J.P. Vodovod I Kanalizacija
Montenegro

PREPARATORY SURVEY II REPORT
ON
THE PROJECT FOR URGENT REHABILITATION OF WATER SUPPLY SYSTEM IN THE CAPITAL CITY OF PODGORICA
IN
MONTENEGRO

DECEMBER 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO ENGINEERING CONSULTANTS CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey II on the Project for Urgent Rehabilitation of Water Supply System in the Capital City of Podgorica in Montenegro.

JICA sent to Montenegro a survey team from 17 May to 20 June, 2009.

The team held discussions with the officials concerned of the Government of Montenegro, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Montenegro in order to discuss a draft outline design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Montenegro for their close cooperation extended to the teams.

December 2009

Kikuo Nakagawa
Director General, Global Environment Department
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

We are pleased to submit to you the preparatory survey II report on the Project for Urgent Rehabilitation of Water Supply System in the Capital City of Podgorica in Montenegro.

This survey was conducted by Tokyo Engineering Consultants Co., Ltd., under a contract to JