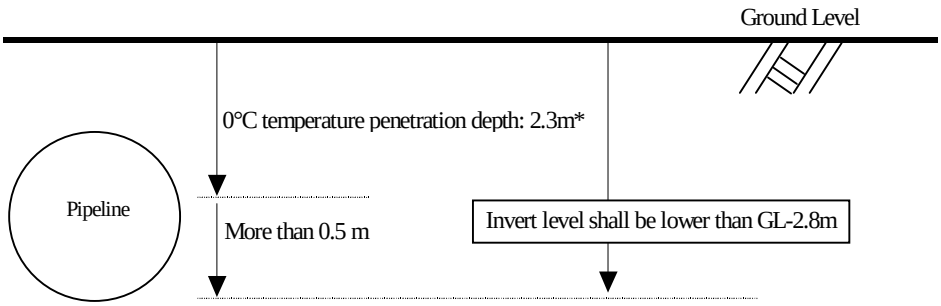
socket, over lapping length of pipes to be connected, the push on type has longer depth than mechanical joint and it could contribute less leakage than mechanical joint in case of any movement of pipe connected. Flange joint is neither type of over lapping nor of direct jointing with welding (melting). Flange joint is easily affected by movement of pipes connected, thus, flanged joints are only used where the pipe is firmly supported like in valve chambers. Therefore it is proposed that ductile iron pipe is jointed with push on socket and spigot joints.

(ii) Steel Pipe (SP)

SP in diameter 900 mm or larger is applied to this project. Welding is most reliable method for SP, thus welding is proposed. Welding work will be done from inside of the pipes.

(3) Pipe Invert Level

Under the terms of SNiP, 0°C temperature penetration depth is 2.3m. Then, pipe invert level is to be lower than GL-2.8m as shown below:



* Astana is located on surrounded with contour line of 230cm of 0°C temperature penetration depth.

Note: "SNiP: 4.01-02-2001-8.42 PUBLIC WATER SUPPLY SYSTEMS AND STRUCTURES"
"Reference Manual to SNiP - Construction Climatology"

Figure 5.4.3 Pipe Invert Level

(4) Thrust Block

Unbalanced thrust forces occur at changes direction of flow, such as at bends (horizontal and vertical), at tees, and at taper, at dead ends or closed valves. Reactive forces to balance these thrust forces are provided by concrete thrust blocks or restrained by special gland (restrained joint)

Concrete blocks provide resistance to thrust forces by passive earth pressure and friction between concrete and soil. Passive earth pressure is effective for horizontal and vertical upward bends, and bearing resistance for downward vertical bends. Subsurface conditions are categorized into several types in accordance with soil and ground water conditions along

pipeline routes, thus, typical types with standard dimensions of the thrust block are provided.

Thrust blocks are sized to provide a minimum factor of safety of 1.5 against unbalanced forces with test pressure of 10 bar (100m). The bearing surface area of the thrust block is sized to provide a minimum factor of safety of 3 against bearing value.

(5) Principal method for rehabilitation of the existing pipeline

The pipe network rehabilitation work consists of replacement of the existing pipes with new pipes and expansion of the pipe network by installation of new distribution pipes. Method of replacement of the existing pipes is as follows:

(i) To plan appropriate length of pipeline for rehabilitation work and investigate the existing pipeline for all of branched pipes and pipeline appurtenances,

(ii) To install new pipeline in parallel to the existing pipeline to be rehabilitated,

(iii) To provide the new pipeline with branch pipes including pipeline appurtenances in order to connect the existing branched pipes,

(iv) To test the new pipeline with pressure and flush the new pipeline,

(v) To cut the start and the end of the existing pipeline to be rehabilitated and connect the both ends with the new pipelines

(vi) To cut the existing branched pipes and connect with the new branched pipes provided in the (ii) above,

(vii) To fill water to the new pipeline and confirm no leakage from any connections between newly installed pipes, and

(viii) To plug all of the opening of the existing pipeline and abandon the existing pipeline.

(6) Crossing railway and river

Two (2) parallel lines are required for river/railway crossings in accordance with SNiP. All pipe materials for casing and main pipe are steel pipes jointed by welding.

As a result of discussion with the agencies, pipes crossing railway and river are shown in Table 5.4.2.

Table 5.4.2 Summary of Crossing Pipes

No.	Main Pipe	Casing Pipe	Length	Construction of Casing Pipe
A. Railway Crossing				
1	Dia. 300 mm x 2 lines	Dia. 500 mm x 2 lines	40 m x 2 lines	Open Cut, in W239
2	Dia. 300 mm x 2 lines	Dia. 500 mm x 2 lines	12 m x 2 lines	Open Cut, in W239
3	Dia. 200 mm x 2 lines	Dia. 500 mm x 2 lines	60 m x 2 lines	Jacking, in W240
4	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	35 m x 2 lines	Open Cut, in W241
5	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	25 m x 2 lines	Open Cut, in W241
6	Dia. 200 mm x 2 lines	Dia. 400 mm x 2 lines	25 m x 2 lines	Open Cut, in W244
7	Dia. 300 mm x 2 lines	Dia. 500 mm x 2 lines	40 m x 2 lines	Open Cut, in W244
8	Dia. 300 mm x 2 lines	Dia. 500 mm x 2 lines	30 m x 2 lines	Open Cut, in W244
9	Dia. 300 mm x 2 lines	Dia. 500 mm x 2 lines	15 m x 2 lines	Open Cut, in W244
10	Dia. 300 mm x 2 lines	Dia. 700 mm x 2 lines	120 m x 2 lines	Jacking, in W245
11	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	12 m x 2 lines	Open Cut, in W246
12	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	45 m x 2 lines	Open Cut, in W246
13	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	12 m x 2 lines	Open Cut, in W247
14	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	12 m x 2 lines	Open Cut, in W247
15	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	12 m x 2 lines	Open Cut, in W247
16	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	12 m x 2 lines	Open Cut, in W247
17	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	12 m x 2 lines	Open Cut, in W247
18	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	12 m x 2 lines	Open Cut, in W247
19	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	17 m x 2 lines	Open Cut, in W259
20	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	15 m x 2 lines	Open Cut, in W259
21	Dia. 400 mm x 2 lines	Dia. 600 mm x 2 lines	50 m x 2 lines	Open Cut, in W259
22	Dia. 400 mm x 2 lines	Dia. 700 mm x 2 lines	100 m x 2 lines	Jacking, in W259
B. River Crossing				
1	Dia. 300 mm x 2 lines	Concrete Casing	30 m x 2 lines	Open Cut, in W228
2	Dia. 700 mm x 2 lines	Concrete Casing	30 m x 2 lines	Open Cut, in W234
3	Dia. 300 mm x 2 lines	Concrete Casing	20 m x 2 lines	Open Cut, in W245
4	Dia. 900 mm x 2 lines	Concrete Casing	140 m x 2 lines	Open Cut, in W249
5	Dia. 900 mm x 2 lines	Concrete Casing	70 m x 2 lines	Open Cut, in W249
6	Dia. 600 mm x 2 lines	Concrete Casing	280 m x 2 lines	Open Cut, in W250
7	Dia. 1000 mm	Concrete Casing	100 m	Open Cut, in W258

(7) Measures against Corrosion

(i) Corrosivity of Soil

Ductile cast iron and steel pipes are used for the existing raw water transmission mains and distribution pipelines. In order to find the requirements of pipe coating, geotechnical investigation in terms of soil corrosiveness was conducted.

The investigation was conducted following the American National Standard for Polyethylene Encasement for Gray and Ductile Cast Iron Piping for Water and Other Liquids, ANSI A21.5 (AWWA C105), which specifies that five properties of the soil; 1) soil resistivity, 2) pH value, 3) redox potential, 4) moisture content, and 5) sulphide content, as presented in the following table:

Table 5.4.3 Corrosivity Evaluation for Soil (ANSI A 21.5/ AWWA C 105)

Property	Measured Value	Points
Soil resistivity (Ω-cm)	Less than 700	10
	700 to 1,000	8
	1,000 to 1,200	5
	1,200 to 1,500	2
	1,500 to 2,000	1
	More than 2,000	0
pH value	0 to 2	5
	2 to 4	3
	4 to 6.5	0
	6.5 to 7.5	0*
	7.5 to 8.5	0
	More than 8.5	3
Redox potential (Oxidation-reduction potential) (mV)	More than 100	0
	50 to 100	3.5
	0 to 50	4
	Less than 0	5
Moisture content	Poor drainage and continuously wet	2
	Fair drainage and generally moist	1
	Good drainage and generally dry	0
Sulphide content	Positive	3.5
	Trace	2
	Negative	0

Note: If sulphides are detected and low or negative, Redox potential results are obtained, three (3) points shall be given for this range.

Points were assigned according to the measured values of these properties, and corrosion protection is recommended if the total of these points is 10 or more.

The result of soil investigation is as shown in Table 5.4.4.

Table 5.4.4 Soil Corrosivity Tendency

Sampling No.	1		2		3		4		5	
Item	Value	Point	Value	Point	Value	Point	Value	Point	Value	Point
Water contents	Wet	1	Wet	1	Dry	0	Wet	1	Wet	1
Resistant Rate (Ω-cm)	55	10	275	10	920	8	140	10	140	10
pH	7.7	0	8.2	0	7.7	0	8.6	3	8.0	0
Redox electric potential (mV)	273	0	359	0	470	0	466	0	457	0
Sulphide content*		3.5		3.5		3.5		3.5		3.5
Total point	14.5		14.5		11.5		17.5		14.5	

Among surveyed values shown in the above table, the resistivity is extremely small. The values measured in the last winter might be affected by melted soil since it was very hard to penetrate electrodes into frozen surface soil without melting the soil. In July 2003 test pit

excavation in order to conform under ground utilities was conducted. Resistivity of soil was also measured at excavation pit and the results ranged from 800 to 3000 ohm-cm and show 1400 ohm-cm as mean value. The pH values measured in the pit show acid soil contrary to the above Table 5.4.4. When the measurement results conducted in the study are considered, the total points mentioned above range from 8.5 to 9.5. It may be interpreted that the soil is rather corrosive but not heavily.

(ii) Corrosion Control of Ductile Cast Iron Pipe

Ductile cast iron pipe contains silicon, carbon, and other elements much more than steel pipe. The corrosion resistance of ductile iron pipe is as high as gray cast iron and corrosion volume is smaller than that of steel pipe.

Because of corrosive tendency of soil, corrosion protection by polyethylene sleeve method is recommendable. Application of polyethylene sleeve is easy, economical and effective.

Furthermore, since ductile cast iron has relatively high electric resistance, it is resistant to corrosion caused by stray current. Furthermore, ductile cast iron pipes and fittings are connected by rubber gasket joints and, therefore, are insulated electrically. Thus they are relatively free from corrosion caused by stray current.

(iii) Corrosion Control of Steel Pipe

Corrosion control of steel pipe should be examined carefully. Leakage of the existing pipeline would seem to be caused by corrosion of pipe material.

Thus it is proposed that pipes shall be coated by plastic material (polyurethane or polyethylene), which is preferable for corrosion control, instead of bituminous material typified as asphalt. Mean coating resistance of plastic is 5,000Ω-m^2, which is larger than that of bituminous (1,000Ω-m^2).

However, this coating with plastic material alone will be insufficient in the sites where measure against stray current is necessary. Stray current is often observed at adjacent to railroad or pylon for high voltage power transmission line. Therefore, electrical corrosion control (Cathodic protection method) shall be adopted in such sites, i.e. probably railroad crossing in the proposed pipelines.

There are two types of electrical corrosion control method such as impressed current system and galvanic anode system. Comparison of these two methods is shown in Table 5.4.5. In addition, the impressed current system is applied only to the existing raw water transmission main of the present pipelines for the water supply system. At present, eight (8) stations of

the impressed current system are equipped on the raw water transmission main and leakage caused by corrosion has been decreased drastically.

Pipeline sections with steel pipe in the Project are parts of distribution main, which are of large diameter. Judging from characteristics of both methods, impressed current system is recommended for specific site such as railway crossing or adjacent to pylon for high voltage power transmission line subject to detailed survey prior to installation of steel pipes.

Table 5.4.5 Comparison of Electrical Corrosion Control (Cathodic Protection Method)

Item	Galvanic anode system	Impressed current system
Effective area	Limited	Large
Initial cost	Low cost in case of short length	Relatively high cost Number of stations is few in case of long length
Current control	Difficult	Easy
Maintenance	Number of stations is many and electrode is consumed fast.	Easy because of insoluble electrode
Others	No excessive control	Effective to corrosion caused by stray current

Hence, the plastic coating protection is applied to steel pipes. Where stray current is observed, the cathodic protection by the impressed current system should be adopted to steel pipes buried at the site.

5.4.5 Hydraulic Network Analysis

The future pipeline network analysis is made to determine pipe diameter properly. The criteria for pipe network analysis and results are as follows:

(1) Design Criteria

1) Pipeline network

Pipeline network to be analyzed consists of rehabilitated existing pipeline and pipeline in the new government area, which was studied in M/P.

2) Daily Maximum Demand

Network Analysis is carried out taking into account water demand applied in the M/P. Table 5.4.6 shows daily maximum demand of each district based on M/P.

Figure 5.4.4 shows the pipeline network for the year 2030, and Figure 5.4.5 shows pipeline network and the district presented in Table 5.4.6.

3) Peak Hourly Factor (based on Master plan)

Domestic, Commercial, Industrial water = 1.4
Thermal plant (TETs) = 1.1

4) Fire Fighting Water

Following water is added to hourly maximum water demand as fire-fighting water based on SNiP.

3 hydrant x 95(l/s) = 285 (l/s) (Population: 800,000)

5) Water Level of WTP

Table 5.4.7 shows water levels of WTP, which are set for the hydraulic analysis taking into account of operation at existing WTP.

Table 5.4.7 Water Level of WTP (m)

WTP	2010	2020	2030
Existing & Expansion	402.00m	402.00m	402.00m
New (future)	-	408.00m	408.00m

Besides, the existing booster pump stations are not considered for pipe network analysis because of their ineffectiveness to water level of the pipe networks i.e. as used to boost water from the pipe network to the certain consumers separated from the network.

Table 5.4.6 Daily Maximum Demand by District (m^3/day)

District	2010	2020	2030
Residential District 1	964	2,208	3,719
Residential District 2	4,822	7,652	10,990
Residential District 3	12,266	16,534	20,048
Residential District 4A	16,833	21,850	24,311
Residential District 4B	775	11,265	12,651
Residential District 5	8,344	10,752	12,078
Residential District 6	8,964	11,316	12,728
Residential District 7	16,718	19,885	22,369
Residential District 8	6,599	7,554	8,484
Residential District 9	6,251	7,155	8,037
Residential District 10	1,243	2,698	3,030
Residential District 11	844	1,736	14,918
Residential District 12	3,496	4,002	4,494
Residential District 13	8,994	10,962	11,553
Residential District 14	6,369	13,235	20,576
Residential District 15	0	3,794	4,959
Residential District 16	91	5,015	11,340
Residential District 17	12,670	16,989	19,082
Residential District 18	0	6,963	7,821
Residential District 19	0	4,395	4,936
Central Industrial District	4,941	6,607	6,740
Northern Industrial District	3,941	5,309	5,522
Industrial District - Station 40	2,453	2,841	3,123
West Industrial District	509	594	614
Planning District I	0	0	0
Planning District II	0	0	0
Planning District III	0	0	0
Planning District IV	80	155	218
Planning District V	825	945	1,060
Planning District VI	369	262	364
Planning District VII	554	852	1,112
Planning District VIII	0	0	0
Planning District IX	0	0	0
Sub-total (1)	129,915	203,525	256,877
Thermal Plant 1	4,938	5,928	5,928
Thermal Plant 2	37,947	37,947	38,895
Sub-total (2)	42,885	43,875	44,823
Total	172,800	247,400	301,700

Source: M/P FINAL REPORT Volume III: SUPPORTING REPORT June 2001, Table F.3.1

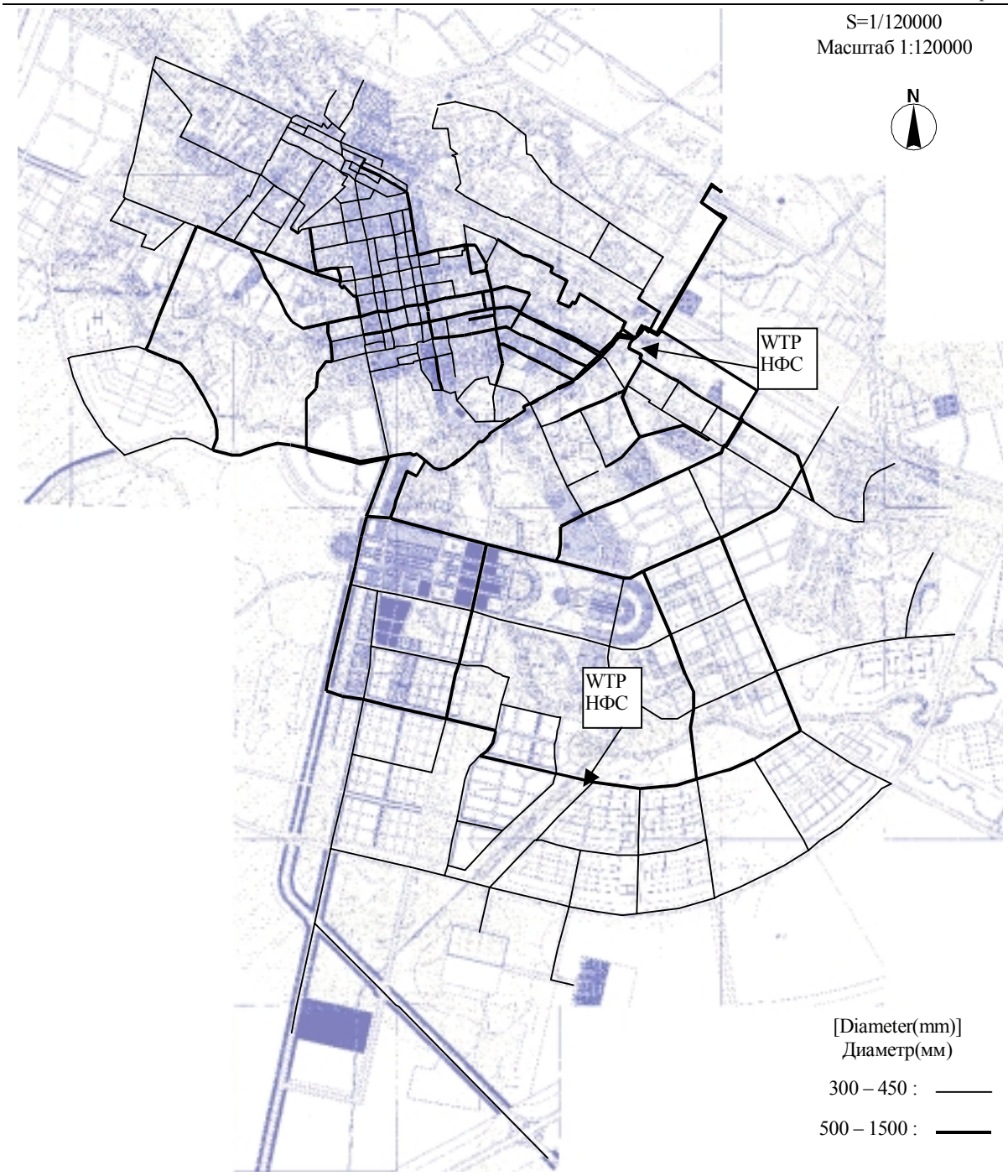


Figure 5.4.4 Pipeline of year 2030

Чертеж 5.4.4 Водопровод на 2030

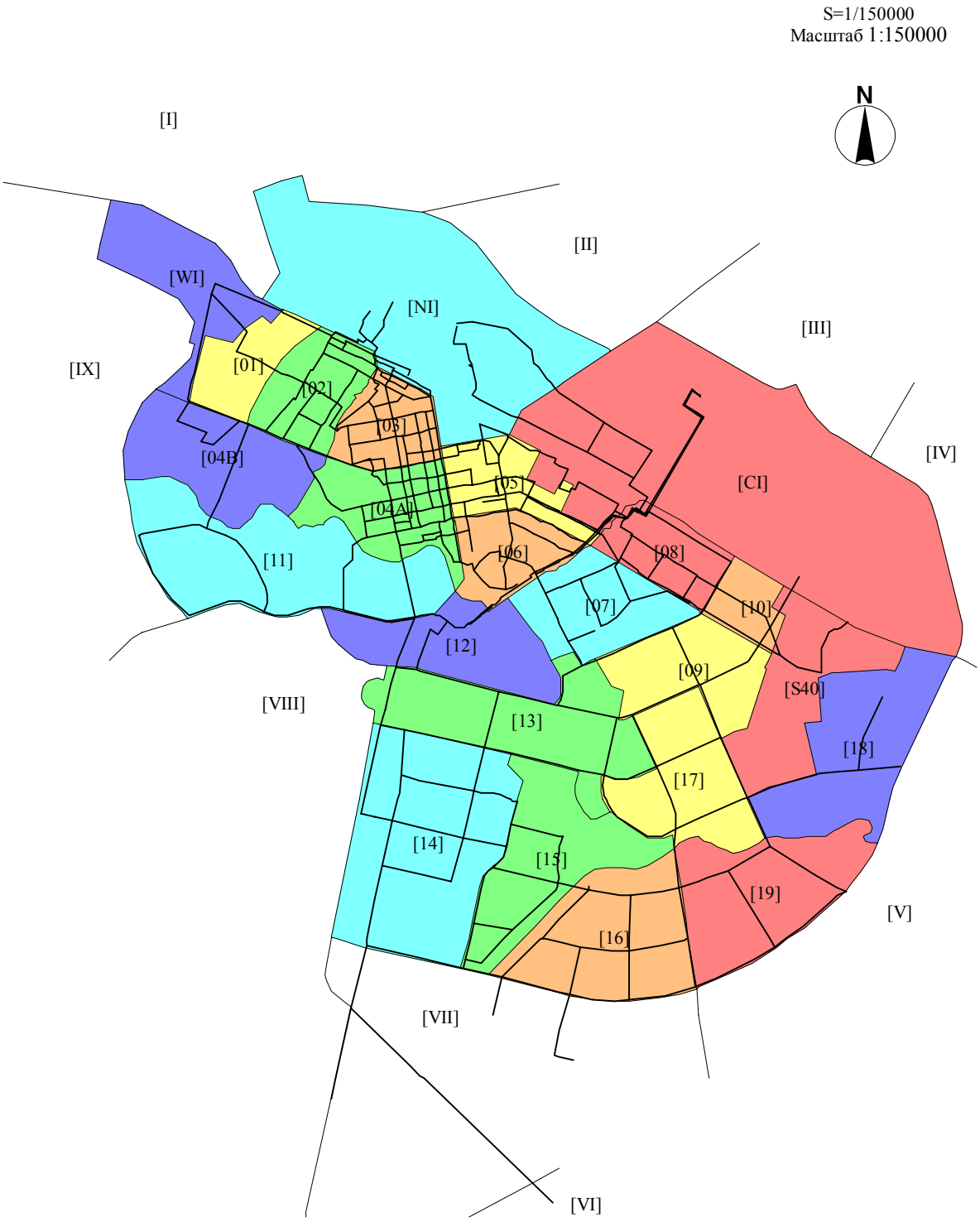


Figure 5.4.5 District and Pipeline

Чертеж 5.4.5 Район и Водопровод

(2) Analysis Result

As a result of hydraulic network analysis on the above criteria, proper diameters to secure enough pressure at the pipe network are proposed for rehabilitated pipelines.

1) Hourly Maximum Demand

Table 5.4.8 shows flow of each WTP and effective head on the pipelines.

Table 5.4.8 Flow of Each WTP and Effective Head on the Pipelines

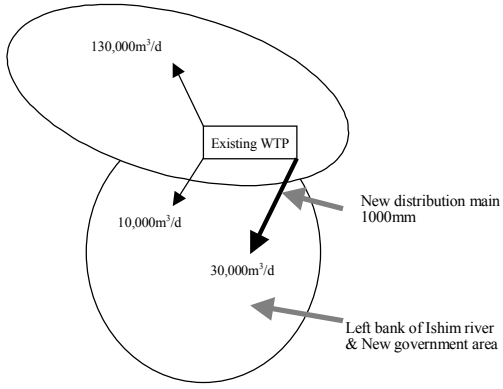
Item	Year	2010	2020	2030
Flow (l/sec)	Existing WTP	2,651.1	2,240.3	2,831.5
	New WTP	-	1,616.2	1,901.5
	Total	2,651.1	3,856.5	4,733.0
Effective Head (m)	Maximum	56.9	58.0	57.9
	Average	48.9	49.7	48.7
	Minimum	26.1	28.2	27.7

Schematic water distribution plan in each year is as follows:

- Year 2010:

  Total Daily Maximum Demand = 170,000 m^3/d (1,968 l/sec)

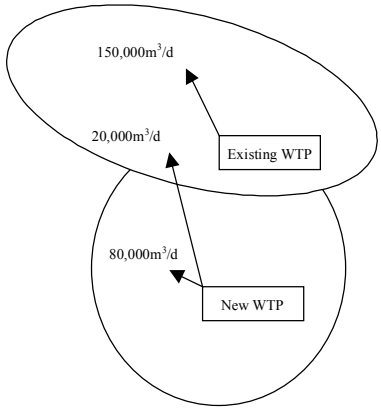
  All service area is supplied from existing WTP including proposed expansion plant. Left bank of Ishim River & new government area is mainly supplied by new distribution main pipeline.



- Year 2020:

  Total Daily Maximum Demand = 250,000 m^3/d (2,894 l/sec)

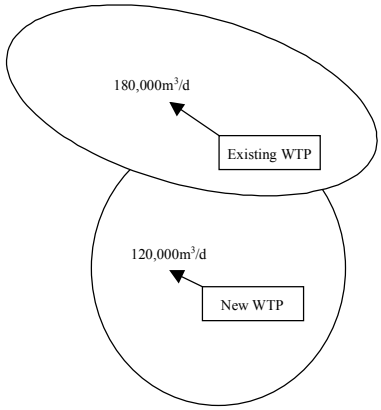
  Existing service area is supplied from existing WTP & new WTP, and left bank of Ishim river & new government area is supplied from New WTP.



- Year 2030:

  Total Daily Maximum Demand = 300,000 m^3/d (3,472 l/sec)

  Existing service area is mainly supplied from existing WTP and left bank of Ishim river & new government area is supplied from New WTP.



Pipeline network diagrams of year 2010, 2020 and 2030 are shown in Figures 5.4.6, 5.4.7 and 5.4.8 respectively.

2) Fire Fighting

Figure 5.4.9 shows pipeline network diagram in case of fire-fighting in the year 2030. In this case, effective minimum head of 27.5m is secured as a result of analysis.

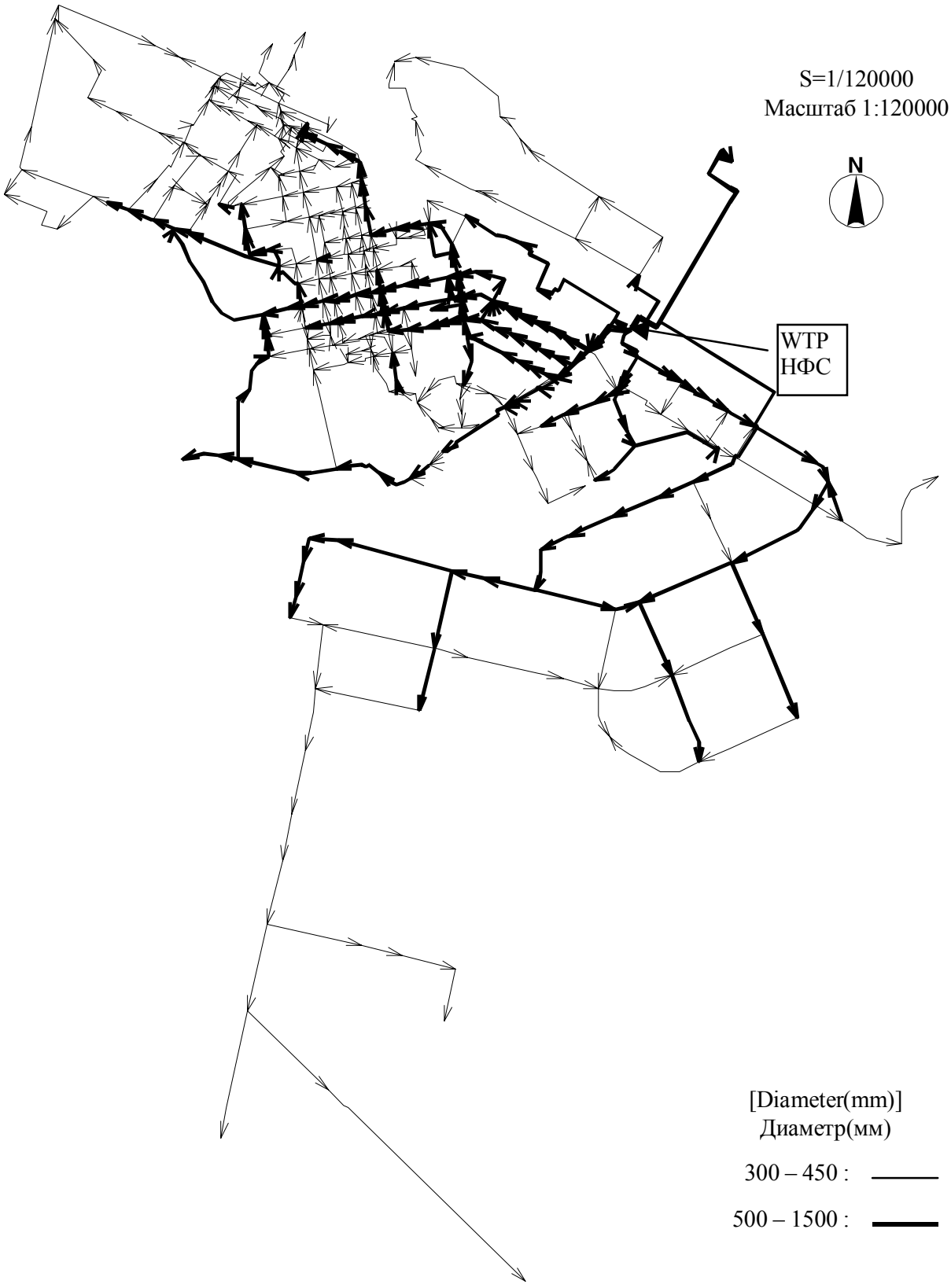


Figure 5.4.6 Pipe Network Diagram Year 2010

Чертеж 5.4.6 Схема сетей водопровода на 2010

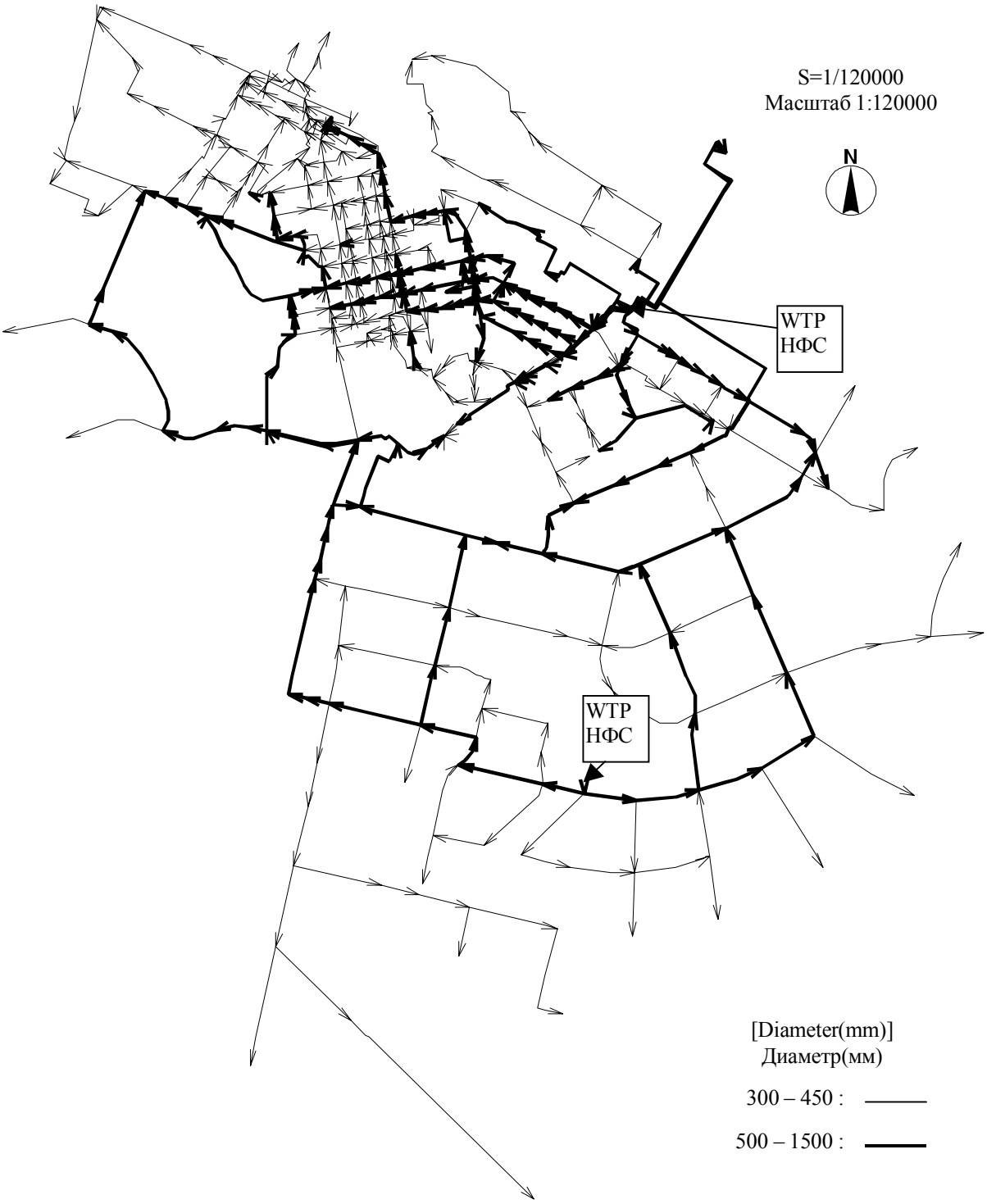


Figure 5.4.7 Pipe Network Diagram Year 2020

Чертеж 5.4.7 Схема сетей водопровода на 2020

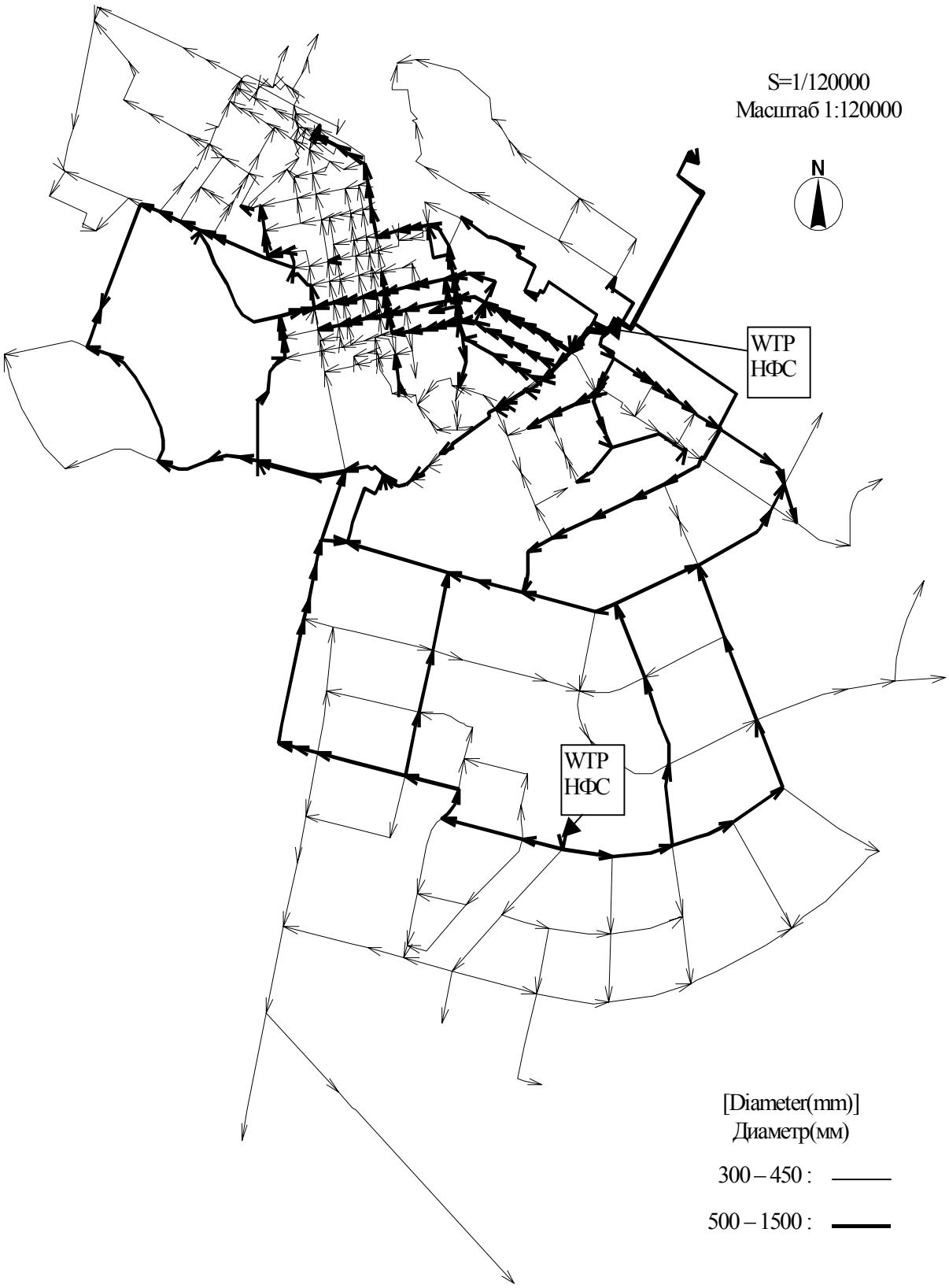


Figure 5.4.8 Pipe Network Diagram Year 2030

Чертеж 5.4.8 Схема сетей водопровода на 2030

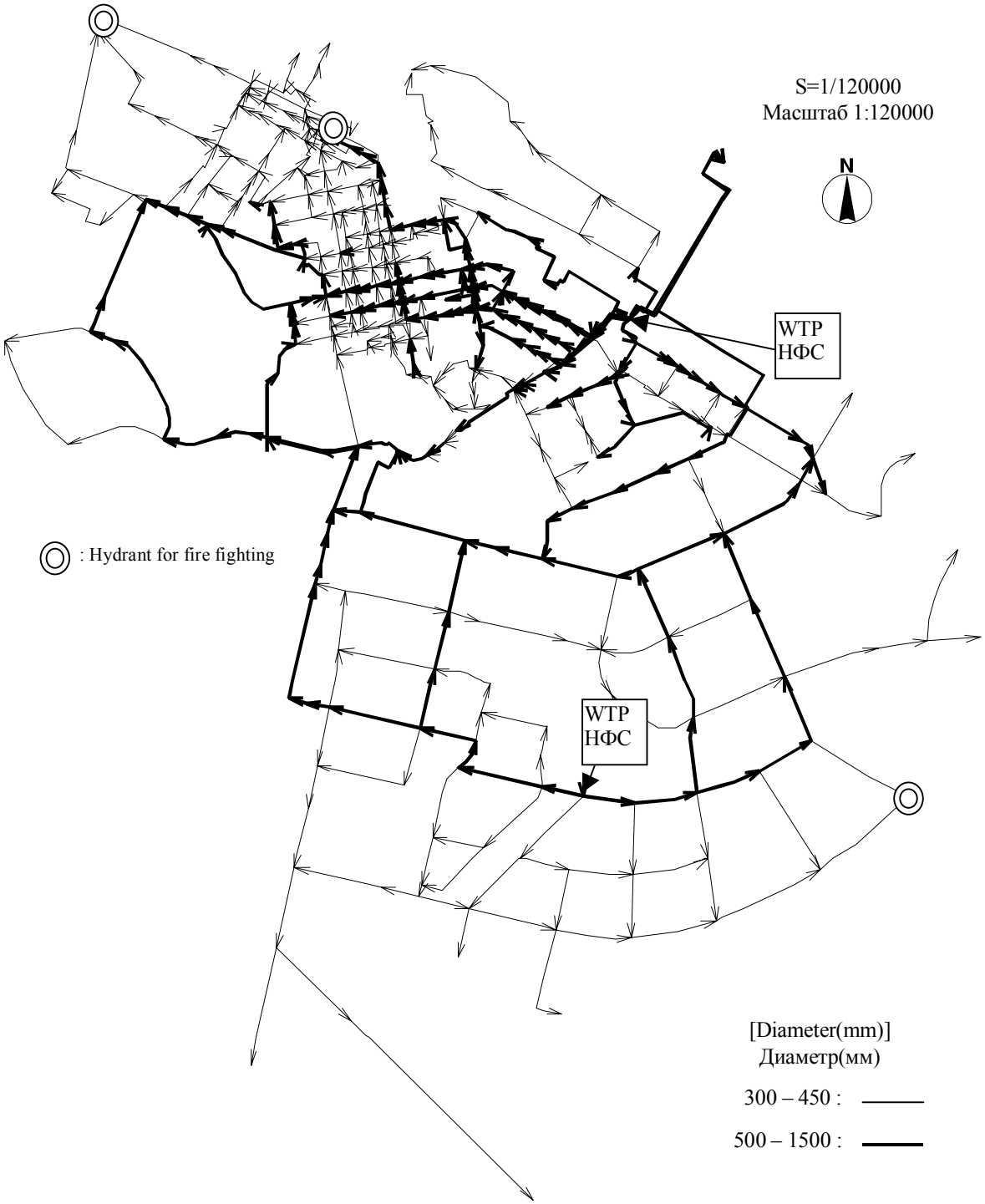


Figure 5.4.9 Pipe Network Diagram in case of Fire Fighting at Year 2030

5.5 Procurement and Installation of Water Meters

5.5.1 General

This section covers the detail design study for procurement and installation of the bulk water meters and domestic water meters. Total 153,899 units of bulk water meters and domestic water meters are procured and installed under this Project.

5.5.2 Number of Households and Water Meters required in Astana City

The number of the independent houses, apartment houses, public buildings/facilities, and households in these houses as of December 2002 is shown in Table 5.5.1:

Table 5.5.1 Number of Households for which piped water is to be provided (As of December 2002)

	Number of House or Building	Number of Households
Independent House	13,983	19,489
Apartment House	1982	92,951
Public Building and Facilities		1,724

For these households, the total number of the bulk water meters and the domestic water meters, which have been already installed and/or should be installed as of December 2002, are shown in Table 5.5.2:

Table 5.5.2 Total Number of Bulk and Domestic Water Meters required in Astana City

	Bulk Water Meter	Domestic Water Meter			Grand Total
	For Cold Water	For Cold Water	For Hot Water	Total	
1. Independent House	None	19,489	None	19,489	19,489
2. Apartment House	1982	144,955	144,955	289,910	291,892
3. Public Building and Facilities					1,724
Total					313,105

The independent houses have no provision of bulk water meter and have provision of the domestic water meter for cold water.

Some of the independent houses have two households and each household has one domestic water meter.

Meanwhile, each apartment house has one bulk water meter. Each household in the apartment houses has two to six domestic water meters (half for cold water and half for hot water) due to the size of the household.

5.5.3 Number of Existing Water Meters

The number of bulk water meters and domestic water meters, which were installed as of Today, are shown in Table 5.5.3.

Table 5.5.3 Number of Existing Bulk Water Meters and Domestic Water Meters

	Bulk Water Meter	Domestic Water Meter			Grand Total
	For Cold Water	For Cold Water	For Hot Water	Total	
1. Independent House	N/A*	340	N/A*	340	340
2. Apartment House	100	28,766	28,766	57,532	57,632
3. Public Building and Facilities					1,724
Total					59,696

N/A*: Not Applicable

Meanwhile, all the public buildings and facilities have water meters at present. Therefore, no provision of water meters is required for the public buildings and facilities under this Project.

5.5.4 Number of Water Meters to be provided under this Project

Total 153,899 units of water meters should be provided under this Project. Total 19,149 units of domestic water meters are provided for the independent houses. As a result of it, all the independent houses have the domestic water meters.

Total 1,882 units of bulk water meters are provided for the apartment houses. As a result of it, all the apartment houses have bulk water meters.

Total 132,868 units for domestic water meters (half for cold water and half for hot water) are provided for the apartment houses. This is equivalent to 57.2% of the required number (232,378 units).

The Table 5.5.4 shows summary of the number of the bulk water meters and the domestic water meters to be provided under this Project.

Table 5.5.4 Number of Bulk Water Meters and Domestic Water Meters to be provided

	Bulk Water Meter	Domestic Water Meter			Grand Total
	For Cold Water	For Cold Water	For Hot Water	Total	
Independent House	None	19,149	None	19,149	19,149
Apartment House	1,882	66,434	66,434	132,868	134,750
Public Building and Facilities	None	None	None	None	None
Total	1,882	85,583	66,434	152,017	153,899

5.5.5 Procurement for Water Meters

(1) Manufacturers of Water Meters

The water meter manufacturers shall have the state license issued by the Construction Affaires Committee of the Ministry of Industry & Trade of the Republic of Kazakhstan. Currently the following five companies are used as the water meter manufacturers by ASA:

1) ZENNER (Germany)
2) Allmess (Germany)
3) SchulmBerger (France, Italy)
4) PKF "Betar" (Chistopal, Russia)
5) ABB (Germany)

Therefore, ASA proposed to select the water meter manufacturer among the same five companies taking easier maintenance work into consideration.

(2) Specification for Water Meters

The bulk water meters and domestic water meters shall comply with ISO 4064. The bulk water meters and the domestic water meters for cold water shall be designed so as to meet the maximum working pressure of 10 bar and the maximum working temperature of 30℃. The domestic water meter for hot water shall be designed so as to meet the maximum working pressure of 10 bar and the maximum working temperature of 90℃. All the water meters shall be of less than 1 bar of head loss at the maximum flow rate.

The type of bulk water meters shall be of single-jet or of multi-jet and it of domestic water meters for cold water and for hot water shall be of single-jet. The meter has a robust body with antimagnetic shield to avoid magnetic fraud. Its register shall be dry type.

The direction of flow will be clearly marked on the casing of the meter. The meter shall be vandal proof. All materials of water meter, which are in contact with the water flowing, shall be non-toxic and non-tainting. The water meter shall be made of such materials that are resistant to normal internal and external corrosion. The water meter shall be able to work continuously during six years for cold water and four years for hot water without verification test.

Any water meter to be delivered under this Project shall be authorized by GosStandard and included into state register of the Republic of Kazakhstan.

Water consumption, normal flow rate, connection size, type and quantities for each meter are shown in Table-5.5.5, -5.5.6 and -5.5.7, respectively.

Table 5.5.5 Connection Size, Normal Flow Rate, Type and Quantities for Bulk Water Meters

Bulk Water Consumption, (m^3/month)	Connection Size (mm)	Normal Flow Rate (m^3/hr)	Type of Meter	Quantities to be installed (unit)
0-500	15	1.5	Single-jet	30
500-700	20	2.5	Single-jet	64
700-1000	25	5	Multi-jet	374
1000-1400	32	6	Multi-jet	366
1400-2300	40	10	Multi-jet	986
2300-4800	50	16	Multi-jet	62
Total				1,882

Table 5.5.6 Connection Size, Normal Flow Rate, Type and Quantities for Domestic Water Meter (cold water)

Household Water Consumption, (m^3/month)	Connection Size (mm)	Normal Flow Rate (m^3/hr)	Type of Meter	Quantities to be installed (unit)
0-500	15	1.5	Single-jet	85,583

Table 5.5.7 Connection Size, Normal Flow Rate, Type and Quantities for Domestic Water Meter (hot water)

Household Water Consumption, (m^3/month)	Connection Size (mm)	Normal Flow Rate (m^3/hr)	Type of Meter	Quantities to be installed (unit)
0-500	15	1.5	Single-jet	66,434

The specification sheets and drawings for each meter shall be prepared by the water meter manufacturer and be approved by ASA before start of production of the water meters.

(3) Test Program for Water Meter

In principle, the shop inspection for the water meters to be implemented by the water meter manufacturer shall comply with ISO 4063-3.

Before starting a shop inspection, the test program shall be prepared by the water meter manufacturer, which includes, for example, a description of the tests for the determination of measurement error, pressure loss and wear resistance. The test program shall also define the necessary levels of acceptability and stipulate how the test results shall be interpreted.

The test program shall be submitted to ASA for approval before start of the production. ASA shall witness the inspection, if required.

5.5.6 Installation of Water Meters

(1) Location of Water Meter Installation

In principle, the bulk water meters are located in the basement of the apartment houses and the domestic water meters are located in the rooms like the toilets where the water stand pipes are laid down in the household.

In the basement, the bulk flow meters are installed horizontally in the illuminated rooms, which have the temperature not lower than 15℃ and the relative humidity not more than 80 %, easy to get access.

In principle, the domestic water meters are installed horizontally in such illuminated rooms as the toilets, which have the temperature not lower than 15℃ and the relative humidity not more than 80 %, easy to get access.

(2) Water Meter Connection Diagram

In principle, the requirement on the installation work for water meters shall comply with ISO 4064/Ⅱ.

The bulk water meters and the associated materials shall be installed horizontally in accordance with Figure-5.5.1 Bulk Water Meter Connection Diagram attached at the end of this section.

The domestic water meters and the associated materials shall be installed horizontally in accordance with Figure-5.5.2 Typical Domestic Water Meter Connection Diagram attached at the end of this section. However, in case that a space in the room to be installed horizontally is not enough, the domestic water meters may be installed vertically subject to approval by

ASA in advance.

For the bulk water meter installation, all the materials including the water meter shall have threaded connections or flanged connections taking easier maintenance work into consideration.

On the other hand, for the domestic water meter installation, all the materials including the water meter shall have threaded connections

The water meter shall be easily accessible for fitting, reading and removing. The water meters shall not be subjected to undue stresses caused by pipes and fittings. Therefore, for the bulk water meter installation, the bulk water meter and/or the associated materials shall be mounted on plinths or brackets. For the domestic water meter installation, the domestic water meter and/or the associated materials shall be supported by the adequate material, if necessary.

The typical installation drawings for each water meter shall be prepared by the installation company and submitted to ASA for approval before start of the installation work.

(3) Specification of Associated Materials

All the associated materials such as pipe, fittings, valves, strainers, flanges, gaskets bolts, nuts, etc. except for the associated materials supplied by the water meter manufacturer shall be procured by the installation company. The associated materials to be required for connection with the existing pipes shall be procured by the installation company as well.

The specifications for the all the associated materials shall comply with International Standard Code like ISO, BS, GOST etc. All the associated materials shall be non-toxic and non-tainting.

All the associated materials to be used for the bulk water meter installation and the domestic water meter installation for cold water shall be able to work continuously without any problem under the maximum working pressure of 10 bar and the maximum working temperature of 30℃.

All the associated materials to be used for the domestic water meter installation for hot water shall be able to work continuously without any problem under the maximum working pressure of 10 bar and the maximum working temperature of 90℃.

For the associated materials for the bulk water meter installation, the following materials shall be used;

(1) Pipe, Fitting, Flange, Valve, Strainer, Bolt & Nut ---------- Carbon Steel

(2) Gasket ---------- Non-asbestos

For the associated materials for the domestic water meter, the following materials shall be used;

(1) Pipe ---------- Polyethylene Plastic or Carbon Steel for cold water

Polyethylene Plastic reinforced with Metal Sheet or Carbon Steel for hot water

(2) Fitting ---------- Polyethylene Plastic or Carbon Steel or equivalent

(3) Valve ---------- Chromium-plated Carbon Steel or equivalent

(4) Strainer ---------- Bronze or equivalent

(5) Sealing Material ---- Teflon or equivalent

The specification sheets for all the associated materials to be used for each water meter installation shall be prepared by the installation company and submitted to ASA for approval before start procurement of the materials. The installation company shall get material certificates for all the associated materials from the material supplier and/or the material manufacturer.

(4) Installation Plan

The installation company shall have the state license issued by the Construction Affaires Committee of the Ministry of Industry & Trade of the Republic of Kazakhstan for water meter installation.

The installation company, which has such a state license and the experience of water meter installation work in Astana city, shall be used for the installation work. Taking working schedule and quantities of water meters into consideration, more than one water meter installation company may be used.

As the bulk water meter installation work includes the welding work, the installation company shall has the qualified welders certified for water pipe by the authority concerned.

The procurement and installation work for water meters shall be completed within forty months from the contract award of the Project. Based on this requirement, the appropriate installation schedule shall be prepared by the installation company. During the installation work, the progress control and quality control shall be monitored by ASA.

As soon as the installation work is completed, the pre-commissioning and commissioning work for the water meters and the associated materials shall be carried out by the installation

company. The installation company shall clean and disinfect the inside of the water meter and associated material, pass water into the meter and the associated materials, ensure no leakage for them and finally ensure that the water meter is working properly.

After completion of commissioning work for the bulk water meters, the Contractor shall paint the external surface of non-painted carbon steel materials.

(5) Inspection

After completion of the pre-commissioning and commissioning work, ASA shall witness the inspection for water meters and, if the inspection is passed, ASA shall seal and register the water meters.

(6) Required Manpower for Installation Work

To complete the procurement and installation work within forty months from the contract award of the Project, three years are expected as the installation work period. Consequently, the manpower of 23 crews is estimated to be required for installation work based on the following calculation:

Assumption;

- 10 domestic water meters per day can be installed by one crew
- 2 bulk water meters per day can be installed by one crew
- 3 persons per 1 crew for bulk water meter (1 welder & 2 technicians)
- 2 persons per 1 crew for domestic water meter (2 technicians)
- Period for installation work; 3 years
- 21 day working days per 1 month

Calculation;

- Number of meters to be installed by one crew per year;

  10 meters/day x 21 days/month x 12 months/year = 2,520 meters/year

  2 meters/day x 21 days/month x 12 months/year = 504 meters/year

- Number of crews to be required for 3 year installation work;

  152,000 domestic water meters / 2,520 meters/year/crew / 3 years = 20.1 crews

  – say 21 crews

1,900 bulk water meters / 504 bulk meters/year/crew / 3 years = 1.3 crews

– say 2 crews

Total 23 crews

5.5.7 Payment for Water Meters and Installation Work

The cost for procurement and installation work of the water meters shall be reimbursed based on the quantities of water meters installed actually. Therefore, the unit prices for the water meters and the installation work shall be quoted. The payment for the procurement and the installation work of the water meters shall be made based on the unit prices.

5.5.8 Maintenance for Water Meters

Currently, four years have passed since the oldest water meters started running. They have not yet attained periodical calibration test as recommended by the water meter manufacturers.

ASA intends to make the periodical calibration test using the calibration equipment to be delivered under the Project. Meanwhile, ASA has one failed water meter per day on average now. This failed water meter is replaced by new one by ASA or the water meter installation company having the state license. In the future, ASA intends to have his own repair shop for water meters.

When the water meters delivered under the Project run, number of water meters will increase to approximately 210,000 from 60,000. As a result, number of water meters per day to be calibrated periodically is expected as follows;

Assumption;

- Interval of periodical calibration test; 5 years
- 21 working day per month

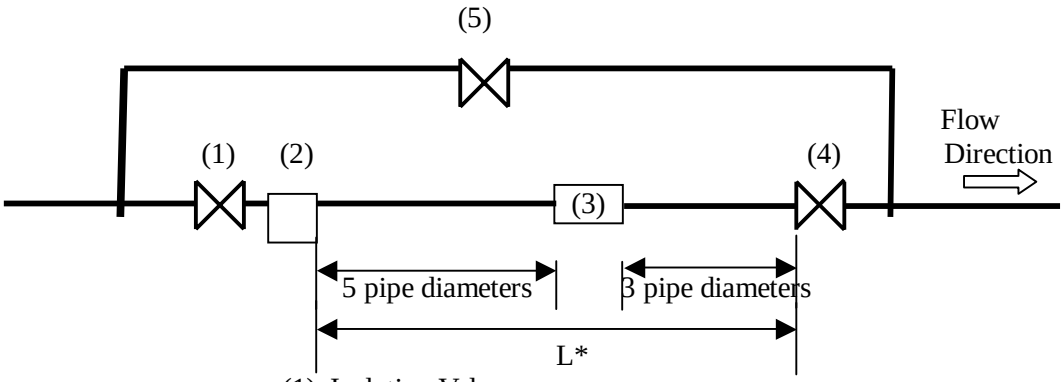
Calculation;

- Number of water meters to be calibrated periodically per day

  210,000 water meters / 21 working day/month / 12 months/year / 5 years = 166.7 water meters/day

  - say 167 water meters/day

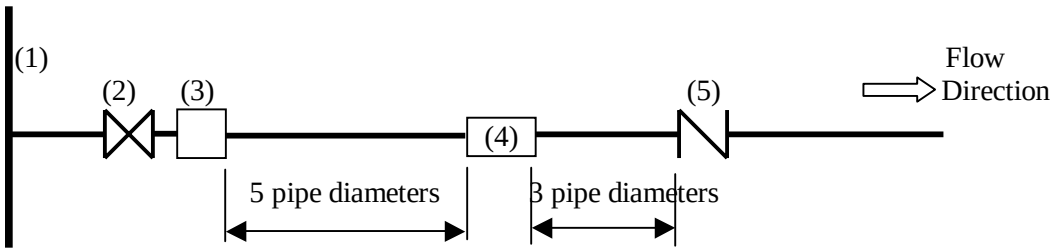
Meanwhile, as the water meters are getting older year after year, failed water meters per day are expected to increase to 5~10 water meters from the current one water meter in average.



(1) Isolation Valve
(2) Strainer
(3) Flow Meter with Antimagnetic Shield
(4) Isolation Valve
(5) Bypass Line Isolation Valve

Note: * The section "L" should be positioned horizontally and be straight without cross sections, laterals and joints.

Figure 5.5.1 Bulk Water Meter Connection Diagram



(1) Water Supply Stand Pipe
(2) Isolation Valve
(3) Strainer
(4) Flow Meter with Antimagnetic Shield
(5) Check Valve

Figure 5.5.2 Typical Domestic Water Meter Connection Diagram

5.6 Architectural Facility

5.6.1 Outline of Architectural Facilities

Concerned buildings for architectural design are shown in Table 5.6.1.

Table 5.6.1 List of Buildings in Water Treatment Plant

Building Name			Area (m^2)			Building Dimension	Story	Structure
			Building Area	Total Floor				
				●	○	L x W		
W11	●	Intake Pump Station	393.88	393.88	-	Φ22.4	1	RC
W12	●	Surge Control House	324.00	324.00	-	18.0 x18.00	1	RC
W17	●	Intake Sub- station	135.00	135.00	-	15.0 x 9.0	1	PC
W18	●	Intake Guard House	24.00	24.00	-	6.0 x 4.0	1	PC
W31	●	Distribution Chamber	148.40	148.40	-	14.0 x 10.6	1	PC
W35	○	Distribution Pump Station	1,158.96	-	2,094.96	96.58 x 12	1+ B	-
W36	●	Washing Drain Basin	118.00	118.00	-	6.0 x 18.0	1	PC
W37	●	Sludge Thickener	622.00	622.00	-	Φ18.5 x 2	1	RC
W40	●	Discharge Pool	65.40	645.40	-	6.0 x 10.9	1	PC
W43	●	Water Treatment Building	7,084.80	8,536.32	-	123 x 57.6	1	RC
W44	●	Administration Building (including Connecting Corridor)	810.00	2,430.00	-	54 x 15	3	PC
W46	●	Guard House	24.00	24.00	-	6.0 x 4.0	1	PC
W47	●	WTP Sub-station	432.00	432.00	-	36 x 12	1	PC
Total Floor Area				13,833.00	2,094.96			

●: New Construction ○: Rehabilitation
B: Basement of Building Scope (B): Basement of Civil Scope
RC: Reinforced Concrete structure PC: Pre-cast Concrete Structure

All buildings will be newly constructed, except the Distribution Pump Station. Eleven (11) buildings excluding the Administration Building and the Guard House are planned for the facilities of the water treatment.

5.6.2 Administration Building

(1) General

The administration building is located beside the water treatment building. The administration building has an important function for control, management, operation and maintenance for whole water treatment plant. Moreover, this building should be designed from viewpoint of not only function mentioned above but also sound working environment for employees.

The following are requirements for the building design as ASA presented.

- To reserve the space beside the administration building for a new building to be constructed by ASA in the future.
- Not to be buried by buildings which will be constructed in the surrounding area in the future.
- To consider that materials of external finishing for the public facility should be durable over a long period of time; fifty years.

Laboratory area in the building should be completely blocked off from other area in accordance with SNiP.

(2) Building Outline

The Administration Building will be designed as the center of the water treatment plant and to provide incentives to the staff. The Administration Building is 15m wide and 54m long, 3 stories with a penthouse.

The building has hipped roofs with 39% and 12% slope and an arched skylight on the penthouse floor and the rain or snow would be flow out through gutters and downspouts. The internal main finishing is as follows.

Floor: Vinyl sheet, Ceramic tile
Wall: Cement sand plaster with paint
Ceiling: Acoustic tile

(3) Number of Personnel in Administration Building

The number of staff for design of the Administration Building is shown on Table 5.6.2.

Table 5.6.2 Numbers of Personnel in Administration Building

Room	Day time	Night time	Total	Remarks
Manager	1	0	1	
Deputy manager	1	0	1	
Clerk	3	0	3	
Worker	2	0	2	
Canteen worker	2	0	2	
Electrical engineer	1	0	1	
Mechanical engineer	1	0	1	
Assistant Engineer	1	0	1	
Operating chief engineer	1	1	4	1person x 2shifts x every 2days
Electrical operator (Engineer)	1	1	5	1person x 2shifts x every 2days + 1p stand by

Machine operator	1	1	4	1person x 2shifts x every 2days
Filter & Coagulant operator	1	1	4	1person x 2shifts x every 2days
Workshop staff	4	0	4	
Laboratory chief	1	0	1	
Laboratory analyst	8	0	8	
Laboratory engineer	3	0	3	
Laboratory shifting analyst	2	2	9	2persons x 2shifts x every 2days + 1p stand by
Total	34	6	54	

(4) Required Rooms

First Floor

Entrance Lobby, Office, Electrical Room, Workshop, Canteen, Toilet

Second Floor

Monitoring Room, Stack, Staff Room, Shower & Locker Room, Toilet

Third Floor

Laboratory, Manager Room, Engineer -1 Room, Engineer -2 Room, Toilet, Pantry

(5) Thickness of External Wall

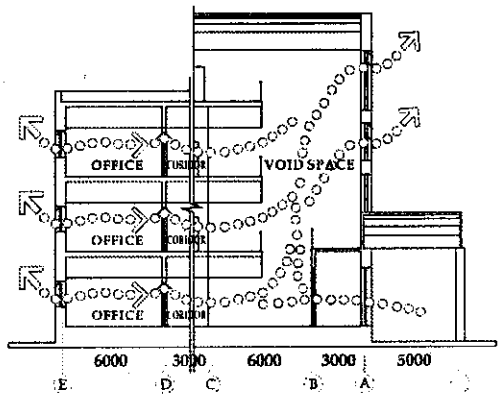
Specified temperatures are set in accordance with SNiP 4-01-02-2001 "Water Supply, External Networks and Facilities". Specified temperatures are as followings.

- Outside air temperature: -33℃
- Habitable room temperature with water heating: 16℃
- Electrical room temperature with water heating: 5℃

Specified material for external wall is brick. Thicknesses of brick walls for the habitable and for the electrical room are; 610 mm with 100 mm thick insulation, and 510 mm respectively in accordance with the local empirical model on the above-mentioned condition.

(6) Natural Ventilation

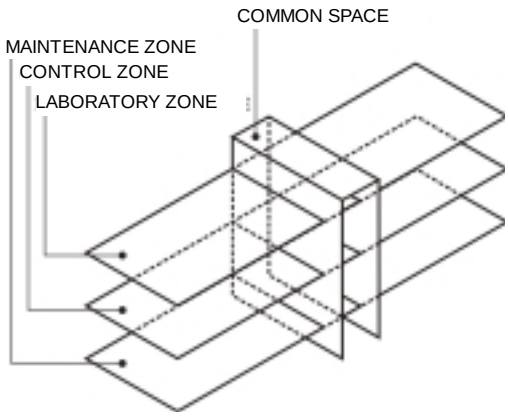
Void space is a suitable space as a natural ventilator for hot air in summer season. Void spaces will be provided at the entrance and the staircase through the 1st floor to the top floor, respectively.



(7) Building Functional Zoning

Concept of zoning plan of the building is productivity, which ensures efficient utilization. The space for this building is vertically divided into three floor zones to be utilized by different function.

Three zones are connected vertically by a common space located at middle of building, which consists of entrance, lobby, staircase and void space.



i) Maintenance Zone

Maintenance zone located at the first floor is planned for workshop, electrical room, mechanical room, and rooms for maintenance staff.

ii) Control Zone

Control zone has two functions; management of whole plant site and operation of the water treatment plant. This zone is located at the second floor.

iii) Laboratory Zone

Laboratory zone is the space for examination and analysis for proper water treatment, and the space for laboratory staff. This zone is located on the third floor.

(8) Building Elevation

Fine brick is adopted as the finishing material for external building wall, because maintenance is not necessary and good taste of sense. The fine brick gives the building an impression of calm and trust, which are required for public facility.

Arcuation form at the top of building and a glass part at middle of building façade give an accent to the building.

(9) Required Rooms

Required areas for each room are set in accordance with SNiP 2.09.04-87- Administrative and Accessory Buildings.

i) Maintenance Zone

Maintenance staff room-1

The room located at the first floor is required for 15 men for the general maintenance and 5 men for the electrical one. The room is used for internal meeting and locker installation.

Assuming a space requirement of 2 m^2 per person, required area is 40m^2 (= 2 x 20p). Allotted area located at the second floor is 72m^2.

Maintenance staff room-2

The room is required for 4 women for the building maintenance. The room is used for resting, repairing equipments and locker. Assuming space requirement of 2 m^2 per person for rest, required area is 8 m^2 (= 2 x 4p). Allotted area located on the second floor is 18m^2.

Maintenance staff room-3

The room is required for 4 women for room cleaning. The room is used as for resting space, cleaning equipment and locker. Assuming a space requirement of 2 m^2 per person for rest, required area is 8 m^2 (= 2 x 4p). Allotted area l is 18m^2.

In addition to above rooms, following rooms will be provided:

Workshop, Electrical room, Mechanical room

ii) Control Zone

Monitor Room

Water treatment system is monitored at the monitor room around the clock in application of a two (2)-shift system. The free access floor for wiring of monitoring equipment is provided.

The floor concrete slab of the monitor room is lower than 2nd floor standard level. Free access floor fills in this space.

Manager room

Assuming space requirement of 6 m^2 per person for deskwork, the required area is 6m^2. In addition, surplus space is required. Allotted area located on the second floor is 36 m^2.

Engineer Room-1

This room is for general engineers and assistant technicians. Assuming space requirement of 6 m^2 per person for the deskwork, required area is 12 m^2 (= 6 x 2p). Allotted area for internal meeting and locker installation is 36 m^2.

Engineer Room-2

This room is for electrical and mechanical engineers. Assuming space requirement of 6 m^2 per person for the deskwork, required area is 12 m^2 (= 6 x 2p). Allotted area for internal

meeting and locker installation is 36 m^2.

Operation staff room

This room is required for 4 women operators in the shifting system. The room is used for the internal meeting, resting and locker. Assuming space requirement of 2 m^2 per person for rest, required area is 8 m^2 (= 2 x 4p). Allotted area is 36 m^2.

iii) Laboratory Zone

The laboratory zone is specially required to be blocked off from other zones. Moreover, this zone is divided into two areas by a common space, which is located at the middle of building. One is for rooms of examinations and analysis of water treatment and the other is for office work and meeting etc. A door is provided at the access part to the former rooms.

The layout of each room for examination and analysis was made based on the request of the chief of laboratory and is in accordance to SNiP. The chemical store will be provided in the existing administration building.

iv) Common Space

Canteen

The kitchen fixture not only for washing but also for cooking will be provided by the user. Food can be warmed up and tea will be prepared there. Expected number of users of the Canteen is 30 persons.

Assuming space requirement of 2 m^2 per person and two times turnover in an hour, required area is 30 m^2 (30p x 2 m^2 / 2).

In addition to above rooms, following rooms will be provided:

Toilet, Shower Booth

(10) Connecting Corridor

Second floor of this building is connected to the top floor of the Water Treatment Building beside the connecting corridor. The connecting corridor is provided to connect above two buildings.

5.6.3 Water Treatment Building and Others

(1) Water Treatment Building

The top floor of Water Treatment Building is connected to the second floor of Administration

Building. The Water Treatment Building is 133m wide, 57.6m long, reinforced concrete structure with three expansion joints.

The building can be divided into three zones; the storage zone with 3 stories, the sedimentation basin zone and the rapid sand filter zone. Two of the latter are built on the civil structures. The building has flat roofs with 2% slope and an arched skylight, and the rain or snow will flow out through rain drains and downspouts.

External brick wall thickness is 470 mm with the insulation of 100 mm thickness and external wall finishing is the exposed fine brick. The internal main finishing is as follows.

Floor: Ceramic tile, Cement mortar screed finishing

Wall: Cement sand plaster with paint

Ceiling: Exposed concrete with paint

(2) Distribution Chamber

The Distribution Chamber is 14m wide, 10.6m long, reinforced concrete structure built on the civil structure buried underground. The building has a flat roof with 2% slope and the rain or snow will flow out through rain drains and downspouts.

External brick wall thickness is 470 mm with the insulation of 100 mm thickness and external wall finishing is the exposed fine brick. The internal main finishing is as follows.

Floor: Cement mortar screed finishing

Wall: Cement sand plaster with paint

Ceiling: Exposed concrete with paint

(3) Washing Drain Basin

The Washing Drain Basin is 6m wide, 10.9m long, pre-cast concrete structure built on the civil structure buried underground.

The roof and the external wall are as same as those for the Distribution Chamber as stipulated in (2). The internal main finishing is as follows.

Floor: Cement mortar screed finishing

Wall: Cement sand plaster with paint

Ceiling: Cement sand plaster with paint

(4) Surge Thickener

The Surge Thickener consists of two circular forms of 18.5m diameter, the reinforced concrete structure for column and beam and the steel structure for roof truss, is built on the civil structure buried underground. The building has sloped roofs.

The external wall is as same as those for the Distribution Chamber stipulated in (2). The internal main finishing is as follows.

Floor: Cement mortar screed finishing

Wall: Cement sand plaster with paint

Ceiling: Exposed insulation panel for roof

(5) Discharge Pool

The Discharge Pool is 6m wide, 10.9m long, pre-cast concrete structure, built on the civil structure buried underground. The roof and the external wall are as same as those for the Distribution Chamber stipulated in (2). The internal main finishing is as same as the one for the Washing Drain Basin stipulated in (3).

(6) WTP Guard House

The Guard House is 6m wide, 4m long, pre-cast concrete structure. The roof and the external wall are as same as those for the Distribution Chamber stipulated in (2). The internal main finishing is as same as the one for the Washing Drain Basin stipulated in (3).

(7) WTP Sub-station

The WTP. Sub-station is 36m wide, 12m long, pre-cast concrete structure. The roof and the external wall are as same as those for the Distribution Chamber stipulated in (2). The internal main finishing is as same as the one for the Washing Drain Basin stipulated in (3).

(8) Intake Pump Station

The Intake Pump Station is a circular form with 36m diameter, reinforced concrete structure built on the civil structure. The building has the sloped roof.

External concrete wall is 600 mm with the insulation of 100 mm thickness and external wall

finishing is the exposed concrete with paint. The internal main finishing is as follows:

Floor: Ceramic tile, Concrete screed finishing

Wall: Cement sand plaster with paint

Ceiling: Acoustic tile, Exposed concrete with paint

(9) Surge Control House

The Surge Control House is 18m wide, 18m long, reinforced concrete structure.

The building has two pits underground with 4m in depth.

The roof, the external wall and the internal main finishing are as same as those for the Distribution Chamber stipulated in (2).

(10) Intake Sub-station

The Intake Sub-station is 15m wide, 9m long, pre-cast concrete structure. The roof and the external wall are as same as those for the Distribution Chamber as stipulated in (2). The internal main finishing is as follows.

Floor: Light weight concrete screed finishing

Wall: Cement sand plaster with paint

Ceiling: Exposed concrete with paint

(11) Intake Guard House

The Intake Guard House is 6m wide, 4 m long, pre-cast concrete structure. The roof and the external wall are as same as those for the Distribution Chamber stipulated in (2). The internal main finishing is as follows.

Floor: Ceramic tile

Wall: Cement sand plaster with paint

Ceiling: Acoustic tile, Exposed concrete with paint

(12) Distribution Pump Station - Rehabilitation Work

Scope of Rehabilitation Work

Repair of leaking place at Roof

-Corrugated metal sheet roofing work on existing roof with gutter and downspout

Painting of External Wall, Internal Wall, All Doors and Windows

- Removing of existing coated surface completely.
- Repairing damaged surface
- Cleaning surface of materials
- Performing three coating (Primer, Intermediate, Topcoat)

Change of Ventilation Chimney Pipes

- To change malfunctioned ventilation chimney pipes

5.7 Mechanical Facility

Based on the process design in the previous chapter, detailed design for mechanical facilities for the intake pump station, water treatment plant and distribution pump station were prepared.

5.7.1 Raw Water Intake Pumps

(1) Pump Selection

Although adoption of submersible mixed flow pump was studied, ASA requested to design the intake pump station was studied considering the possibility of the future replacement with larger pumps than the planned capacity. In order to meet this requirement, installation of larger diameter of rising pipes for the pumps were proposed at that time. Further study, however, has been made and the following problems arose for this option.

1) The proposed pump has one of the largest capacities in adopted pump type, and it is hardly replaced with larger pump of the same type.
2) Only several pump manufacturers in the world can make such type and capacity of pumps, and their experiences are still limited.
3) Cables and chains in the rising pipe will be large and unstable, and they have to be fixed in the rising pipe. Therefore, removal of pumps without removing fixed cables and chains is hard.

Due to these difficulties, it was judged that application of the submersible mixed flow pumps for this pump station was not appropriate. Therefore, the vertical double suction volute pump (dry type) is applied. This pump type has the following features (refer to Table 5.7.1):

- Many experiences – Most of world well-known manufacturers produce this type of pump, and the products of even large capacity are reliable.
- Easy access - Pumps are installed in a dry well and operators have thus easy access to monitor pumps for operation and maintenance;
- Less installation space – Driving shafts of pumps are installed vertically, and therefore the motors are located on the upper floor of the pumping station. Consequently, required space is minimal;
- Easy maintenance - ASA maintenance crews are familiar with the proposed type of pumps, which are similar to those in the existing facilities. Large submersi-

ble pump motors are unlikely to be repaired at local workshops, due to lack of skills and facilities.

The proposed specifications for the intake pumps will be as follows:

1) Type : Vertical double suction volute pump (dry pit type)
2) Capacity: : 36.5 m^3/min (2,188 m^3/hour)
3) Number: : 6 sets (including 2 sets for standby)
4) Head : 35.0 m (operation range: 15.0 m to 35.0 m)

(2) Pump Control System

Three types of alternative flow control systems, namely, i) valve control, ii) speed control, and iii) operating pump number are applicable for the intake pump installations as shown in Table 5.7.2.

In order to accommodate the wide range of operating heads due to fluctuation of friction head loss caused by variation of flow, and to overcome two major peaks on the transmission pipelines, some control methods shall be employed to regulate flow and pressure in the pipes properly.

Combination of the valve control system and the pump number control system for control of flow and pressure is recommendable as shown in the following illustration:

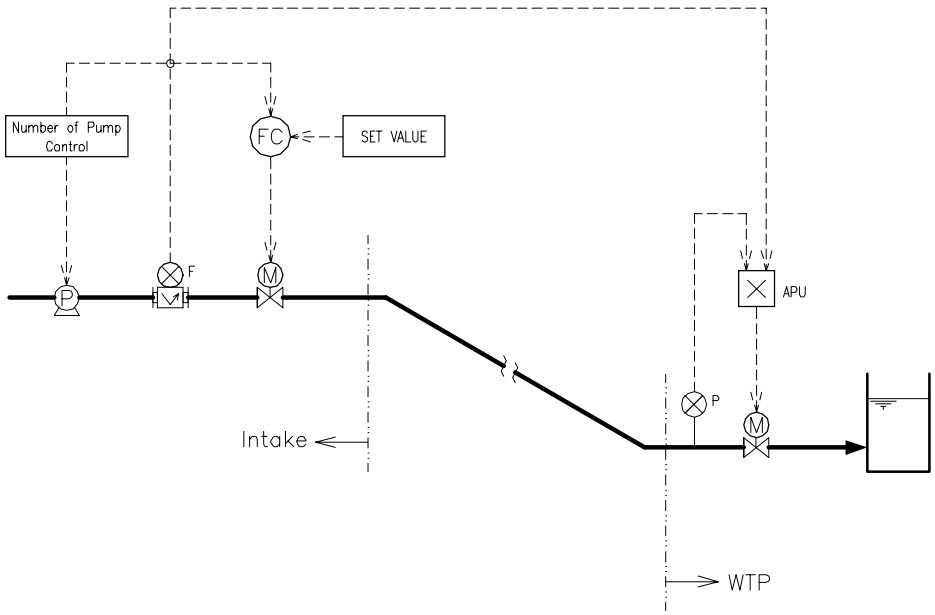


Figure 5.7.1 Intake Flow Control System

Intake flow is monitored by a flow meter at intake pump station and it will be controlled by number of operating pumps and a flow control valves. All four-duty pumps will be operated

for the maximum flow, and the flow control valve will adjust the flow. To decrease the flow to required level, the valve will be gradually closed until the certain flow, then one pump will be stopped and the valve will be open to minimize energy consumption. The flow control of raw water can be accomplished automatically by the proposed system.

A control valve at WTP will sustain the pressure in the pipelines to prevent entering air at the peaks along the pipelines.

This control system was recommended for the following reasons:

- Less cost - The proposed control system requires less initial cost than the pumps with speed control.
- Continuous setting – The proposed control system can be continuously operated against the varying heads within the pre-determined range.

Since dry type pumps without speed control will be employed, the motors will be dry type 6 kV induction type as same as the existing ones.

5.7.2 Sludge Collection and Withdrawal for Sedimentation Tank

(1) Sludge Collection

Six sedimentation basins are proposed as discussed in the previous chapter, and each will be provided with mechanical sludge collectors to ensure that sludge is effectively withdrawn automatically by means of sludge withdrawal valves.

For horizontal sedimentation basins, the following major types of sludge collectors could alternatively be used as per Table 5.7.3.

a) chain flight sludge collector
b) reciprocating flight sludge collector
c) travelling blade sludge collector

Reciprocating flight sludge collector is recommended because of the following specific advantages;

- low cost – simple operation and structure for the collector will incur low cost;
- easy maintenance - simple operation and structure do not require special devices and materials for repair or maintenance. Local technicians could handle repairs using materials available in the local market.

(2) Sludge Removal

Sludge removal is automatically carried out by means of pneumatic sludge withdrawal valves. The valves is pre-set to open and close by turns using timers.

For the operation of sludge withdrawal, hydraulic, pneumatic or motorized actuators are applicable. Hydraulic actuators have been used for many years, but of recently the use of pneumatic and motorized actuators has become more widespread, because of the need for cumbersome maintenance of hydraulic devices. Pneumatic actuators are often used for operation of sludge withdrawal valves. Pneumatic actuators is used for the following reasons:

- pneumatic actuators can readily monitor the operation conditions such as opening, and can be indicated on the control panel;
- pneumatic actuators can be closed automatically using the spring in the actuator, when power failure occurs.

Eccentric valve is recommended for sludge withdrawal valves, due to less clogging and less time for open/close.

5.7.3 Filter Control Units

After certain period of filtration process, head loss of the filter reaches to an unacceptable level or turbidity breakthrough occurs, washing process is required to clean the filter media. Filters are facilitated with automatic washing process to be started by the operator. When the operator judges washing is necessary by monitoring filtration time or water level of the filters, the operator can start washing process, and the filter is automatically washed by a cycle consisting of drain, surface wash and backwash. For the operation, siphons and pneumatic valves were employed.

5.7.4 Chemical Dosing Facilities

(1) Alum Dosing

As a coagulant, solid alum (aluminum sulfate) is currently used in the existing plant, and it will be continued after new treatment facilities are constructed. Alum dosing facilities consist of dissolving tanks and dosing devices. The dissolving tank is made of chemical-resist concrete tanks with motorized mixers. Three typical chemical dosing methods, namely measuring pump type, pump with return pipe type and gravity flow type are illustrated in Table 5.7.4. Pump with Return Pipe type be used for the following reasons:

- measuting chemical pumps are seldom used in water treatment plant in Kazakhstan and they can be difficult to maintain by the local technician;
- gravity flow type requires chemical pump and the head tank

(2) Chlorination

The chlorination will be done at two dosing points in the proposed water treatment plant. The dosing points are one at receiving well as pre-chlorination and another at filter outlet as post-chlorination. The chlorination facilities consist of chlorine cylinders, weighing devices, evaporators, chlorinators, injectors and safety devices.

Only two duty chlorine cylinders will be provided at the chemical room, and other storage will be kept at the existing chlorine cylinder storage building.

5.7.5 Distribution Pump Station

(1) Pump Selection

Dry well horizontal double suction volute pumps are applied for the clear water distribution. The pump has the advantages as listed below.

- easy access - the pumps are installed in a dry well and operators have thus easy access to monitor pumps for operation and maintenance;
- easy maintenance - ASA maintenance crews are familiar with the proposed type of pumps, which are of similar type as in the existing facilities. Vertical mixed flow (turbine) pumps in the wet well require the disassembly of the column pipes and the line shafts, before attending to the maintenance of the pump proper. Submersible pump motors are not available for this operation range.
- high efficiency - dry well vertical double suction volute pumps have superior efficiencies than submersible pumps. (Interim Report page 3-15)

There are eight distribution pumps for drinking water in the existing pump station. Among them, two pumps were recently converted from use for technical water to use for drinking water distribution to meet increase of drinking water demand. The type of pumps is the horizontal double suction volute type. The pumps are operated at the discharge head of 50 m during day and 40 m at night. Nos. 2 and 5 pumps are used, while others are standby. Out of existing 8 pumps, ASA requested replacing of pumps Nos. 4, 7 and 8 in this project, because of their heavy deterioration. Specifications of existing pumps are summarized be-

low:

No	Capacity (m^3/hr)	Head (m)	Motor Output (kW)	Year
1	1,600 (2,720)*	90	500	2002
2	2,500 (2,720)*	64	500	2001
3	1,500 (1,740)*	64	320	1987
4	6,300 (5,440)*	64	1000	1985
5	3,200 (3,430)*	64	630	1987
6	3,200 (3,430)*	64	630	1987
7	3,200 (3,430)*	64	630	1980
8	3,200 (3,430)*	64	630	1980

*: Capacity in ( ) is calculated at 50 m discharge head, considering motor output.

Judging from the status of existing pumps and water demand, grouping of pumps was recommended to have variable and reliable operation.

The following specifications for the distribution pumps for replacement were applied:

1) Type : Horizontal double suction volute pump (dry pit type)
2) Large (Nos. 4 and 7) : Capacity: 66.7 m^3/min (4,000 m^3/hour)
   Number: 2 units
   Small (No. 8) : Capacity: 41.7 m^3/min (2,500 m^3/hour)
   Number: 1 set
3) Head : 55.0 m

(2) Pump Control System

In the existing distribution pump station, the pumps are manually operated to control the pressure of discharge header, consequently it meets water demands in the distribution network. Following the current operation practice, a large pump (No. 7) and a small pump (No. 8) are manually operated, however another large pump (No. 4) with variable speed motor shall be automatically operated to adjust the distribution pressure to the pre-determined pressure (ex. 50 m at daytime and 40 m at night). Flow meters and a pressure gauge is provided on the delivery pipe of distribution pump stations to monitor flow and pressure in the pipes.

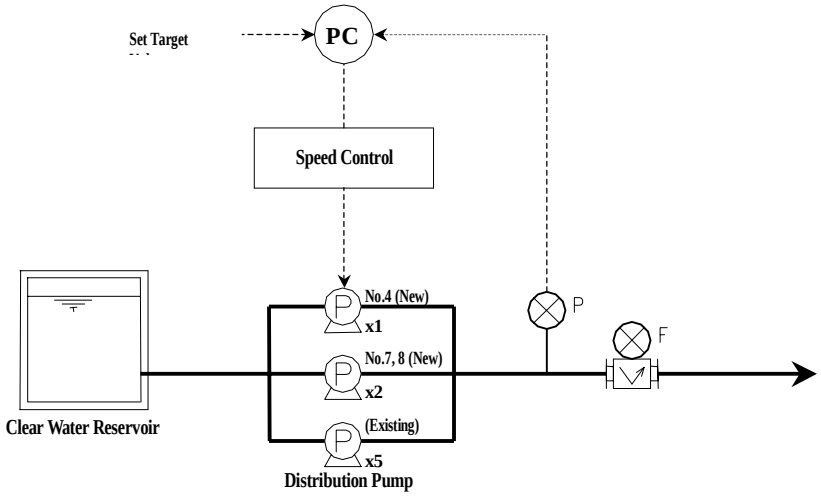


Figure 5.7.2 Distribution Pump Control System

Table 5.7.1 Comparison of Pump Stations (1/2)

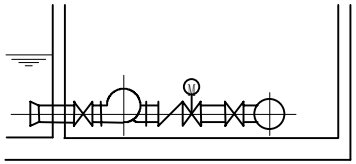
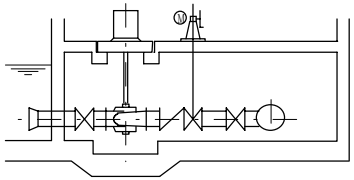
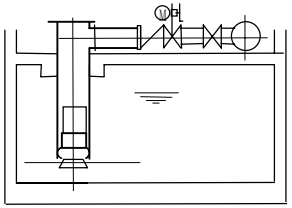
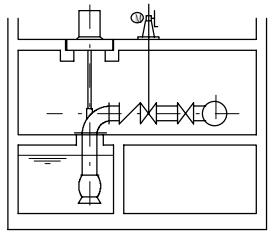
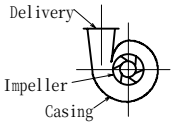
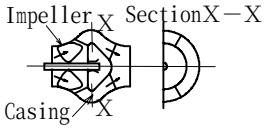
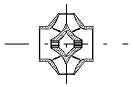
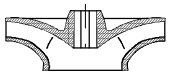
Item \ Type	Horizontal Double Suction Volute Pump	Vertical Double Suction Volute Pump	Submersible Pump	Vertical Mixed Flow Pump
Plan (Section)				
Structure Casing				
Impeller				
Bearing	・Impeller and shaft are supported by bearings located at both end of casing.	・Same as left	・Impeller and shaft are supported by bearings located at upper end of casing.	・Impeller and shaft are supported by bearings located at bowl case, rising pipes and bearing case.
Performance Characteristic	・Q-H curve shows moderate pressure drop at higher flow. ・Efficiency is generally high, and it is extended at wider range.	・Same as left ・Same as left	・Same as left ・Efficiency is comparatively low.	・Q-H curve shows steep pressure drop at higher flow, and shut-off head is relatively high. ・Efficiency is comparatively low.
Suction	・Suction head is relatively high, and the pump is safe for cavitation.	・Same as left	・Same as left	・Suction head is relatively low, and the pump is less safe for cavitation than volute pumps.

Table 5.7.1 Comparison of Pump Stations (2/2)

Item \ Type	Horizontal Double Suction Volute Pump	Vertical Double Suction Volute Pump	Submersible Pump	Vertical Mixed Flow Pump
Load	・Loads of both motor and pump are beard by pump room floor.	・Loads of motor and pump are separately beard by pump and motor room floor.	・Loads of both motor and pump are beard by pump pit floor.	・Loads of motor and pump are separately beard by pump and motor room floor.
Installation	・Easy.	・Difficult than left	・Easiest.	・Complicate.
Operation	・Priming device is not required due to positive suction head. ・Shut-off operation can be done for short period.	・Same as left ・Same as left	・Same as left ・Same as left	・Same as left ・Same as left
Maintenance	・Easy for maintenance. Only dismount of upper casing is required for maintenance of impeller, rotor etc.	・Same as left	・Easy for maintenance. Pump and motor can be lifted from pump pit. ・Submersible motor is difficult to maintain at local workshop.	・Difficult for maintenance. All motor, bearing case, rising pipe shall be disassemble to maintain pump.
Noise/Vibration	・Least noise and vibration	・Less noise and vibration	・Least noise and vibration	・Less noise and vibration
Station Area	・Largest area required.	・Larger area required than submersible pump.	・No pump room required. Smallest area required than other pumps.	・Larger area required than submersible pump.
Depth	・Positive suction head.	・Positive suction head.	・Positive suction head.	・Deepest.
Shape	・Simple. No floor for motor is required.	・Floor for motor is required.	・Simplest. No dry pit is required.	・Complicate.
Supply Record	・Many	・Less than left	・Less than left for water supply.	・Less than horizontal type.

Table 5.7.2 Comparison of Pumping Facility Control (1/2)

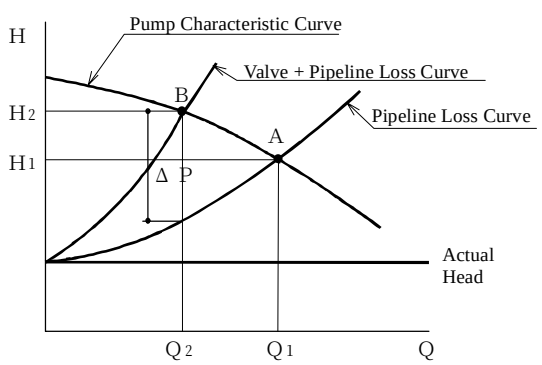
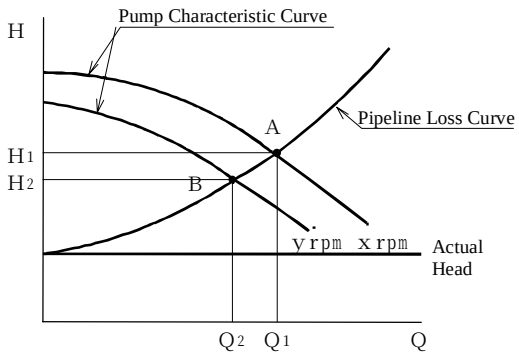
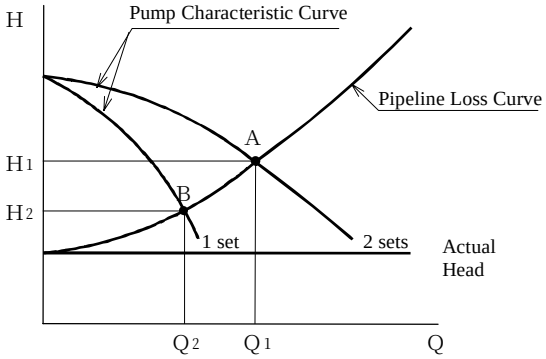
Type / Item	Valve Control	Speed Control	Pump Number Control
Control Method			
	Pump is operating at A, and the flow is Q_1. If flow Q_2 is required, the operation should be shifted from A to B. However, an additional loss is needed to this shift. Closing the flow control valve gives the additional loss (ΔP) and the operation of the pump moves from A to B.	Pump is operating at A, and the flow is Q1 with pump operation speed of x rpm. If flow Q2 is required, the pump operation speed should be changed from x rpm to y rpm to change the pump characteristic curve. It reduces pumping capacity and head, and makes pumping operation at B.	Two pumps are operating at A, and the flow is Q1. If flow Q2 is required, one of the operating two pumps should be stopped and one pump supplies flow Q2.

Table 5.7.2 Comparison of Control of Pump Facility Control (2/2)

Item \ Type	Control Valve	Speed Control	Pump Number Control
Feature	Continuous control is available, by adjusting opening of the control valve	Continuous control is available, by adjusting pump-operating speed.	Only stepwise is available, by control number of operating pumps.
Advantages	Continuous flow setting is applicable. Only one set of control valve required. Wide range of flow control is available with operating pump number control.	Continuous flow setting is applicable. Power consumption is reduced following to the decreasing of pump speed Wide range of flow control is available with operating pump number control.	Special devices are not required. Lowest construction cost is required.
Disadvantages	Cavitation can be occurred at the operation with small opening of the control valve. Maintenance of the control valve is required. One control valve can hardly control small flow.	Speed control device is relatively expensive. Maintenance of the speed control device is required.	Continuous flow setting is not applicable. Round flow control cannot be done.
Maintenance	Easy	Easy	Some difficulty for setting
Supply Record	Many	Many	Many for small capacity

Table 5.7.3 Comparison of Sludge Collectors (1/2)

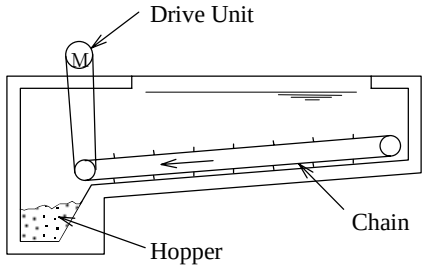
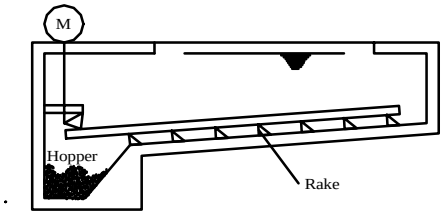
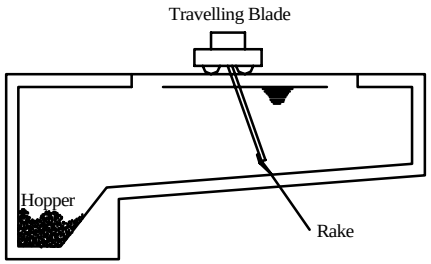
Item \ Type	Chain Flight	Reciprocating Flight	Traveling Blade
Drawing			
Outline	Drive unit on the top slab rotates shafts in water by drive chains. Two main sprockets on the shafts pull two endless chains with many flights. The main chains run continuously.	Drive unit on the top slab push and pull driving rod. Vertical reciprocating motion of the rod is changed to horizontal motion by angle arm unit, and it is transferred to the rake. Many flights are equipped to the rake at right angle to the rake. The rakes make reciprocating motion continuously.	Traveling blade runs forward and backward on rails installed on the top slab. The blade hangs a rake to the bottom of the tank. The traveling blade is operated periodically.
Major Equipment	Drive Unit: motor, reduction gears Underwater: chains, sprockets, shafts, bearings, flights, shoe	Drive Unit: motor, reduction gears Underwater: rod, angle arm unit, rake, flights, guide rails	Surface: blade, motor, reduction gears, rails Underwater: rake
Operation	Two endless chains with flights runs continuously. Flights scrapes and collects settled sludge to sludge hoppers.	Rake with many flights installed on the bottom runs forward and backward by reciprocating link motion. Flights on the rake scrape and collect settled sludge to sludge hoppers.	Traveling blade installed on the top slab runs forward and backward. Rake hung from the blade scrapes and collects settled sludge to sludge hoppers.

Table 5.7.3 Comparison of Sludge Collectors (2/2)

Item \ Type	Chain Flight	Reciprocating Flight	Traveling Blade
Advantages	Inclinated plates may be installed. Less moving parts underwater Continuous scraping	Inclinated plates can be installed. Less moving parts underwater Continuous scraping Easy Installation Easy operation and maintenance	Less moving parts underwater Easy operation and maintenance
Disadvantages	Most of moving parts, such as chains, sprockets, bearings etc are located underwater, and regular maintenance is required. Main chains can be cut off. Main chains can be loosen for long term operation. Breaks of the main chain are not monitored from the top slab.	Most of moving parts, such as rakes, flights, etc. are located underwater, and regular Maintenance is required, but less frequency.	Inclinated plates cannot be installed. Only periodical scraping Top slab should bear large load.
Maintenance	・Surface replace of gear oil: once a year lubrication of driving chains: once a month ・Underwater loosen of chain wearing of chains/sprockets damage of flights	・Surface replace of gear oil: once a year lubrication of driving chains: once a month ・Underwater wearing of guiderails damage of flights	・Surface replace of gear oil: once a year lubrication of driving chains: once a month wearing of wheels/sprockets: once a month loosen of wire ropes: once a month damage of rakes: once a month
Supply Record	・Many	・Recently increasing.	・Many

Table 5.7.4 Chemical Dosing Methods (1/2)

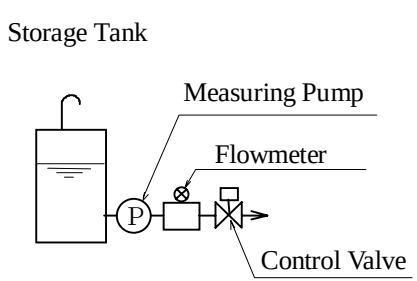
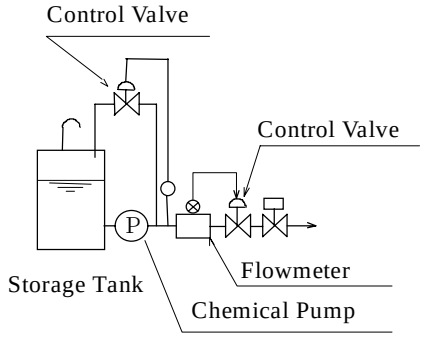
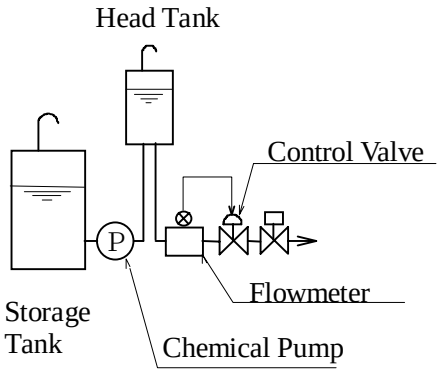
Item \ Type	Measuring Pump	Pump with Return Pipe	Gravity Flow
Schematic Diagram			
Features	1. Flow can be controlled with a range of 1:20 by controling stroke and speed of the measuring pump. (it can be differed on chemicals, flow, etc.) 2. Clogging rarely occurs in the dosing pipes. 3. Flow is controlled by stroke and speed of the measuring pump, so that the actual flow can be differed from the requirement. 4. A measuring pump is required for each dosing point/chemical.	1. Flow can be controlled with a range of 1:10 to 1:15 in general. 2. Clogging can occurs in the dosing pipes with diameter/small flow. 3. Flow is controlled by the actual flow in the dosing pipe. 4. Excess flow is returned to storage tank through return pipe.	1. Flow can be controlled with a range of 1:10 to 1:15 in general. 2. Clogging can occurs in the dosing pipes with diameter/small flow. 3. Flow is controlled by the actual flow in the dosing pipe. 4. Running of camical pump can be minimized. 5. Head tank with proper heigh is required.

Table 5.7.4 Chemical Dosing Methods (2/2)

Item \ Type	Measuring Pump	Pump with Return Pipe	Gravity Flow
Maintenance	1. Measuring pumps are complicated, and difficult to maintain comparing with centrifugal pumps 2. Measuring pumps are required periodical overwholes for proper operation. 3. Automatic control units for the pump are also required proper maintenance.	1. Diameter of control valve is comparatively small, and clogging on the valve sometimes can be occured. 2. Clogging can occurs in the dosing pipes with small diameter and small flow. 3. Flow is controlled by control valve, measuring the actual flow in the dosing pipe. 4. Excess flow is returned to storage tank through return pipe.	1. Diameter of control valve is comparatively small, and clogging on the valve sometimes can be occured. 2. Clogging can occurs in the dosing pipes with small diameter and small flow. 3. Flow is controlled by control valve, measuring the actual flow in the dosing pipe.
Supply Record	Many	Many	Less

5.8 Electrical Facility

5.8.1 Power Supply

(1) Main Power Supply

1) Intake pump station

The existing outdoor substation at the intake pump station has three 35kV incoming lines from the Astana Energo Service and these lines are downed to 6kV by two transformers. One transformer is for duty and theother one is for stand-by mutually. The 6kV line which was downed at the substation has been distributed to the existing pump station by a duplex line. The 6kV class switchgears which are installed at the outdoor substation have become too old for satisfactory work. And it was judged that these switchgears need rehabilitation. In this project, a new electrical room for the 6kV switchgears is planned to be built. Power will be distributed to a new pump station by the new 6kV duplex line from the new electrical room. Power supply to the existing pump station from the new electrical room will be done by connection to the existing cable.

2) Water treatment plant

The water treatment plant has two 11kV and one 35kV incoming lines from the Astana Energo Service. Power is downed to 6kV at the outdoor substation and is distributed to the electrical room in the pump station by a duplex line. The capacity of transformers is enough for the new and the existing water treatment plants. The new 6kV switchgears, however, are needed for power distribution to the new plant. There is not enough space to add new switchgears in the existing electrical room, and the existing substation is deteriorated and has poor reliability. Furthermore, it is necessary to relocate the existing substation for rehabilitation of the distribution main pipelines. Consecuently, a new high voltage substation shall be installed with transforming capacity covereing both of the existing and the new plants. The power will be distributed to the existing and new 6kV switchgears by the new 6kV duplex line from the new substation.

A power generator for power cut is not provided at both of the intake pump station and the water treatment plant, because of the reliable duplex power incoming system.

(2) UPS Power Supply

The UPS (Uninterupted Power Supply) power supply equipment receives the AC power from

low voltage distribution board. AC power is converted to DC power through the rectifier, which charges the storage batteries. When the main power supply interruption happens, DC power from the batteries is converted to AC power by the inverter. Then, the UPS continues to supply AC power without an interruption.

In the proposed plant, the UPS power supply will be provided for operation or control of:

- high voltage substation facilities;
- protection relays of the high tension metal-enclosed switchgear;
- air circuit breaker (ACB) of the low voltage switchboard;
- SCADA (Supervisory Control and Data Acquisition) system;
- PLC (Programmable Logic Controller); and
- where even a momentary service interruption is not permissible.

The UPS will be a cathode absorption seal, lead-acid battery (MSE) type, 220V output, with 30-minute backup time.

5.8.2 Power Device

(1) Bus Bars

The type of high-tension bus bar is the duplex incomer and the single bus bar type with a tie breaker. The current capacity of the bus bar should endure the electric power demand of the whole plant.

(2) Circuit Breakers

Vacuum circuit breakers (VCB) will be adopted for high-tension circuit breakers for ease of maintenance. The breaking capacity at receiving point is 1000MVA at 33kV. The breaking current rating of VCB's is 25kA.

(3) Transformers

A high voltage transformers, which are installed outdoor, are the oil immersed type. While, inside of the building, the type of transformers is the molded dry type with metal enclosure for fire-proof, crack-proof, dust and moisture-proof, which is smaller, lighter, stronger than the oil immersed transformer.

Some of 6kV power supply from the network shall be stepped down to 380V by a minimum

of 2 numbers of transformers. The two transformers are duty and stand-by, so that when one transformer is unserviceable or under repair, another transformer takes over the power supply for the plant. The capacities of the main transformers are sized in accordance with the maximum demand of the plant and with a minimum surplus capacity of 10 %.

(4) Lightning Arrester

Indoor-type lightning arresters are installed in the power receiving panel to protect in-plant electrical equipment from surge induced on the network power line.

(5) Metering and Protection

The electricity metering device, which comprises of VCT and kWh-meter, is installed by the Astana Energo Service on the incoming high voltage side.

An over-current relays are provided in the power-receiving panel to protect the electrical equipment from electrical faults such as over-currents.

The grounding system is the isolated neutral system at 6kV system. A GPT (Grounding Potential Transformer) is provided to sense the grounding fault current and a grounding over-current relays are provided to protect the electrical equipment from grounding fault.

The low voltage grounding system is the type TN-S system of the earthed neutral system, in which neutral and protective functions are separated with two conductors throughout the system. In this system, grounding over-current relays are provided to protect the electrical equipment from grounding fault.

(6) Low Voltage Distribution

The power from the transformers is distributed at 380-220V, 3-phase, 4-wire to the low voltage distribution boards.

Low voltage bus bars are provided to carry the full load current of the transformers and designed to endure the full short circuit load of the transformers.

In principle, all outgoing feeders are installed with grounding over-current relays to protect the electrical equipment from faults such as grounding fault.

(7) Power-factor Improvement

Power-factor improvement is achieved by static capacitor, and the compensated power-factor will be better than 95 %. The capacitors for power-factor improvement are provided with

series reactor to restrain higher harmonics.

The capacitors are installed individually at each motor starter panel for above 55kW load except distribution pumps. The collective capacitors for the distribution pumps are installed at 6kV bus bars intensively, considering existing motors. The power-factor is adjusted automatically by APFC (Automatic Power Factor Controller), which is installed at the secondary feeder of transformer.

(8) Single line Diagram

The outline of single line diagram is shown in Figure 5.8.1 and Figure 5.8.2

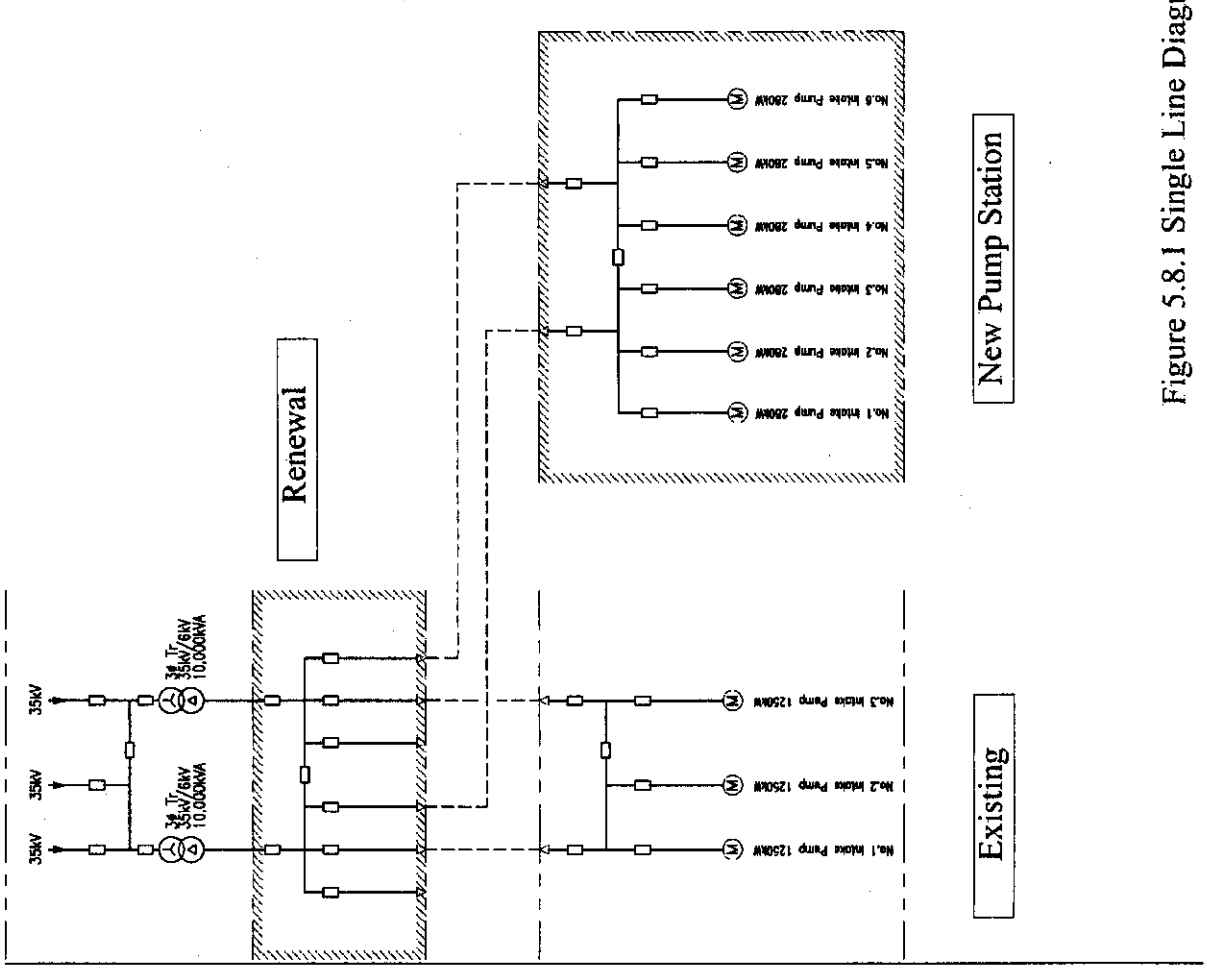


Figure 5.8.1 Single Line Diagram for Intake Pump Station

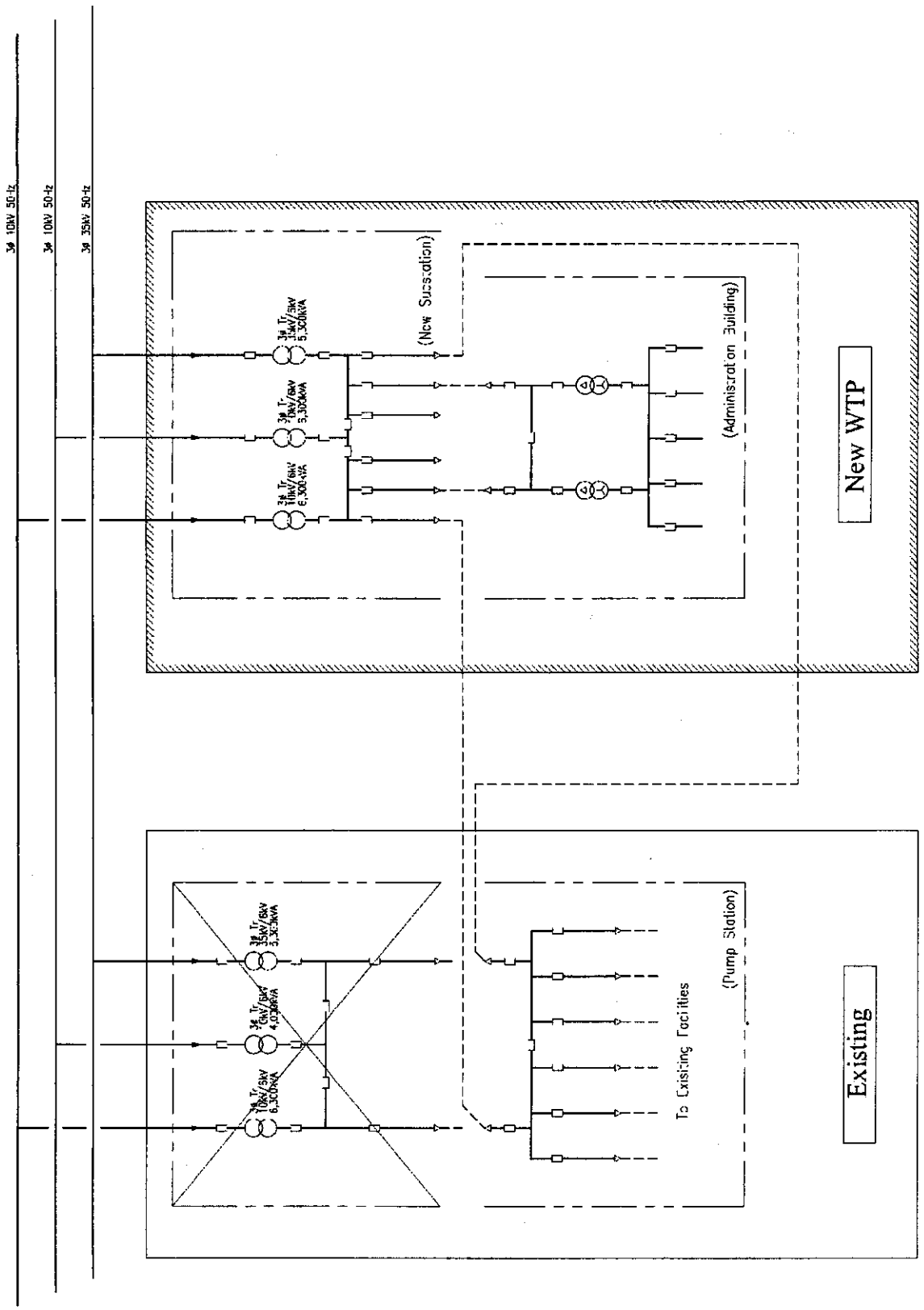


Figure 5.8.2 Single Line Diagram for Water Treatment Plant

5.8.3 Motor Control

(1) Motor Voltage

Generally, 3-phase motor voltages should be provided in accordance with the specifications shown in Figure 5.8.3. In this project, 6kV and 380V is adopted for the motor voltage. Motors up to 300kW is provided with 380V and for motors over 300kW, 6kV is provided.

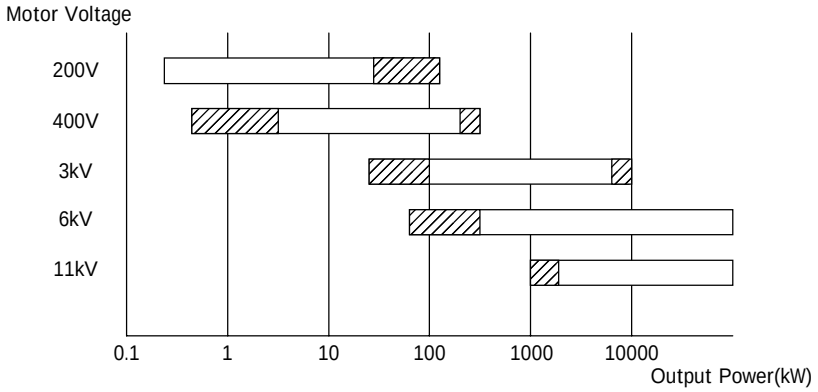


Figure 5.8.3 Economical Range of Every Voltage for Motor

(2) Motor Starters

All motors are provided with starters as follows:

- up to 7.5kW - full voltage starting
- 7.5kW to 30kW - star delta starting
- above 30kW (low volt.) - auto transformer starting
- above 300 kW (6kV) - reactor starting
- No.4 distribution pump (6kV) - VVVF starting

All motor starters are installed in separate cubicles, and over current protection are provided.

(3) Combination Starter

A combination starters are provided for 6kV motor starter panels. These panels are divided into a power fuse and a vacuum contactor. The former is for a short breaking function, and the latter is for a switching operation function. A circuit breaker is not suitable for frequent switching operation and it is also economically disadvantageous.

(4) Motor Control Center

Motor control centers are provided to supply power for loads up to 55kW. Motor control centers are composed of draw-out type units, that are assembled with circuit breakers, magnetic contactors and similar control devices.

Motors or equipment are controlled by auxiliary hard relays and PLCs' software. Auxiliary hard relays and PLCs have manual-mode operation and auto-mode operation control circuits respectively.

The starter panels for the sludge treatment facilities are installed the local independent starter panels because of a few number of loads.

(5) Motor Protection

All motors shall be protected from damage by faults such as overload, grounding fault, lack of phase, reverse of phase, and imbalance of the three phases, which detected by thermal relays, solid state overload relays, earth leakage relays or peak power cut relays.

(6) Variable Speed Drives

To control the speed of motors, it is necessary to adopt VVVF (Variable Voltage Variable Frequency). VVVF makes it possible by changing the voltage and frequency of the electricity supply with the inverter. VVVF is also effective in saving energy.

As a countermeasure for higher harmonics suppression, VVVF is always installed with RNF (Radio Noise Filter).

The VVVF unit is provided for the No.4 distribution pump.

(7) Local Control Switches

Local control panels are provided adjacent to all process equipment. Each panel has a key switch for "LOCAL-CENTRAL" controls or "SINGLE-LINK" controls, "ON-OFF" switch positions, etc. All motors is able to be controlled by manual operation at local control panel installed by the side of each motor.

(8) Distribution and Cabling

All main cabling are laid using multi-core XLPE, SWA, PVC cables. For cables wired under the ground, concrete trenches or corrugated hard-polyethylene pipe (FEP) with

concrete draw pits are provided.

All cables will be fully protected from UV degradation.

5.8.4 Instrumentation Equipment

(1) Measuring Items

The measuring items and types are shown in Table 5.8.1.

Table 5.8.1 Measuring Items and Types

Measuring Items	Types
Raw Water Intake Flow	Ultrasonic type flow meter
Pump Suction Water Level (Reservoir Water Level)	Hydrostatic level transmitter (Flange type)
Flow Control Valve Opening Degree	Valve standard equipment
Inflow Pressure	Diaphragm type pressure meter
Inflow Control Valve Opening Degree	Valve standard equipment
Raw Water Distribution Flow	Ultrasonic type flow meter
Sampling Pump Pit Water Level (for Pump Operation)	Electrode Type Level Switch
Filter Water Level (for Pump Operation)	Electrode Type Level Switch
Surface Wash Water Flow	Ultrasonic type flow meter
Reservoir Water Level	Submersible hydrostatic type level meter
Distribution Flow	Ultrasonic type flow meter
Distribution Pressure	Diaphragm type pressure meter
Recovery Water Flow	Electromagnetic flow meter
Washing Drain Water Level	Hydrostatic level transmitter (Flange type)
Washing Drain Basin Water Level (for Pump Operation)	Electrode Type Level Switch
Wastewater Discharge Flow	Electromagnetic flow meter
Discharge Pool Water Level	Hydrostatic level transmitter (Flange type)
Discharge Pool Water Level (for Pump Operation)	Electrode Type Level Switch
Coagulant Dosing Flow	Electromagnetic flow meter
Coagulant Control Valve Opening Degree	Valve standard equipment
Coagulant Tank Water Level (for Pump Operation)	Electrode Type Level Switch
Flocculant Tank Water Level (for Pump Operation)	Electrode Type Level Switch
Activated Carbon Tank Water Level (for Pump Operation)	Electrode Type Level Switch
Outdoor Atmosphere Temperature	Resistance Thermometer

5.8.5 Control and Supervisory System

(1) Concept of System

The hierarchy system and horizontally distributed control system are adopted. The hierarchy system is useful in saving labor and easy to operate due to supervision of the whole set of equipment from one place, whereas the horizontally distributed control system improves the reliability of the control system.

The supervisory control level is further classified into three levels. They are the site level, electrical room level, and central monitoring room level. The details of each level are discussed in below.

(2) Site Level

In the site level, local operation panels are installed for manual operation such as independent operation, unit test or adjustment test. Accordingly, to carry out it securely, it is necessary for the manual operation to be assembled with a hard relays, even if abnormal conditions happened to the PLC of the upper class system.

The process values, such as electric current, water level, water pressure etc., are needed for independent operation are indicated on the local operation panel. These process values shall be branched off from the instrumentation converter directly without passing through the PLC.

The failure display lamps, such as over load and/or mechanical failure, are installed on the local control panel along with the group failure indicating lamps. Also, the condition status indicating lamps, such as high and low water level, will be installed on the local control panel at same location.

(3) Electrical Room Level

The electrical room level has a function of the main control and local supervisory. On this level, a control of each load is carried out by hard relays and controllers. The PLCs work for the automatic and linked control system, and the hard relays, work for the manual control system.

In the distributed control system, a failure risk will be dispersed by control devices which installed in each electrical room distributively, and reliability of the control will be improved. Furthermore, in order to cope with a failure of a single PLC, manual operation circuits for motors are composed of auxiliary hard relays instead of the PLCs' software.

The instrumentation panels are installed in each electrical room. It is composed of indicator, controller, setting device and so on. All measuring values of instrumentation can be watched on these panels.

(4) Central Supervisory Room Level

The system is designed to facilitate the monitoring of the whole plant, and processing the data at the central monitoring room level. All of important items such as alarm or status of pumps can be monitored and recorded comprehensively from the central monitoring room.

The master computers which are installed in this room are connected with all local PLCs in each electrical room by LAN cables and will communicate each other with Ethernet protocol. The master computers have man-machine interfaces to monitor the whole plant through a graphical interface.

Furthermore, the processed data by the computer are accumulated to the server. And the server is connected with the logging and the alarm processing printers by the upper information LAN.

The mimic panel is installed in the central monitoring room. The function of the panel is to provide status and alarm indications of the whole plant facilities, using an wide overview picture.

However, existing facilities are not subjects for monitoring at the new central monitoring room except the distribution pump station facilities.

(5) Telecommunication System

A radio communication system is established in the Project as a communication medium between the Intake P/S and the WTP to monitor or control the remote Intake P/S form the WTP.

The data or the information listed below are uploaded or down loaded to maintain or operate the Intake P/S properly from the WTP.

1) Intake water quantity a day (to monitor and record actual intake water quantity)
2) Plant loads status
3) Plant loads failure
4) Send the data from the WTP to the Intake P/S to control the water intake flow rate

The existing radio communication system is working and remained under the condition

specified below, in conjunction with the relay station, which repeats signals between the Intake P/S and the WTP.

1) Receiving at the WTP: 150.85 MHz for voice communication

2) Transmitting at the WTP: 165.85 MHz for voice communication

3) Output: 5W

In this project, the new radio communication system connects the both stations directly without a relay station to exclude an external interruption. To make it possible, direct communication between the two stations, an antenna tower of 65 m height at the WTP and an antenna tower of 35 m height at the intake P/S will be constructed. The frequencies of 405.475 MHz/413.725 MHz and 405.575 MHz/413.775 MHz are allocated to the system for voice communication and data transmission respectively, and an output of 25 W is usable to the system.

(6) Monitoring System Diagram

The monitoring system diagram is shown in Figure 5.8.4

(7) Principal Automations

1) Intake flow automation

The automatic control of intake flow is done by the flow control valve through the adjustment of the opening degree. It is possible to set the value of the intake flow from both of the intake pump station and the central monitoring room.

The detail of the principal automation is explained in Section 5.7.

2) Transmission pressure automation

The No.4 distribution pump is controlled by the discharge water pressure by a speed control unit automatically. The target value of pressure can be set from the local operation panel. The detail of the principal automation is explained in Section 5.7.

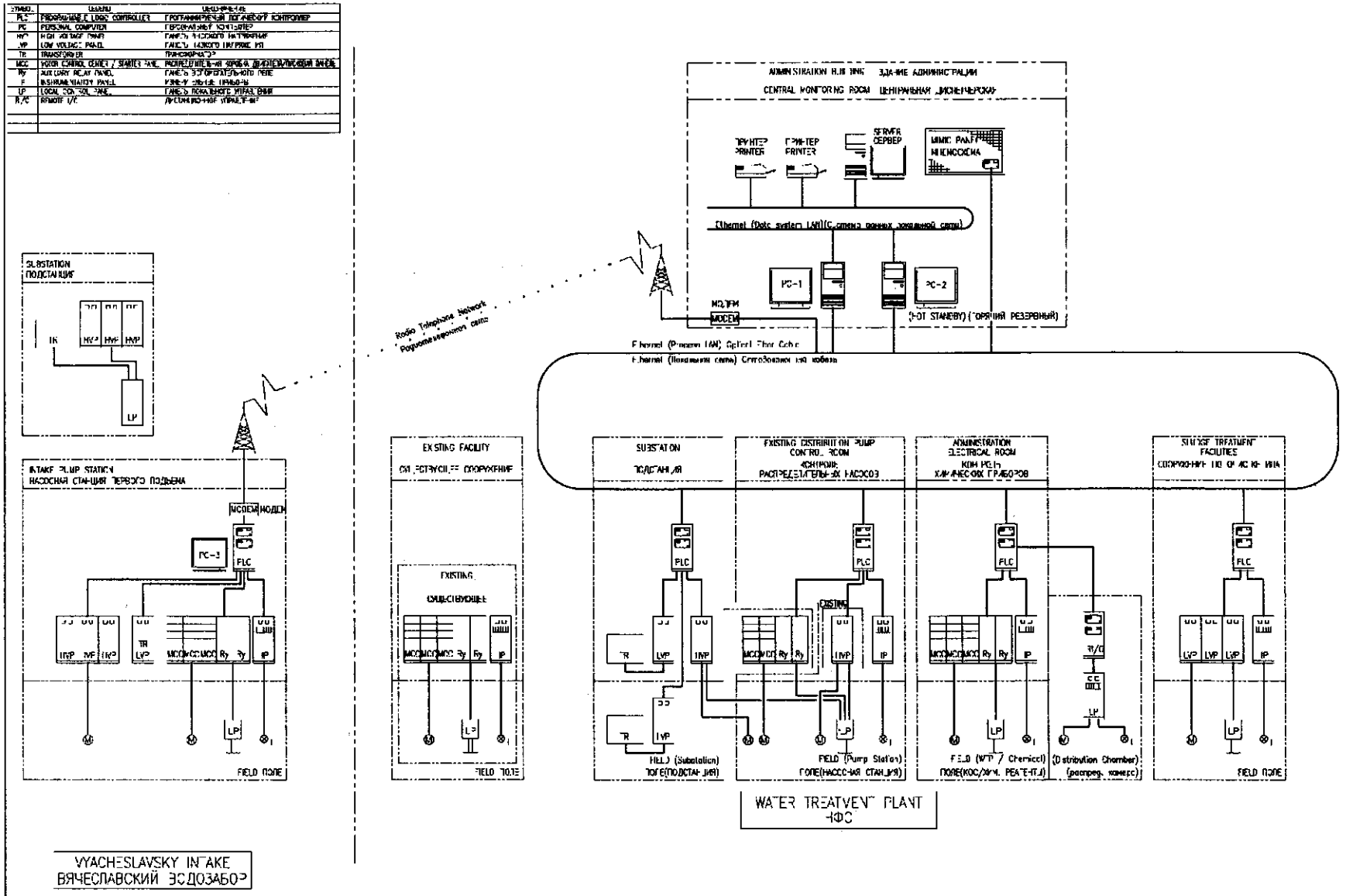


Figure 5.8.4 Monitoring System Diagram

CHAPTER 6 SEWERAGE FACILITIES

CHAPTER 6 SEWERAGE FACILITIES

6.1 Sewage Treatment Plant

6.1.1 Design Policy

Basic concepts established in M/P and F/S for the sewerage system are applied including future development tactics, staged construction/expansion and cost saving in operation and maintenance of the facilities. Immediate improvement in synthetic arrangements in treatment process, maintenance and administration is a major concern of this study. Monitoring and control system for the facilities are also considered.

In the design, natural characteristics such as climate and soil condition are considered for the reliability of the facilities. The following is a simplified summary.

1) Environmental and Site Conditions

The project site location of sewerage facilities is as follows:

Sewage treatment plant: SSW of city center at 344 m above sea level

Intermediate pump stations and sewers: City center at approximately 340~360 m above sea level

The general site terrain in Astana city is flat, and existing buildings and facilities are on the site. The climate is severely continental with maximum extreme temperatures as indicated below:

Absolute maximum summer temperature: +52.0 deg.C.

Absolute minimum winter temperature: -42.0 deg.C.

Annual mean temperature: + 1.4 deg.C.

2) Wind force

Wind force was determined in accordance with SNiP 2.01.07-85 Section 6.

Astana is zone-area category III, and basic wind pressure is 0.38 kPa

Other details are stated in Chapter 5

3) Snow/Ice:

Load criteria stated in SNiP 201.07-85 Sections 5 and 7 shall be adopted. The following is a simplified summary:

For snow loading, Astana is zone-area category III

Uniform standard snow loading is 1.0 kN/m^2

Average wind speed (for drifting calculations) is 5.0 m/s

For ice, the design thickness of ice for Astana is 5mm (zone II). However, this is only applicable for the design of ropes, cables, antennae etc, and special high towers, and is generally not applicable to most of the buildings in the project.

4) Seismic force

As Astana is in a non-seismic region, design earthquake forces need not be considered.

5) Soil and ground water condition

Expected ground water level is around GL-2.5m, and the depth of soil freezing is estimated around GL-2.3m. All foundations will be taken down to a depth below the design soil freezing line, GL-2.3m.

The chemical composition of the soil is also checked to determine what precautions are necessary to prevent soil corrosion of foundations and other durability concerns. Precautions shall follow the relevant requirements of SNiP regulations.

6.1.2 Design Condition of STP

(1) Fundamentals

1) Basic Information on Astana Sewage Treatment Plant

Land Area:	Approximately 43 ha
Ground Level:	+344.7 - +351.3 m
Influent Pipe Diameter:	Diameter 1400mm x 2
Land Use:	Exiting STP

Collection System: Separate Sewer System

- Treatment Method:

  [Sewage Treatment]: Conventional Activated Sludge

  [Sludge Treatment]: Thickening + Digestion + Mechanical Dewatering

Effluent Discharge Point: Taldy Kol Reservoir

Discharge Point Water Level: +346.8m

Design Target Year: 2010

Design Population: 490,000 (2010); 800,000 (2030)

2) Flow rates

Table 6.1.1 Flow Rates

Items	m^3/day	m^3/hr	m^3/min	m^3/sec
Daily Average Flow	114,000	4,750.0	79.17	1.319
Design Average Daily Flow	136,000	5,666.7	94.44	1.574
Maximum Flow	200,000	8,333.3	138.89	2.315

3) Water quality

Table 6.1.2 Water Quality

Item	Influent (mg/L)	Primary Treatment		Secondary Treatment		Total Removal Ratio
		Removal Ratio	Effluent (mg/L)	Removal Ratio	Effluent (mg/L)	
BOD	170	30%	119	83.2%	20	88%
SS	210	40%	126	84.1%	20	90%

4) Design sludge volume for the basic design

Table 6.1.3 Design Sludge Volume

Items	Volume (m^3/day)	Sludge Generation (t/day)	Water Content (%)
Thickened Sludge	546	27.3	95
Digested Sludge	546	16.4	97
Sludge Cake	74	14.7	80

5) Sludge disposal

Sludge disposal is out of the S/W of this project. Implementation of new sludge disposal program is necessary before completion of this project.

(2) Results of site investigation

1) General

Site investigations were conducted for the detailed design. Two items of concrete structure neutralization test and measurement of existing facilities were made other than scope of work. The first is to find the extent of neutralization to get the information of deterioration of concrete structure. The other is confirmation of configuration and specification. All the data were reflected to the detailed design.

2) Soil investigation

Soil investigation was made to get information on supportive strength of the soil, the occurrence and location of any rock or compressible strata and groundwater table. Where piling is required, the investigation results are useful to determine the allowable capacity of pile loads and to estimate pile terminal depth. The results of the soil investigation are included in Appendix.

3) Test excavation

Test excavation was conducted to confirm existence, location, depth, and specification of the underground conduits in the STP site. Seven investigation points are selected at the plant site (refer to the location of the points in Appendix).

4) Water and sludge quality analysis

Water and sludge quality analysis was conducted to confirm the present conditions and treatment capability.

5) Sulphate analysis of the soil

Sulphate analysis of the soil at the STP was conducted to get information on the corrosive nature of the soil.

6) Sludge coagulant examination

Qualification of several coagulants was confirmed through the experiment as references for sludge thickening.

7) Other investigations

a) Concrete Neutralization Test

Concrete neutralization test was conducted to confirm the durability of the facilities from the viewpoint of remaining life of concrete. The result is summarized as follows;

Maximum concrete neutralization depth is 30mm at outside cylinder of Sludge Digestion Tank. The average value is 15mm. These values are considered to be common for the facilities used over 30 years. Remaining life of structure is assumed to be 10~20 years from the result of analysis.

b) Existing Facilities Measurement

On-site measurement of existing facilities was conducted to get information on the structures, materials and dimensions to make drawings of detailed design. Observation was also made concerning water and sludge flow to ensure the flow of existing buried conduits.

6.1.3 Plant layout Examination

(1) Future Plant Layout

The arrangement of all future facilities shall be contemplated at this stage. In addition to the future expansion of process modules, land area should be ensured for those facilities that may be required to upgrade effluent quality. A flexible approach to facility layout is needed to avoid an inefficient and disorganized layout that may result in an inability to expand in the future. For this purpose, the future plan for the year 2020 was made. Design concept is as follows:

- Treatment capacity shall be 172,000 m3/d for the year 2020
- Flexibility in construction shall be ensured: Easy future expansion, rehabilitation and staged construction
- Easy operation and maintenance
- No use of sludge drying bed
- Capability of advanced treatment in consideration of the future discharge to the river instead of using Taldy Kol reservoir

General plan in the future is developed as shown in Figure 6.1.1. Main features of this plan are summarized below:

- Pump station with the grit chamber shall be located near the receiving chamber.

- Sewage treatment facilities (primary sedimentation tank to final sedimentation tank) shall be rectangular shape provided for the pipeline corridor inside. Location shall be at the place of existing sludge drying bed.
- Treatment process is nitrification-denitrification process using modified activated sludge process.
- Discharge pump station shall be aligned after the sewage treatment facilities.
- Sludge treatment facilities shall be located at almost same area of existing facilities. Mechanical thickener/dewatering building shall be adjacent to the gravity thickener.
- Administration building shall be close to the entrance for administration and control of visitor.
- Area used for the existing sewage treatment facilities shall be reserved after demolishing, for the construction of facilities in the succeeding stage of 2020 project.

(2) Plant layout for the Project

Since the target year of this project is between the present (up to2010) and the final target (2010~2030), facility layout plan considers existing one and future plan described in the above sub-section. Therefore, the following new facilities need adjusted consideration such as shape of the facilities, location, structure, conduits construction, and future expansion and plant aesthetics for the present and the future.

- Grit Chamber
- Return Sludge Pump Station
- Mechanical Thickener Building
- Mechanical Dewatering Building
- Dewatered Sludge Cake Yard

For the primary/final sedimentation tank and sludge digestion tank, the design shall follow the existing facilities based on the FS. Plant layout plan is shown in Figure 6.1.2 and Plant flow chart diagram is shown in Figure 6.1.3.

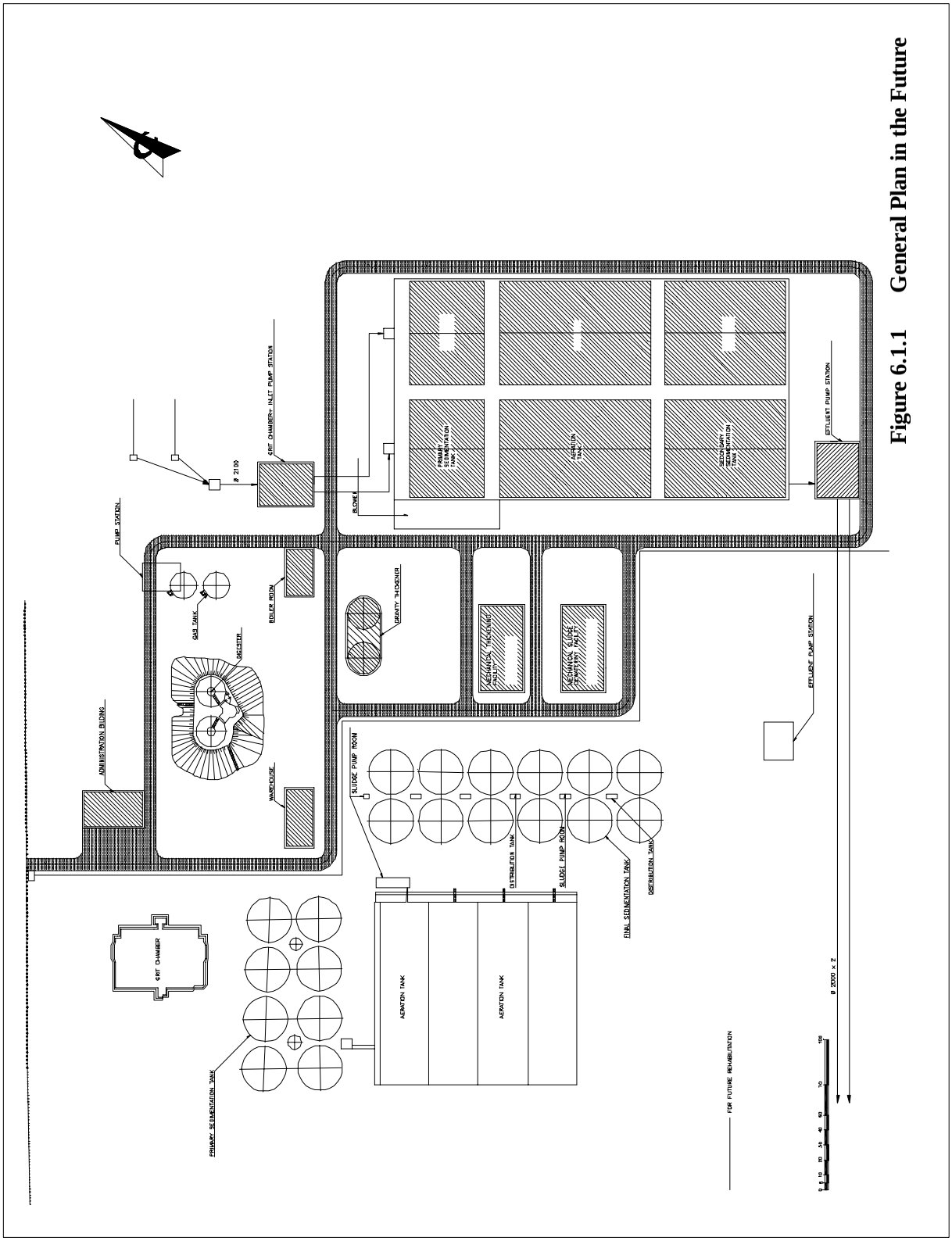


Figure 6.1.1 General Plan in the Future

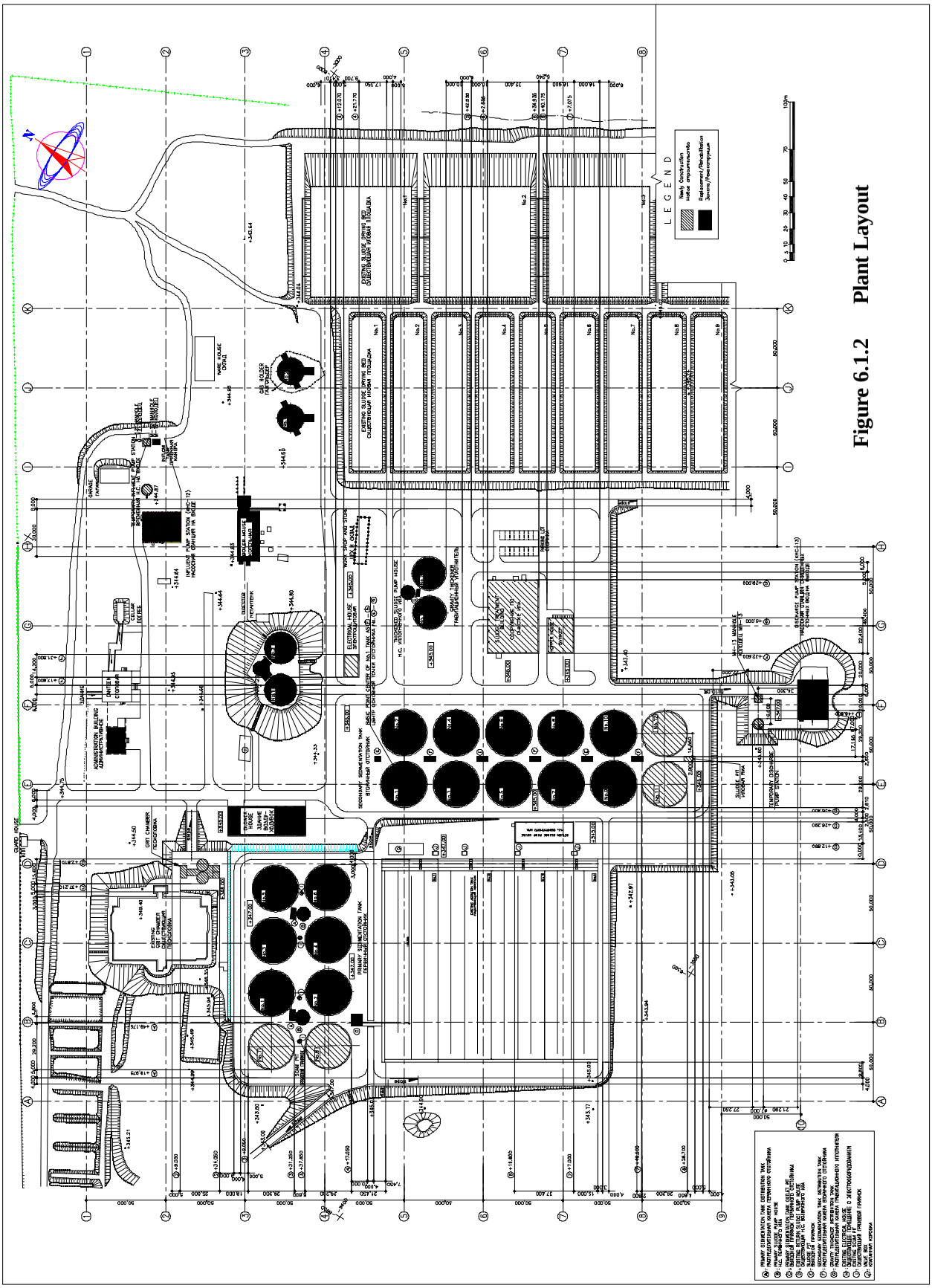


Figure 6.1.2 Plant Layout

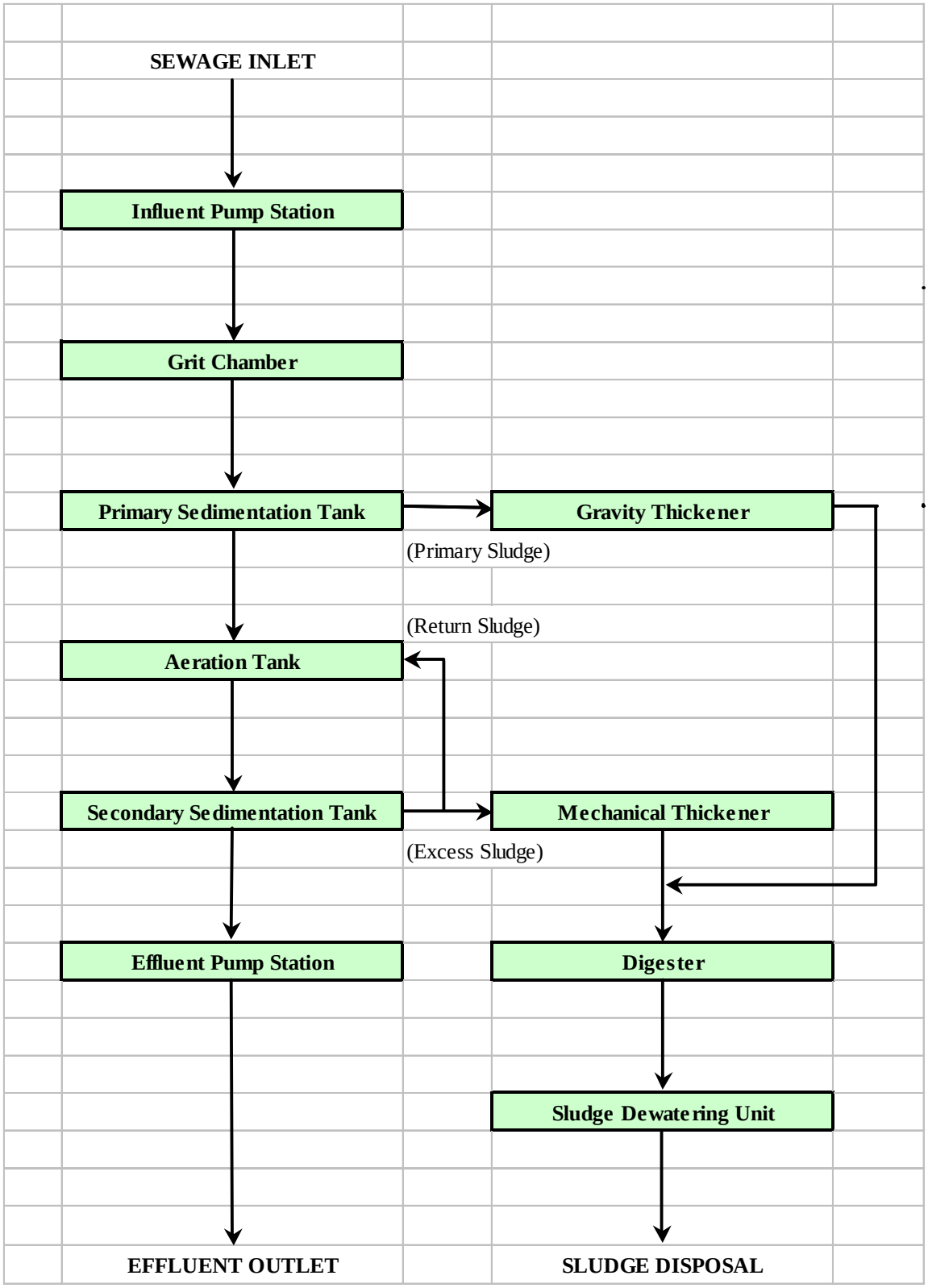


Figure 6.1.3 Plant Flow Diagram

6.1.4 Unit Process

(1) Inlet Chamber and Inlet Pipe

- Inlet Pipe Diameter: Dia. 1,400mm x 1 pipe
- Material: Reinforced concrete pipe
- Invert Level: Approximately + 339.5m
- Nominal Capacity: 1.54 m^3/sec = 133,000m^3/day

Existing inlet pipe does not have enough capacity for proposed peak hourly maximum flow of 200,000 m^3/day as shown above and additional inflow pipeline is needed. Aside from this, the construction work is not possible without drying up reservoir well of existing pump station. Therefore, the replacement work shall be done either providing a new pump station or a temporary pump station.

Work for the Inlet chamber includes rehabilitation of the inside wall of the structure and extension of the underground RC chamber for installation of gate. The size of the gate is 1400 mm in rectangular shape. This new gate shall be installed to stop the inflow and/or to change the flow to temporary pump station (TPS) for drying up the pump well at the existing pump station.

In this project, construction of a temporary pump station is recommended. After the divergence from inlet chamber by the pipe with a diameter 2000mm, the sewage flows into the manhole to which the other inflow pipe will be connected in the future to accommodate a total flow of 200,000m3/d at the STP. The pipe with a diameter of 2000mm is expanded up to pump well of the TPS from the manhole.

Specification of TPS is as follows:

- Pump well/manhole diameter: 6000mm
- Pump unit: three (3) units of submersible pump (diameter 500mm)
- Depth of TPS: 9.027m (from the ground surface)
- Diameter of Pressure pipeline from TPS to grid chamber: 1200mm

TPS is connected to KHC-12 PS with a new inlet pipe (diameter of 1400 mm). After the dismantlement of temporary pump units, the pump well will work as a mere manhole. Thus, manhole bottom shall be arranged with cement mortal for smooth flow of sewage.

Pipe arrangements required are as follows:

- Installation of pipe; Dia. 1,400mm x 1 pipe (after completion of new pump station)
- Inlet pipe capacity after installation of a new pipe (Dia. 1,400mm x 2): 1.54 m3/sec = 266,000 m3/day

(2) Inlet Pump Station (KHC12)

1) Construction/Installation

Construction of one (1) pump station or temporary pump facility is required for the rehabilitation. Temporary pump station using submersible pump with manhole type is recommended from required cost and construction period.

The capacity of the temporary pump station shall be at least 100,000m^3/d (72m^3/min) to accommodate the flow during summer season.

The new pump station shall be equipped with pump pit for three (3) units of dia. 500mm submersible pump. Since existing receiving chamber has insufficient room for the above-mentioned pump equipment, the construction of a temporary pump station is required, which is planned as a manhole structure. This recommendation is also supported by the increase of inflow beyond the capacity of the existing pump station.

After completion of a temporary pump station, existing pump pit shall be dried up to rehabilitated.

2) Rehabilitation/Replacement

Rehabilitation of underground concrete structure of existing pump station shall be done by chipping (or using high- pressure water jet) at the surface up to the depth of normal concrete appearance and placing no shrinking mortar after painting epoxy on the chipped surface. This work shall be conducted after completion of a temporary pump station as stated 1). Reinforcing bar for the structures shall be rehabilitated where necessary. Architectural rehabilitation shall also be done including facilities such as ventilation.

Replacement work for mechanical equipment is as follows:

- Mechanical screens; 3 units
- Pumps; 0.9m^3/s x 2units, 0.45m^3/s x 2units
- Pressure pipelines including 3gates in the channels to the screen and valves inside the pump station
- Beam crane

(3) Grit Chamber

New construction of following grit chamber with mechanical equipment:

- Type: Vortex Circle Radiation-Flow Type
- Structure: Reinforced Concrete
- Size/Tank Number: Diameter 7.3m x Depth 1.0m x 2 chambers

(4) Primary Sedimentation Tank

1) Construction/Installation

New tanks (Numbering is made as No.7 and No.8) including mechanical equipment shall be constructed/installed as follows;

- Construction of No.7 and No.8 tanks of Diameter 28m x Depth 3.5m (2 tanks)
- Installation of Sludge Scraper for No.7 and No.8 tanks
- Installation of Primary Sludge Pump for No.7 and No.8 tanks

Primary sedimentation tank capacity after construction of 2 new tanks (for a total of 8 tanks):

$$Capacity = \frac{28.0^2 \times 3.14}{4} \times 30.0 m^3 / m^2 \cdot day \times 8 \tan ks \cong 147{,}500 m^3 / day$$

Construction of 2 tanks (Total 8 tanks) makes enough capacity for proposed flow rate of 136,000m^3/day.

2) Rehabilitation/Replacement

Rehabilitation/Replacement shall be done covering all existing tanks as follows:

- Rehabilitation of existing No.1 – No.6 tanks of Diameter 28m x Depth 3.5m (6 tanks) shall be done depending on the condition of each tank.
- Rehabilitation of 2 distribution tanks with the replacement of stop gates
- Replacement of drive units and wheels for sludge scraper for existing No.1 – No.6 tanks
- Repair of sludge scraper equipment for existing No.1 – No.6 tanks
- Replacement of primary sludge pump for existing No.1 – No.6 tanks
- Installation of v-notch weir plate for existing No.1 – No.6 tanks to make uniform effluent

(5) Aeration Tank

Rehabilitation/Replacement shall be done covering all existing tanks as follows:

- Size/Tank Number: Width 8.0m x Length 119.0 m x Depth 4.0 m x 4 channels x 4 tanks

Nominal Capacity (for 4 tanks):

$$Capacity = \frac{8m \times 119m \times 4m \times 4channels \times 4\tan ks}{8hr} \times 24hr / day \cong 182{,}000m^3 / day$$

Since existing 4tanks (No.1-4) have enough capacity for proposed flow rate of 136,000m^3/day, no new construction is needed for the conventional activated sludge process.

Concrete surface of all tanks (4 tanks) shall be rehabilitated to cope with corrosion.

Rehabilitation work shall start from No.3 and 4 that are not operated at present. After the start of operation of No.3 and 4, rehabilitation of No.1 and 2 shall be followed. In order to make operation of No.3 and 4 possible, it is necessary to rehabilitate air pipe and outflow pipeline for these two facilities at the same time.

(6) Blowers and Blower house

Rehabilitation/Replacement shall be done as follows:

- Rehabilitation of existing blower house shall be done.
- Replacement of 5 air blowers with required accessories such as air filter and air pipelines.
- Replacement of utility water pumps and accessories at the underground of the blower house.

(7) Secondary Sedimentation Tank

1) Construction/Installation

New tanks with mechanical equipment (Numbering is made as No11 and No 12) shall be constructed/installed as follows;

- Construction of No.11 and No.12 tanks of Diameter 28m x Depth 4.0m (2 tanks)
- Installation of Sludge Scraper for No.11 and No.12 tanks

- Installation of Primary Sludge Pump for No.11 and No.12 tanks

Secondary Sedimentation Tank capacity after construction/installation of 2 new tanks (for total of 12 tanks):

$$Capacity = \frac{28.0^2 \times 3.14}{4} \times 25.0 m^3 / m^2 \cdot day \times 12 \tan ks \cong 184{,}500 m^3 / day$$

2) Rehabilitation/Replacement

Rehabilitation/Replacement shall be done covering all existing tanks as follows:

- Rehabilitation of existing No.1 – No.10 tanks of Diameter 28m x Depth 4.0m (10 tanks) shall be done depending on the condition of each tank.
- Rehabilitation of 6 distribution tanks with the replacement of stop gates
- Replacement of drive units and wheels for sludge suction equipment for existing No.1 – No.10 tanks
- Repair of sludge suction equipment for existing No.1 – No.10 tanks
- Installation of v-notch weir plate for existing No.1 – No.10 tanks to make uniform effluent

(8) Discharge Pump Station (KHC13)

1) Construction/Installation

Construction of one (1) pump station or temporary pump facility is required for rehabilitation of existing discharge pump station. Construction of temporary pump station is recommended from the reasons of lower cost and construction period required.

The capacity of the pump shall be at least 100,000m^3/d (72m^3/min) to accommodate the flow during summer season.

The temporary pump station shall entail pump pit for installation of three (3) units of dia. 500mm submersible pump.

After completion of a new pump station, existing pump pit shall be dried up, to make possible rehabilitation work.

2) Rehabilitation/Replacement

Replacement work for mechanical equipment is as follows:

- Replacement of stop valve at the inlet
- Replacement of pumps of 0.9m^3/s x 2units and 0.45m^3/s x 2units
- Replacement of pressure pipelines
- Replacement of beam crane

(9) Gravity Thickener

1) Construction/Installation

Nominal combined Capacity of 2 tanks (for Sludge Volume):

$$Capacity = \frac{\frac{20.0^2 x3.14}{4} \times 3.5m \times 2\,tanks}{8hr} \times 24hr/day = 6{,}500m^3/day$$

Existing 2 tanks have enough capacity for the treatment of proposed primary sludge volume 258m^3/day. It is not necessary to construct a new gravity thickener.

2) Rehabilitation/Replacement (2 tanks and their accessories)

Rehabilitation/Replacement shall be done as follows:

- Concrete structure of 2 tanks shall be rehabilitated depending on the condition of the tanks.
- Replacement of two scrapers in gravity thickener
- Replacement of two thickened sludge pump in the pump room
- Installation of v-notch weir plate to make uniform effluent
- Installation of GRP covers on the tanks to prevent diffusion of odor.

(10) Mechanical Thickener

A new building for mechanical thickeners shall be merged into the sludge dewatering building as stated in other sub-section.

- Structure: Reinforced concrete structure
- Equipment: Screw-press type

(11) Sludge Digestion Tank

1) Rehabilitation/Replacement

Type: Anaerobic Digestion (Thermophilic digestion)

Size/Tank Number: Dia. 17.5m x Depth 8.0m x 2 tanks

Nominal Capacity (For 2 tanks):

$$Capacity = \frac{\frac{17.5^2 \times 3.14}{4} \times Depth\,8.0m \times 2\,tanks}{6\,days} \cong 640\,m^3 / day$$

- Rehabilitation of existing 2 tanks of Diameter 17.5m x Depth 8.0m.
- Replacement of 2 Sludge Digestion Tank covers
- Replacement of mechanical equipment such as the mixing device and sludge heating

(12) Sludge Treatment Building

Sludge treatment building shall be constructed for installation of sludge dewatering units. Sludge cake hopper to carry sludge out of the STP shall be furnished in the sludge cake stock house ($15m^3$ each for 6 units: refer to Figure 4.2.12).

- Structure: Reinforced concrete structure. A merged structure plan with the mechanical thickening building was developed in view of saving construction cost and easy maintenance.
- Equipment: Type of Screw-press is recommended from the viewpoint of construction cost, maintenance cost, easy-maintenance and safety. As for the details of the equipment, refer to Section 6.5.

It is generally said that about 500m is enough as the buffer zone against offensive odor. However, northeast wind is prevalent in summer season in Astana. It means the wind direction is from STP site to the new government area. In consideration of this condition, wet scrubber system shall be employed to avoid dispersion of odor and be installed in the sludge treatment building.

(13) Sludge Drying Bed

Digested sludge will be treated in sludge dewatering unit. Existing sludge drying beds will remain as standby for sludge dewatering.

(14) Boiler

Replacement of 2 sets of coal boiler (4.0t/hr) with the required equipment is required.

(15) Gas Holders

Rehabilitation of existing wet type 2 tanks of Diameter 14.0 m x Height 6.0m shall be done. Equipment and pipelines connected to gasholder shall be repaired.

(16) Connecting Conduit and Others

1) Present Condition

Wastewater pipe

- Diameter: Dia 500mm – 1,750mm
- Materials: Concrete Pipe, Steel Pipe
- Length: Approximately 3,800m

Sludge pipe

- Diameter: Dia 200mm – 500mm
- Materials: Steel Pipe
- Length: Approximately 2,700m

Supernatant pipe

- Materials: Steel Pipe
- Diameter: Dia 100mm –500mm
- Length: Approximately 5,700m

Air blower pipe

- Diameter: Dia 400mm – 1,500mm
- Materials: Steel Pipe
- Length: Approximately 400m

2) Rehabilitation/Replacement

Wastewater pipe

- Replacement between pump station and new grit chamber
- Replacement between grit chamber and distribution tank at the entrance of primary sedimentation tank
- Replacement of all pipes that need improvement

Sludge pipe

- Replacement of all pipes that needs improvement

(17) Yard Work

1) Plant Road

In-plant road shall be constructed to access each facility as follows;

- Road width: Main road 6.0m and Sub-road 4.0m
- Pavement material: Asphalt pavement

2) Drainage

L type side ditch shall be installed at the roadside for drainage.

6.1.5 Plant Hydraulics

Plant hydraulics was examined for proposed flow rate in provision of the condition of rehabilitation as shown in Figure 6.1.4.

Final discharging point is Taldy Kol reservoir as described in the S/W.

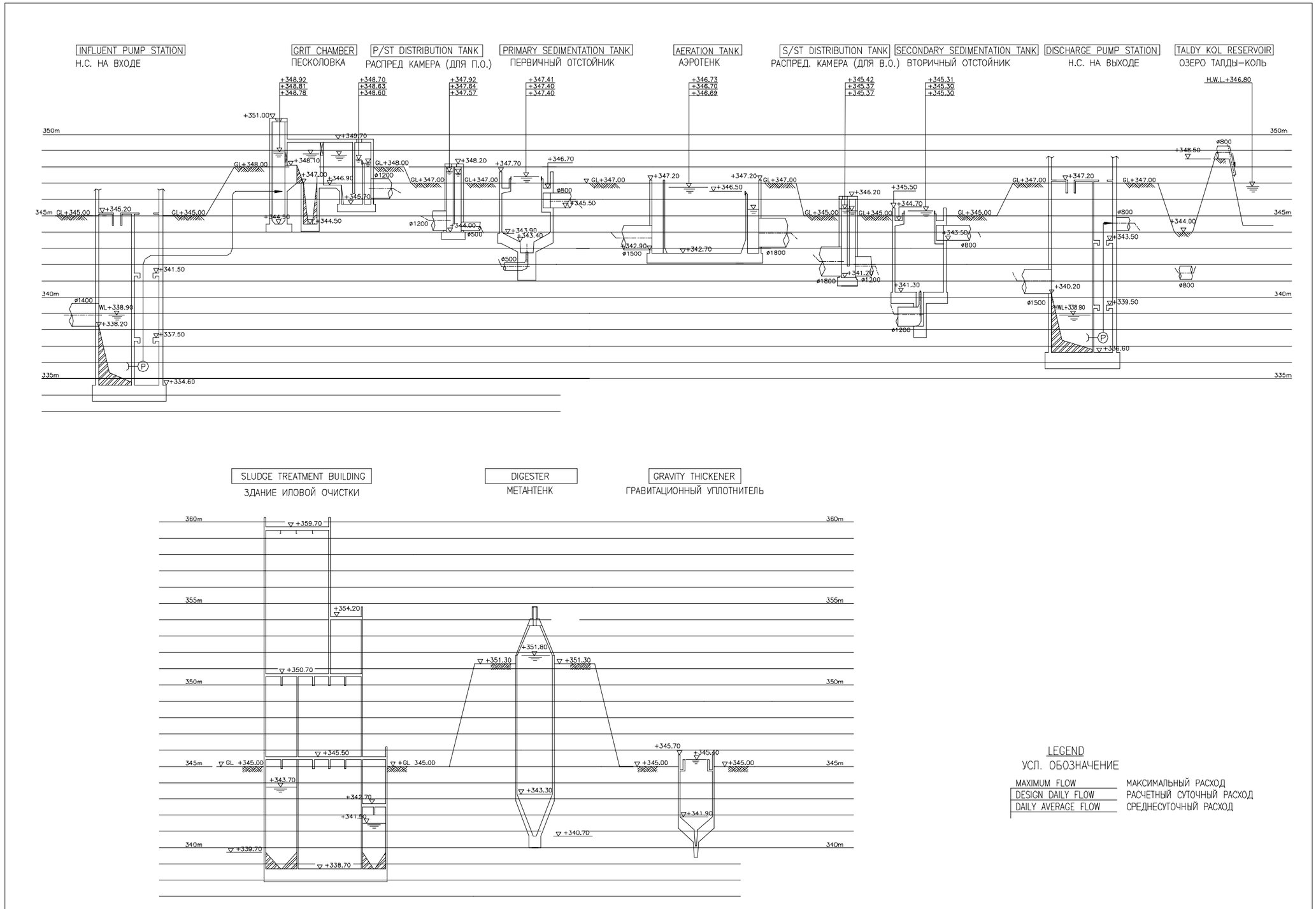


Figure 6.1.4 Plant Hydraulics

6.2 Intermediate Pump Station

6.2.1 Design Policy

The improvements for 17 pump stations are to be made considering the following:

- Mechanical and electrical equipment with necessary appurtenances
- Architectural structure, ventilation, and working circumstances
- Flow measurement and control system

6.2.2 Intermediate Pump Station

(1) Intermediate pump stations to be improved

Table 6.2.1 List of Sewage Pump Stations to be Improved (PS: pump station)

No	Station No.	Location (address)
1.	PS No.1	Beginning of the Abai Ave., the district of the "Moskvich" cooperative
2.	PS No.2	Geroi Krasnodona Str.
3.	PS No.3	Beisekova-Orenburskaya Str.
4.	PS No.4	Ugolnaya Str. – overpass No.2
5.	PS No.6	District of the "Koktal" settlement
6.	PS No.7	"Molodezhnyi" micro-district
7.	PS No.10	"Agromash" Plant – railway-carriage repair plant
8.	PS No.11	Hospital, Abylai-Khan Ave. 3/3
9.	PS No.15	"Tselinnyi"micro-district
10.	PS No.16	Skladskaya Str. 11
11.	PS No.17	"Block 72", beginning of the Moskovskaya Str.
12.	PS No.21	"Prigorodnyi" settlement
13.	PS No.24	Moskovskaya Str. 21/1
14.	PS No.28	"Avtomatika" industrial workshop
15.	PS No.34	PDU settlement – Astrakhansky settlement
16.	PS No.37	Kotovsky Str.
17.	PS No.IH	Isolation hospital

(2) Rehabilitation Requirements

Summary of the rehabilitation work is shown in Table 6.2.2 for 13 intermediate pump stations. (No1 ~13 in Table 6.2.1) With regard to the No.14 ~No.17, they need whole facility rehabilitation (refer to 4).

Table 6.2.2 Summary of Intermediate Pump Station Repair Work

Item	Description		
	Specification	Quantity	Unit
Mechanical			
1. Replacement of the sewage pump	Horizontal/submersible	54	units
2. Replacement of the drain pump	Submersible	14	units
3. Replacement of the fine screen	Mechanical bar screen	7	units
4. Replacement of the screenings grinder	Double-cutter type	8	units
5. Replacement of the hoisting device	Geared trolly/motorized	16	units
6. Replacement of the motor valve	Motorized gate valve	15	units
7. Replacement of the ventilation fan	Intake/exhaust	28	units
8. Replacement of the pipelines/plumbing		17	Lump sum
Civil and Architectural			
1. Rehabilitation of the civil portion	RC surface rehabilitation Substructure	13	Lump sum
2. Rehabilitation of the architectural portion	Roof, wall, door, finish and etc.	13	Lump sum
3.Rehabilitation of the utility	Heating, ventilation, water supply	13	Lump sum
4.Construction of manhole pump station structure	In-situ concrete, caisson type	4	Lump sum
Electrical			
1. Installaton of the power meter		17	sets
2. Replacement of the starter/control system		17	sets

1) Mechanical Equipment (No1 ~13 in Table 6.2.1)

Since horizontal vortex type pump is used for the existing intermediate pumping stations, application of submersible pump for rehabilitation of these facilities is difficult from the viewpoint of shape of pump pit and rehabilitation/installation of screens. Further, horizontal vortex type has higher efficiency than submersible pump. From these reasons, rehabilitation of existing pump station will be made using horizontal type pumps.

- Replacement of the sewage pump units
- Replacement of the mechanical rakes and hoisting devices
- Replacement of the suction and pressure pipeline
- Replacement of the various valves

2) Electrical Equipment (do.)

Installation of sewage flow meter and electric power meter

- Replacement of the starter and control system
- Monitoring of the operation and information transfer

3) Civil/Architectural Work (do.)

- Repair of the roofing and finish (plaster work)
- Protection of underground walls with the waterproof materials
- Replacement of the ventilation, the heating system, the internal water pipe line and the sanitary facilities
- Replacement of the entrance doors and the internal space

4) Whole facility rehabilitation (No.14~17 in Table6.2.1)

Whole facility rehabilitation including structural construction is necessary for four (4) inter mediate pumping stations because of the magnitude of the damages. Four (4) manhole type pump stations with a capacity of 50 m^3/hr shall be rehabilitated covering structure and pump facilities. There are 2 units of pump including one unit of stand-by pump. Automatic water level switch shall be provided for operation of pump unit. Control panel for the pump shall be installed in the reinforced concrete box to protect electrical equipment under the severe climate and in security reason. For these intermediate pump stations, manhole type in use of submersible pump shall be applied.

- PS No. 28 (Avtomatika settlement)
- PS No. 34 (PDU settlement – Astrakhansky highway)
- PS No. 37 (Kotovsky Str., 1)
- PS IH (Isolation hospital)

6.3 Sewers

6.3.1 Design Policy

Rehabilitation of 16 sections of sewers are to be conducted using suitable materials.

6.3.2 Design of Sewers

(1) General

Although the number of pipeline sections was fifteen (15) in the F/S, some of the proposed sewers were already replaced and/or rehabilitated by ASA after the F/S. Reflecting the updated information, 16 sections of sewers that require urgent rehabilitation were identified and selected through the discussion with ASA. Detailed routes were determined by the Astanagenplan that is an authority responsible for the general urban planning.

The proposed rehabilitation work has to be designed according to the regulation with rational diameter, depth and suitable material. Hydraulic calculation will be made to ensure design flow.

(2) Sewer alignment

The proposed sewers among the existing sewer networks are shown in Figure 6.3.1 and Table 6.3.1.

Five (5) pipelines out of 16 pipelines are the gravity flow while the others are pressure lines from the intermediate pump stations. The total length of the planned sewer routes is 15.9km and the pipe diameter varies from 100mm to 800mm with a total pipe length of 21.0 km.

Special considerations are made for the crossing of river and railroad. A double-pipeline installation is necessary where crossing the river under the ground regardless of the flow characteristics in the pipeline. In case of the railroad crossing, installation shall be done by pipe jacking method with double pipelines for pressure line (Single pipeline is allowed when it is gravity flow).

(3) Design Service Area

Referring to the New Capital Development Master Plan, the design service area is determined to meet development plan for the year 2010. The area for the sewer is 24,800ha.

Figure 6.3.1 Pipeline Locations

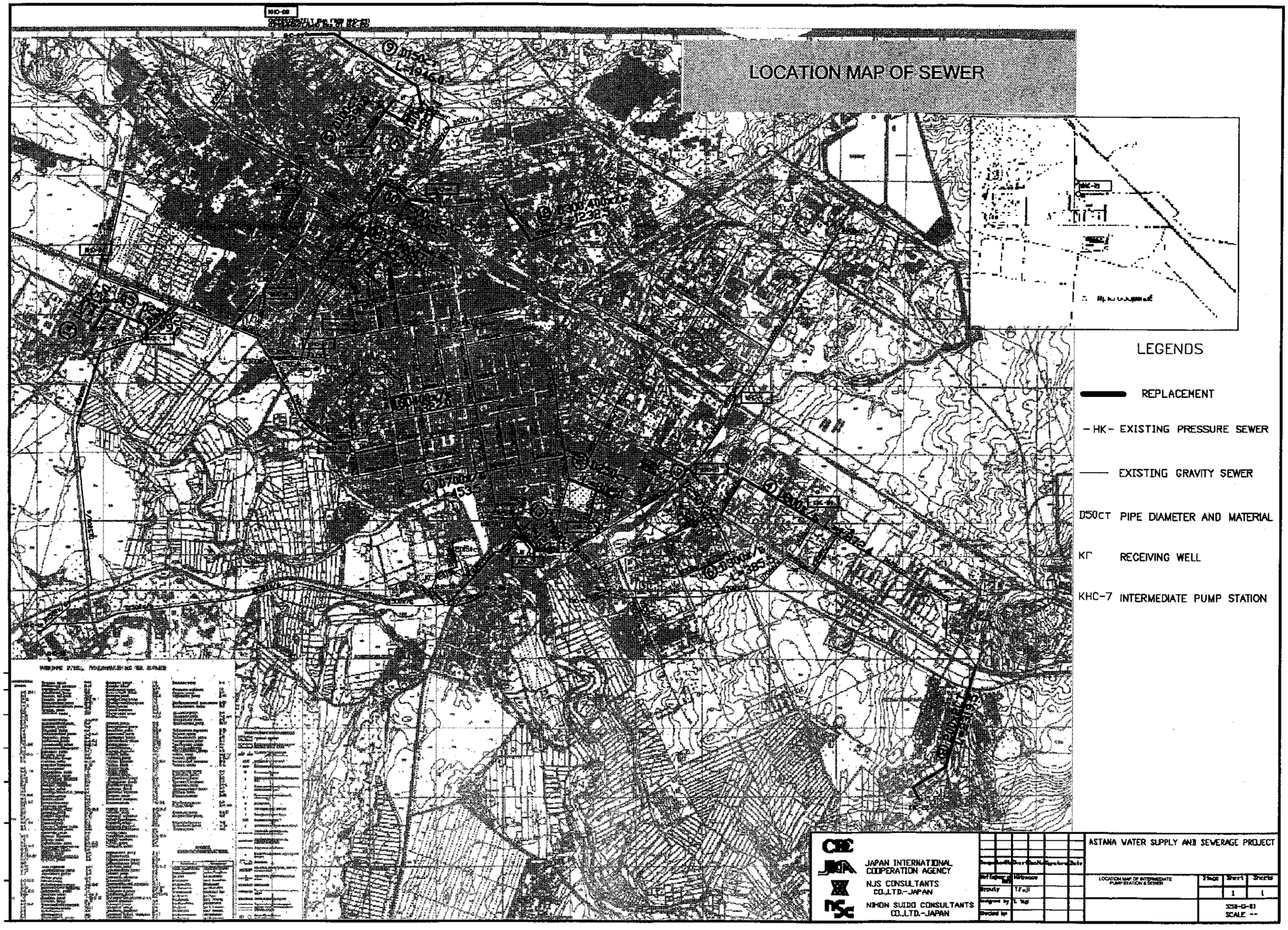


Table 6.3.1 List of Proposed Sewer Network

Line	Pipe Dia. (mm)	Route Length (m)	Categories
1	700	453.5m	Gravity flow
2	250	807.0m	Pressure line
3	250x2	333.0m	Pressure line
4	800	1872.4m	Gravity flow
5	100	995.0m	Pressure line
6	300	385.5m	Gravity flow
7	100	857.1m	Pressure line
8	200x2	2,325.5m	Pressure line
9	150	1,950.0m	Pressure line
10	500x2	1,693.5m	Pressure line
11	300	759.8m	Pressure line
12	300	435.5m	Gravity flow
	400	797.0m	
13	300	755.0m	Pressure line
14	250	412.0m	Pressure line
15	250x2	773.0m	Pressure line
16	400	322.0m	Gravity flow
Total		15,926.8m 20,989.5m	Route Pipeline

(4) Design Sewage Flow

According to the Master Plan and the Feasibility Study the design daily maximum sewage flow in 2,010 is assumed to be 112,300 m^3/day.

The daily average and the maximum hourly sewage flow are 89,800 m^3/day and 157,200 m^3/day, respectively (refer to Table 6.3.2).

Table 6.3.2 Design Sewage Flow

Design Sewage Flow	Flow Rate	Flow (m^3/day)	Flow (m^3/sec)
Daily Average Sewage Flow	0.80	89,800	1.039
Daily Maximum Sewage Flow	1.00	112,300	1.300
Maximum Hourly Sewage Flow	1.40	157,200	1.819

(5) Design Sewage Flow for STP

The capacity of the existing sewage treatment plant is 136,000m^3/day and the design treatment capacity is determined to meet this capacity (refer to Table 6.3.3)

Table 6.3.3 Design Sewage Flow for STP

Design Wastewater Flow	Flow Rate	Flow (m^3/day)	Flow (m^3/sec)
Daily Average Sewage Flow	1/1.2	114,000	1.319
Daily Maximum Sewage Flow	1.00	136,000	1.574
Maximum Hourly Sewage Flow	1.47	200,000	2.315

(6) Sewage Collection Area

Referring to the New Capital Development Master Plan the sewer networks are designed in the concept that one main intermediate pump station serves one sub-service area. Consequently, the design service area is divided into six sub-service areas. The area and population by sub-service area are determined as shown in Table 6.3.4.

Table 6.3.4 Sub-Service Area and Design Sewage Flow

No.	Name of Collection Area	Area (ha)	Population (Person)	Maximum Hourly Sewage Flow (m^3/sec)
1	KHC-6	8,250	163,000	0.605
2	KHC-52	3,100	61,250	0.227
3	KHC-50	2,800	55,320	0.205
4	KHC-4	1,350	26,670	0.099
5	KHC-53	3,500	69,150	0.256
6	KHC-7	5,800	114,610	0.427
Total		24,800	490,000	1.819

(7) Sewer Design Conditions

1) Hydraulic Calculation Formulas

The Manning's formula is adopted for the design of gravity sewer, while Hazen William formula is adopted for the pressure main. The standard coefficients to be used for the type of material are given in Table 6.3.5.

Manning's Formula:

$Q = A \times V$

$V = 1/n \, R^{2/3} \, S^{1/2}$

Q = Discharge in m^3/sec
V = Velocity in m/sec
N = Roughness Coefficient
R = Hydraulic Radius (m)
S = Slope of the Sewer Line
A = Sectional Area (m^2)

Hazen William Formula:

$Q = A \times V$

$V = 0.84935 \, C \, R^{0.63} \, I^{0.54}$

Q = Discharge in m^3/sec
V = Velocity in m/sec

C = Flow Velocity Coefficient
R = Hydraulic Radius (m)
I = Hydraulic Gradient
A = Sectional Area (m^2)

Table 6.3.5 Coefficient for Sewer Design

Type of Pipe	N (Roughness Coefficient)	C (Flow Velocity Coefficient)
Concrete Pipe	0.013	110
PVC Pipe/ Plastic Pipe	0.010	110
Coated Steel Pipe	0.010	110
Cast Iron Pipe	0.013	110

1) Depth of Flow

All sewers are to be designed to accommodate 80% of the full flows.

2) Velocity and Gradient

Sewers are designed in accordance with the grand gradient for economic construction. The range of velocity of the sewage flow in sewer is to be from 0.6 m/sec to 3.0 m/sec.

3) Minimum Cover Depth

In accordance with SNiP, the minimum cover depth is to be 2.8m at pipe bottom.

(8) Pipe Material

Existing types of pipe materials are cast iron, asbestos, ceramics, steel, reinforced concrete and polyethylene. As to the rehabilitation of the proposed sewers, reinforced concrete pipes are adopted for gravity sewers and cast iron pipes for pressure mains.

(9) Construction Method

Excavation not exceeding 4.0m shall be done by open cut with side slopes as shown Fig 6.3.2. While, excavation exceeding 4.0m shall be done with temporary retaining wall and strutting as shown in Figure 6.3.3

Application of “well points” shall be a standard practice for dewatering groundwater in sewer trenches. A diagram showing a method of setting up well points and pump unit is shown in Figure 6.3.4. It is common to use 2-inch well points connected to a 6-inch header pipe or manifold, all connected to a self-priming centrifugal pump.

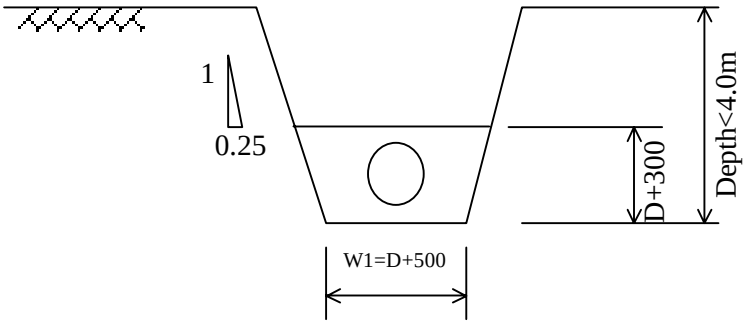


Figure 6.3.2 General Excavation Section up to 4.0m deep

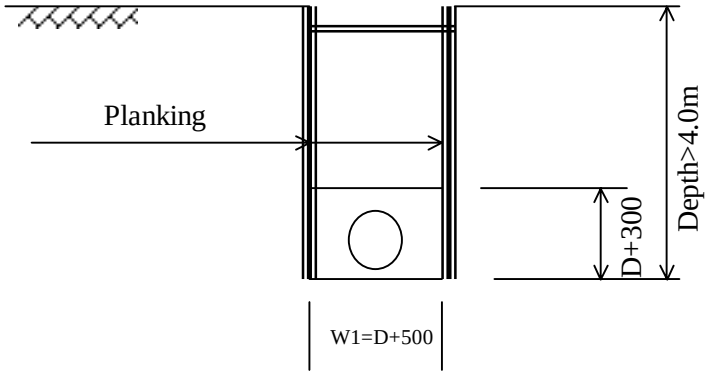


Figure 6.3.3 General Excavation Section Exceeding 4.0m deep

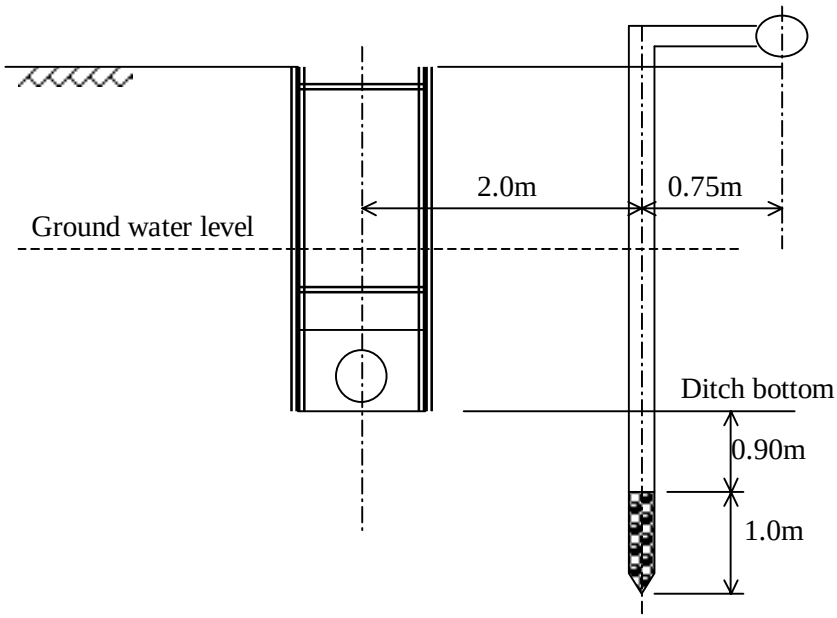


Figure 6.3.4 Well Point System Diagram

The spacing of the well points depends on the amount of groundwater anticipated (from 1.5m to 2.0m centers are common). Although the principles applicable to the design of water wells are equally applicable in the determination of the capacity of well points for drainage purposes, field tests in place will probably give more satisfactory information on which to estimate the number of points and capacity of pump units to use.

(10) The arrangement of the pipes underground

The alignment of the pipes shall follow the plan of the Astanagenplan. Arrangement of plan and profile shall be as follows;

1) Gravity pipeline

The gravity pipeline shall be the same bottom elevation with the existing pipeline in consideration of connection with existing branch pipeline for households (The slope of the pipeline may differ with each section because of this reason).

2) Pressure pipeline

All the start points of a pressure pipeline are intermediate pumping stations. A manhole for the branch shall be built at the distance of 5m from the branch point of the existing pipe. In case of full new construction, flange junction shall be placed at the point of 3m away from the intermediate pump station. Bend pipe shall be used to clear the obstacles vertically in case there is an underground structure.

(11) Arrangement for the road plan

In Astana city, extension and rehabilitation of the road is implemented every year based on the plan of Astanagenplan. All the pipelines that shall be constructed or rehabilitated need arrangement with the road plan.

(12) Railroad crossing

The railroad crossing adopts jacking method or open-cut method depending on the location and topographical feature. Casing pipe as an outer cover for pipeline shall be used under the railroad. Gravity pipeline is allowed to be single pipe installation, while pressure pipeline should have two pipelines under the railroad. The manholes with the sluice valve for the maintenance shall be installed on both sides of rail crossing. Earth cover shall follow the standard of SNiP.

(13) River crossing

The part of river crossing adopts one of jacking method and the open cut method of construction according to the situation of a field. Also in which case, a main pipe is put into a casing pipe under of a river. In the case of a gravity pipeline, there is one pipe. In the case of a pressure pipeline, there are tow pipes. The manholes of the sluice valve are made on both sides of river crossing. These are in compliance to the standard of SNiP.

6.3.3 Outlines of Design

(1) Route No.1

The flow of the route No.1 is gravity flow and pipe diameter is 700mm. The new pipeline shall be installed adjacent to the existing pipeline. The slope was adjusted to allow connections from the existing branch pipelines. Temporary retaining wall shall be used for all the sections of this route, since the depth of excavation exceeds 5m.

Cast iron pipe D700 x 453.5m Gravity Flow

(2) Route No.2

The flow of the route No.2 is pressure line and pipe diameter is 250mm. The start point of the pipeline is the intermediate pumping station (KHC-14), and the end point is existing manhole.

Cast iron pipe D250 x 807.4m Pressure Flow

(3) Route No.3

The route No.3 is double pressure line and pipe diameter is 300mm. The start point of the pipeline is the intermediate pumping station (KHC-11), and the end point is existing manhole. Almost of all the length of the route falls on river crossing. In accordance with the standard of SNiP, the main pipe is installed inside of the casing pipe in river crossing.

Cast iron pipe D300 x 2 x 333.0m (329.0 (x 2) + 4.0 gravity) Pressure Flow

(4) Route No.4

According to the plan of Astanagenplan, the road of this route will be rebuilt in 2006. The route No.4 is single gravity line with pipe diameter of 800mm against existing 600mm. The new pipeline shall be installed along the existing pipeline. The slope of the new pipeline shall be adjusted to connect the branch pipeline.

Cast iron pipe D800 x 1,879.7m Gravity Flow

(5) Route No.5

This pipeline is single pressure pipeline with pipe diameter of 100mm. The new pipeline shall be installed adjacent to the existing pipeline. This pipeline crosses a railroad at the point about 300m away from the intermediate pumping station (KHC-16). At the railroad crossing section, double main pipes shall be installed in the casing pipe in accordance with the standard of SNiP.

Cast iron pipe D100 x 995.0m Pressure Flow

(6) Route No.6

This is the gravity flow pipeline with pipe diameter of 300 mm. A new pipeline shall be along the existing pipeline. The slope shall be adjusted in consideration of branch connection.

Cast iron pipe D300 x 385.5m Gravity Flow

(7) Route No.7

Route No.7 pipeline is pressure pipeline with pipe diameter 100 mm from the existing intermediate pumping station (KHC-27). The end point is an existing manhole. This pipeline crosses a railroad at the point about 300m away from the intermediate pumping station. The method of railroad crossing is same as other crossings.

Cast iron pipe D100 x 857.1m Pressure Flow

(8) Route No.8

Route No.8 pipeline is double pressure type with pipe diameter of 200mm from the existing intermediate pumping station (KHC-22). The existing pipeline delivers the sewage to the infiltration facility in the south.

Cast iron pipe D200 x 2 x 2,325.5m (2,319.5 (x 2) + 6.0 gravity) Pressure Flow

(9) Route No.9

Route No.9 is single pressure pipeline with pipe diameter of 150mm from the existing intermediate pumping station (KHC-29). The route passes the steppe to the existing manhole.

Cast iron pipe D150 x 1,950.0m Pressure Flow

(10) Route No.10

Route No.10 is double pressure pipelines with pipe diameter of 500mm from the existing intermediate pumping station (KHC-10). There are one river crossing and three railroad crossings along this route. The method of construction is pipe jacking method for the main railway crossing. In other locations of crossings, open cut method is used because of not frequent use of the railroad.

Cast iron pipe D500 x 2 x 1,645.2m Pressure Flow (Open Cut, Jacking)

Cast iron pipe D500 x 43.3m Pressure Flow (Open Cut)

Cast iron pipe D800x 5m Gravity Flow

(11) Route No.11

The route No.11 is single pressure pipeline with pipe diameter of 300mm from intermediate pump station No.5 (KHC-5). The intermediate pumping station has been rehabilitated as of September 2003. The route passes along the Povedy Ave. after crossing Akzhaik St, and turns towards the existing intermediate pumping station (KHC-2). The pressure line shall connect to the existing pressure line from intermediate pumping station (KHC-2).

Cast iron pipe D300 x 759.8m Pressure Flow

(12) Route No.12

The route No.12 is single gravity pipeline of pipe diameter of 300mm(435.5m) and 400mm(797.0m). The diameter was changed from 600mm at the basic design stage after the field survey and discussion with ASA in the detailed design.

Cast iron pipe D300 x 435.5m Gravity Flow
Cast iron pipe D400 x 797.0m Gravity Flow

(13) Route No.13

The route No.13 is single pressure pipeline of pipe diameter of 300 mm. This pipeline updates the pressure pipeline from the existing intermediate pumping station (KHC-8). The new pipeline shall be installed adjacent to the existing pipeline. The end point is an existing manhole near the intermediate pumping station (KHC-7).

Cast iron pipe D300 x 755.0m Pressure Flow

(14) Route No.14

The route No.14 is single pressure pipeline with pipe diameter of 250 mm. This pipeline is pressure pipeline between existing intermediate pumping station (KHC-35) and the intermediate pumping station (KHC-36). It shall be installed parallel to the existing pipeline.

Cast iron pipe D250 x 412.0m Pressure Flow

(15) Route No.15

This pipeline is a double pressure pipeline with a diameter of 250mm between existing intermediate pumping station (KHC-36) and the intermediate pumping station (KHC-6). It was planed parallel to the planned road. The end point of the pipeline is the existing manhole near the intermediate pumping station (KHC-6).

Cast iron pipe D250 x 2 x 773.0m (769.0 (x 2) +4.0 gravity) Pressure Flow

(16) Route No.16

This is the gravity flow pipeline with diameter of 400mm to cover depressed area of the Dehangildina.St. A new pipeline collects rainwater from the existing manhole.

Cast iron pipe D400 x 322.0m Gravity Fow

6.4 Civil and Architectural Work

6.4.1 Civil Work

(1) Inlet chamber

Work for the Inlet chamber includes rehabilitation of the inside wall of the structure and extension of the underground RC chamber for installation of gate. The size of the gate is 1400 mm in rectangular shape. This new gate shall be installed to stop the inflow and to divert the flow to the temporary pump station (TPS) for drying up the pump well at the existing pump station.

(2) Inlet pipe and Temporary Intermediate pumping station (TPS)

After the divergence from inlet chamber by the pipeline with a diameter 2000mm, the sewage flows into the manhole to which the new inflow pipe will be connected in the future to accommodate at the STP with a total flow of 200,000m^3/d. The pipe with a diameter of 2000mm is expanded up to the TPS pump well from the manhole. Specification of TPS is as follows;

- Pump well/manhole diameter: 6000mm
- Pump unit: three (3) units of submersible pump (diameter 500mm)
- Depth of TPS: 9.027m (from the ground surface)
- Pressure pipeline from TPS to grid chamber (diameter 1200mm)

TPS is connected to KHC-12 PS with a new inlet pipe (diameter of 1400 mm). After the dismantlement of temporary pump units, the pump well shall work as a manhole.

(3) Existing Influent Pump Station (KHC-12)

Aside from the replacement of the equipment and rehabilitation of the structure, new inlet pipe with a diameter of 1400mm shall be installed from TPS to KHC-12. In the pump well, alignment of flow channels is required to make smooth flow to screen (refer to Figure 6.4.1).

(4) Aeration tank (AT)

Rehabilitation work for the AT is limited to the repair of structural surface, suction pipe connection of the return sludge pump and conduit connection to and from SST. Since the work needs dry condition in the facilities, careful arrangements are required as discussed in

the previous sub-section.

(5) Discharge pumping station (KHC-13)

In addition to the replacement of the equipment and rehabilitation of the structure, a stop gate shall be newly installed (1500×1500 mm).

(6) Sludge treatment building and Hopper house

Sludge cake hopper to carry sludge out of the STP shall be furnished in the hopper house ($15m^3$ each for 6 units; refer to Figure 6.4.2). Biological scrubber system shall be employed to avoid dispersion of odour and be installed in the sludge treatment building. Exhaust of treated gas shall be discharged from the rooftop of the hopper house to avoid odour problem in the sludge treatment building.

6.4.2 Architectural Work

(1) Outlines of Architectural Work

Outlines of buildings in Sewage Treatment Plant are shown in Table6.4.1.

Table6.4.1 List of Buildings in Sewage Treatment Plant

Item / Building Name			Area (m^2) Building Area	Total Floor ●	Total Floor ○	Building Dimension L x W	Stories	Structure
S02	○	Influent Pump Station	432.42	-	864.84	24.0x18.0	2	-
S03	●	Grit Chamber	86.40	86.40	-	7.2 x 12	1	PC
S06	○	Primary Sludge Pump House	58.76	-	58.76	R=4,325	1	-
S08	○	Blower House	864.00	-	1,728.00	48x18	2	-
S11	●	Return Sludge Pump House	432.00	864.00	-	36 x 12	1+B	RC
S12	○	Discharge Pump Station	432.42	-	864.84	24.0x18.0	2	-
S22	○	Thickened Sludge Pump House	58.76	-	58.76	R=4,325	1	-
S23	○	Digester & Pump House	44.75	-	44.75	R=3,775	1(+B)	-
S24	●	Sludge Treatment Building	1,412.50	3,756.75	-	45 x 31	2+B	RC
S25	●	Hopper House	358.82	717.65	-	23.15x15.5	2	RC
S26	○	Gas Holder	227.58	-	227.58		1	-
S27	○	Boiler House	455.29	-	956.54		2(3)	-
S28	●	Electrical House	121.50	121.50	-	13.5 x 6.5	1	PC
S29	○	Administration Building	150.00	-	300.00	15 x 10	1	-
		Total Floor Area		6,411.14	2,094.96			

●: New Construction ○: Rehabilitation
B: Basement of Building Scope (B): Basement of Civil Scope
RC: Reinforced Concrete structure PC: Pre-cast Concrete Structure

(2) Sludge Treatment Building

1) General

The Sludge Treatment Building is located beside the Hopper House. This Building has an important function of the controlling; managing, operating and maintenance of the sewerage system. Moreover this building should be designed not only for function mentioned above but also for pleasant working environment in the facilities.

2) Building Outline

The Sludge Treatment Building is reinforced concrete structure with 45m wide and 31m long, 2 stories with basement floor,.

The building has flat roofs with 2% slope and an arched skylight, and the rain or snow flow out through rain drains and downspouts.

Arched skylight that is composed of polycarbonate and the corrugated metal sheet is located on the roof of the dewatering room. Windows; top-hinged out swinging type, are provide near the skylight for the natural ventilation. Then the catwalk with ladder is required for opening and closing of these windows.

External brick wall thickness is 470 mm with the insulation100 mm thickness and external wall finishing is the exposed fine brick. The internal main finishing is as follows:

Floor: Vinyl sheet, Ceramic tile, Concrete screed finishing

Wall: Cement sand plaster with paint

Ceiling: Acoustic tile, Exposed concrete with paint

The building can be divided into two zones; control zone and operating zone.

3) Numbers of Personnel in Sludge Treatment Building

The number of personnel expected to be in the Sludge Treatment Building is shown in Table 6.4.2.

Table 6.4.2 Number of Personnel in Sludge Treatment Building

Room	Day time	Night time	Total	Remarks
Manager	1	0	1	
Technical engineer	1	0	1	
Mechanical engineer	1	0	1	
Electrical engineer	1	0	1	
Documentation staff	3	0	3	
Worker	2	0	2	
Operating chief	1	0	1	
Chemical operator	1	0	1	
Thickener operator	1	0	1	
Dewatering operator	1	0	1	
Sludge cake operator	1	0	1	
Shift operating chief	1	1	4	1person x 2shifts x every 2days
Thickener & chemical operator	1	1	4	1person x 2shifts x every 2days
Dewater & sludge operator	1	1	5	1person x 2shifts x every 2days + 1p stand by
Total	17	3	27	

4) Building Functional Components

The space component for this building is divided into three areas to be utilized by the different function below.

a) Tank Area

Tanks for treatment of sewerage system are located at the basement floor.

b) Operating Area

Operating Areas are the prime one of this building and are located at the first floor with 45m wide, 23m long, 5.2m floor height and at the second floor with 21m wide, 23m long, 9m floor height.

c) Control Area

Control zone has two functions; managing of whole and supporting for the operation of the

water treatment plant. This zone is located at the first floor and the second floor.

Functional component diagram is shown in Figure 6.4.1.

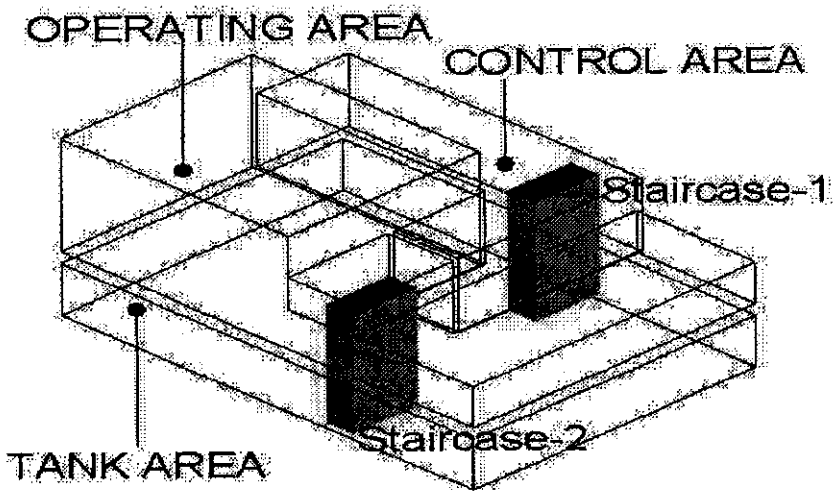


Figure 6.4.1 Conceptual Area Diagram

5) Required Rooms in Control Area

Space requirement for rooms is in accordance with SNiP 2.09.04-87- Administrative and Accessory Buildings except the monitor room.

a) Monitor Room

Sewerage treatment system is monitored in the monitor room around the clock by a two (2) shift system. The free access floor is adopted

b) Offices

Manager room: Assuming a space requirement of 6 m^2 per person, the required area is 6m^2. (6 x 1 = 6 m^2) In addition the space is required for dealing with people. Adapted area located at the second floor is 19.63 m^2.

Engineer Room: The room is for the technical engineer, the electrical engineer and the mechanical engineer. Assuming a space requirement of 6 m^2 per person, the required area is 18m^2. (6 x 3p 18m^2) Adapted area located at the second floor is 35.7 m^2.

Documentation staff room: The room is for one staff and for space of documentations. Assuming a space requirement of 6 m2 per person, the required area is 18m^2. (6 x 3p = 18 m^2) Adapted area located at the second floor is 16.07 m^2.

Operating staff room-1: The room located at the first floor is required for 11 women operators on the shift system. The room is used as the internal meeting space, the resting space with the large table and as the locker space.

Assuming a space requirement of 2 m^2 per person, the required area is 22m^2 (= 2 x 11p). Adapted area located at the second floor is 48m^2.

Operating staff room –2: The room located at the first floor is required for 6 men operators on the shift system. The room is used as the internal meeting space, the resting space with the large table and as the locker space.

Assuming a space requirement of 2 m^2 per person, the required area is 12m^2. (6 x 2p = 12 m^2) Adapted area located at the second floor is 32.00 m^2.

c) Utility Spaces

Required space for Utilities is calculated in accordance with SNiP 2.09.04-87 " Administrative and Utilities Building"

Toilet and Shower Booth:

Number of user for Toilet

Respective toilets for women and for men are located at the first floor and the second floor. Number of utility equipment covers all personnel in whole facilities. Number of men and women for the design is determined referring to present data.

Number of personnel required: 110 persons

Number of present male staff: 57 persons

Number of present female staff: 32 person

Number in Shift System (Two shift system, every two days): 17p x 4 = 68 persons

Number of personnel in daytime on design: 110 p – (17p x 3) = 59 persons

Number of men on design: 59 x (57 / 88) = 32 men

Number of women on design: 59 x (32 / 88) =21 women

Number of equipment for Toilet

Number of equipments is calculated in accordance with SNiP 2.09.04-87 " Administrative and Utilities Building"

Number of closets and urinals for men are respectively three (3).

Number of closets for women is two (2).

(3) Hopper House

The Hopper House is connected to the Sludge Treatment Building on the second floor of the both buildings by the connecting corridor.

1) Building Outline

The Hopper House is 2-story reinforced concrete structure with dimensions of 21m wide and 15m long. The building has flat roofs with 2% slope and an arched skylight and the rain or snow would flow out through rain drains and downspouts.

External brick wall thickness is 470 mm with the insulation100 mm thickness and external wall finishing is the exposed fine brick. The internal main finishing is as follows.

- Floor: Concrete Screed finishing
- Wall: Cement Sand Plaster with Paint
- Ceiling: Exposed Concrete with Paint

The skylight mentioned in Sludge Treatment Building is provided on the roof of Hopper House. Same design element is given an impression of unity of the two buildings.

2) Required Space

Sludge Hopper Room: The space and the opening for access of truck to the first floor are required. The first floor has the slope with 1% for washing away the sludge cake.

(4) Return Sludge Pump Station

1) Building Outline

The Return Sludge Pump Station, reinforced concrete structure (1 story with basement floor), is 36m wide and 12m long. The building has the flat roof with 2% slope and the

rain or snow would flow out through rain drains and downspouts.

External brick wall thickness is 470 mm with the insulation100 mm thickness and external wall finishing is the exposed fine brick. The internal main finishing is as follows.

- Floor: Concrete Screed finishing
- Wall: Cement Sand Plaster with Paint
- Ceiling: Exposed Concrete with Paint

2) Required rooms

- First floor: Monitor Room, Electrical room
- Basement floor: Pump room

(5) Grit Chamber

The Grit Scrubber room, Pre-cast concrete structure with the dimensions of 7.2m wide and 12m long, is built on the Grit Chamber that is the scope of civil work. The building floor level is 1.7 m above ground level. The building has the flat roof with 2% slope and the rain or snow would flow out through rain drains and downspouts.

External brick wall thickness is 470 mm with the insulation100 mm thickness and external wall finishing is the exposed fine brick. The internal main finishing is as follows.

- Floor: Cement mortar
- Wall: Cement sand plaster with paint
- Ceiling: Cement sand plaster with paint

(6) Electrical House

The Electrical House, 1 story pre-cast concrete structure, is 13.5m wide and 9m long. The building has the flat roof with 2% slope and the rain or snow would flow out through rain drains and downspouts.

External brick wall thickness is 470 mm with the insulation100 mm thickness and external wall finishing is the exposed fine brick. The internal main finishing is as follows.

- Floor: Light weight concrete
- Wall: Cement sand plaster with paint
- Ceiling: Cement sand plaster with paint

(7) Rehabilitation Work

1) Subject Building

Existing buildings for rehabilitation and renovation works are as follows.

- S29 Administration Building (Renovation)
- S02 Influent pump station (Rehabilitation)
- S06 Primary sludge pump house (Rehabilitation)
- S08 Blower house (Rehabilitation)
- S22 Thickened sludge pump house (Rehabilitation)
- S23 Digester & Pump house (Rehabilitation)
- S26 Gas holder (Rehabilitation)
- S27 Boiler house (Rehabilitation)

2) Scope of Rehabilitation Work

- Repair of leaking place at Roof
- Inspection the roof leaking place based on the user's information
- Repaired place is one (1) square meter area around leaking point
- Specifications for repair work is same as the existing one.
- Painting of External Wall, Internal Wall, All Doors and Windows

- -Removing of existing coated surface completely.
- -Repairing surface damaged
- -Cleaning surface of materials

- Performing three coating (Primer, Intermediate, Topcoat)
- Exchange or Repair of Damaged Door and Window (included Glass)
- To exchange door or window not functioned
- Exchange or Repair of Water Supply pipe and Drainage Pipe
- Pipes exchanged are End-of-life (25 years)
- Exchange or Repair of Heating Equipment and Pipe
- Pipes and equipments exchanged are End-of-life (25 years)

3) Scope of Renovation for S29 Administration Building

- Demolish of existing internal wall and floor finishing for re-planed room layout.
- Construction the internal wall for re-planed room layout.
- Finishing of wall and floor and replacing utilities based on rearranged room layout.

- Painting of External and Internal Wall

6.5 Rehabilitation of Architectural Part for Sewerage Work

6.5.1 Intermediate Sewage Pump Station

(1) General

The conditions of architectural, structural and utility elements of intermediate sewage pump stations were examined to determine the extent and grade of the rehabilitation work to be done in this project. This work excludes the investigation of the mechanical/electrical equipment that is studied in different section.

Seventeen (17) intermediate pump stations are subject to rehabilitation work in this project. Thirteen (13) intermediate pumping stations were selected by ASA for the rehabilitation (No.1, 2, 3, 4, 6, 7, 10, 11, 15, 16, 17, 21, 24). While, remaining four (4) pump stations were those for re-construction applying manhole type pump stations because of extreme deterioration. (No.28, 34, 37, IH)

The intermediate pumping stations mentioned above were constructed in different years since 1960 and they have been operating for last 20-40 years. They are categorized into 3 groups in terms of pump well size as follows:

i) Small PS - (No.11, 15, 16 , 17, 21, 24) - diameter of the pump well - up to 6.0 m.

ii) Medium PS-(No.1, 2, 3, 4, 6, 10) - diameter of the pump well -up to 16m.

iii) Large PS - (No. 7) - diameter of the pump well - 24 m.

Present conditions of the pump facilities were examined resulted in findings from unsatisfactory (PS No. 16) to relatively good (PS No.7). All PSs situated in the city boundaries must be an architectural type to meet regulations in sanitary protection zone and the requirements of city planning. In this regard, only PS No. 7 meets these requirements. No major replacement of equipment took place in the past since their construction, except for minor repair. Therefore, a large-scale overhaul is required, such as reconstruction of pump stations. Common problems to the intermediate pumping stations are as follows:

i) No data available on the facilities and no existence of O&M manuals

ii) Absence of devices necessary for operation and control of facilities results in occasional flooding and break down of the equipment.

(2) Rehabilitation Work for Respective P/Ss

1) PS No.1 (Abai Avenue, the district of cooperative society " Muscovite ")

The pump well is circular type (D=16,0 m), while the superstructure is rectangular shape (12.0 m x 24.0 m). The joint of substructure and superstructure is located below the ground level. The structure of the joint is not waterproof.

The following are requirements: provision of waterproof, partial restoration of the floor in the dry pump pit, major overhaul of the facade of the building, the roof, internal premises, and partial replacement of the cold water pipe, domestic sewerage system, heating and ventilation. The fence is provided covering the lot of PS.

2) PS No.2 (Heroes of Krasnodon street)

The PS No.2 is one of the oldest pump stations. The configuration of the facility is circular (D=9.0 m). The required rehabilitation work includes the following: internal waterproofing to the underground facility, replacement of wooden removable floors, major overhaul of the facade of the building, the roof, window and door blocks, partial replacement of the cold water pipe, domestic sewerage system, heating and ventilation.

3) PS No.3 (Beisekov - Orenburg street)

The configuration of the facility is circular (D=16.0 m). The PS is situated on the highly developed area that needs sanitary protection zone. Generally PS is under sound conditions, but the following are required: major overhaul for the facade, the roof repair, internal waterproofing of the underground part, repair of finish inside the building, partial replacement of cold water pipe, domestic sewerage system, heating, and ventilation in accordance with the record of defects.

4) PS No.4 (Ugolnaya street) and PS No.10 (factory "Agromash" -VRF)

Both pump stations are situated in the industrial zone of the city. The pump stations lift up sewage collected from the residential area and the industrial area. A significant amount of mineral oil is contained in the sewage, which is inconvenient for the sewers and the sewage treatment plant. Major rehabilitation work is necessary for façade, repair of the roof and internal premises, partial restoration of the cold water pipe, domestic sewerage system, and heating and ventilation in PS No4 and PS No 10. Sanitary protection zone of PS No.4 is determined.

5) PS No.6 (Koktal settlement)

PS No.6 is one of the oldest pump stations in the sewerage system. The PS delivers sewage directly to the main sewer. The surface of the pump well has several damages. The pump house needs restoration. Partial restorations of the cold water pipe, the sewerage system, heating, ventilation, waterproofing of the underground part of dry pump pit are necessary. Arrangements for sanitary protection zone is required.

6) PS No.7 ("Molodezhnyi" micro district)

PS No.7 is the largest station in the sewer network of the city. The superstructure and substructure looked sound. However, repair of equipment and structures are required. Partial replacement is required for the internal water supply, sewerage system, heating, ventilation, waterproofing of walls . The PS has completed sanitary protection zone.

7) PS No.11 (3/3, Hospital, Abylai-Khan Avenue,), PS No.15 ("Tselinnyi" micro district), PS No.16 (Skladskaya street, 11), PS No.17 («72 quarter», the beginning of Moscow street), PS No.21 ("Prigorodnyi" settlement), PS No.24 (Moscow street, 21/1)

All of the listed six (6) PSs fall on the category of small PS (diameter of the pump well - up to 6,0 m). Configuration of the facility (except for PS No.24) is circular. No permanent staff is assigned for these stations. The restorations are necessary for the facade, the roof, internal area, water supply, domestic sewerage system, and heating and ventilation.

Table 6.5.1. Summary of Data on Intermediate Sewage Pumping Stations (1/3)

Station No	Configuration		Superstructure				Substructure		Utility
	diameter	depth	wall	window	door	roof	wall	slab	ventilation heating water supply
11	6,0m	7,0m	Circular 60 m2	-	125x205-1 unit. 120x200-1 , unit.	45m^2	130m^2	42,0 m^2	Complete replacement of water supply, domestic sewerage, heating, ventilation (ref.PS record of defects No.11)
15	6,0m	6,0m	Circular 45 ^{2} Rectangular 14m^2	-	0,9x2,05-1unit 1,0x1,8-2 units	45m^2	150m^2	36,0 m^2	Complete replacement of water supply, domestic sewerage, heating, ventilation (ref. PS record of defects No.15)
16	6,0m	6,0	Rectangular 117m^2	75x170-2 unit 100x235-1 unit	100x195-1unit 90x210-1 unit	42m^2	95m^2	36,0 m^2	Complete replacement of water supply, domestic sewerage, heating, ventilation (ref. PS record of defects No.16)
17	5,0	5,0	Circular 70 m^2	-	95x215-2 units	35m^2	80m^2	25,0 m^2	Complete replacement of water supply, domestic sewerage, heating, ventilation (ref. PS record of defects No.17

Table6.5.1. Summary of Data on Intermediate Sewage Pumping Stations (2/3)

21	6,0	6,5	Circular 70 m^2	90x155-4 units	1,0x2,0-2 units 1,0x2,05-1 unit 0,6x2,05-1 unit	45m^2	120m^2	39,0 m^2	Complete replacement of water supply, domestic sewerage, heating, ventilation (ref. PS record of defects No.21)
24	4,8	7,0	Rectangular 108 m^2	-	1,4x3,3-2 unit '	38m^2	105m^2	34,0 m^2	Complete replacement of cold water pipe, domestic sewerage, heating, ventilation (ref. PS record of defects No.24)
4	16,0	8,0	Rectangular 330 m^2	1,5x3,55-3 units 0,5x1,2-1 unit 1,0x1,2-1 unit	0,9x2,25-lunit 1,7x2,8-2 units 1,5x2,5-2 units 1,5x2,1-1 unit	192m^2	400m^2	128,0 m^2	Partial replacement of cold water pipe, domestic sewerage, heating, ventilation (ref. PS record of defects No.4)
10	16,0	8,0	Rectangular .330 m^2	1,5x3,55-3 units 1,5x1,2-2 units 1,0x1,2-1 unit	0,9x2,25-4 units 1,7x2,8-2 units 1,9x2,5-2 units 1,5x2,1-1 unit	192m^2	400m^2	128,0m^2	Partial replacement of cold water pipe, domestic sewerage, heating, ventilation (ref. PS record of defects No.10)
3	16,0	8,0	Circular 262 m^2	2,05x1,45-6 units	1,6x2,5-1 unit 2,0x2,65-2 units	230m^2	400m^2	120m^2	Partial replacement of cold water pipe, domestic sewerage, heating, ventilation (ref. PS record of defects No.3

Table 6.5.1. Summary of Data on Intermediate Sewage Pumping Stations (3/3)

2	9,0	8,0	Circular 115 m^2 Rectangular 48 m^2	1,05x1,3-1 unit	1,3x2,2-1 unit 1,8x2,5-1 unit 1,75x2,4-1 unit	150m^2	225m^2	72m^2	Partial replacement of cold water pipe, domestic sewerage, heating, ventilation (ref. PS record of defects No.2)
7	24,0	11,0	Rectangular 320 m^2		Doors: 1,0x2,55-1 unit 1,5x2,45-1 unit Gates; 3,9x4,15-1 unit 3,1x3,15-1 unit 1,1x3,15-1 unit 1,65x2,3-3 units	Span roof 475 m^2 m	830m^2	570m^2	Partial replacement of water supply, domestic sewerage, heating, ventilation (ref. PS record of defects No.7)
6	Undergro und part -detached	6,0	Rectangular 1326 m^2	1,5x1,85-6 units	Doors: 1 4Sx7 45-1 1,45x2,45-1 unit 1,5x1,85-1 unit 1,7x2,3-1 unit Gates: 3,15x3,25-2 units 3,1x3,1-1 unit	Shed roof 204 m^2	225m^2	72m^2	Partial replacement of water supply, domestic sewerage, heating, ventilation (ref. PS record of defects No.6)
1	16,0	10,0	Rectangular 1150 m^2	1,45x2,35-8 units	Doors: 1,45x2,05-1 unit 1,5x2,0-1 unit Gates: 2,05x3,3-2 units	Span roof 276 m^2 7 m	500m^2	100m^2	Partial replacement of water supply, domestic sewerage, heating, ventilation (ref. PS record of defects No.1)

6.5.2 Sewage Treatment Plant

1) General condition of the Sewage Treatment Plant

The conditions on architectural, structural and utility elements of sewage treatment plant were examined to determine the extent and grade of the rehabilitation work to be planned. The work excludes the investigation of the mechanical/electrical equipment. The facilities were constructed during 1969-1972

The structures subject to the rehabilitation are as follows; Administration building, Blower house, Boiler house, Sewage pumping station No. 12, and Sewage pumping station No. 13.

2) Administration building

Administration building shall be restored to have a specialized laboratory for carrying out sewage examination. Rehabilitation work for1st and 2nd stories of administration building is as follows; repair works - plastering, painting, laying of ceramic covering for walls, reconstruction of floors, painting ceilings, partial replacement of internal water pipe, sewage system, heating, ventilation.

3) Blower house

Blower house is under relatively favorable condition compared with other architectural buildings, because the building dose not have a contact with corrosive matters or environment. An overhaul of architectural elements of the building is need.

4) Boiler House

Architectural part of the building needs rehabilitation. Maintenance deck and floors are to be rehabilitated urgently (deterioration of concrete, corrosion of fittings and metal surfaces, and complete destruction of walls and ceilings).

5) Sewage pumping stations No.12 and No. 13.

The two houses are almost same in superstructure. The rehabilitation of all architectural and engineering elements is required.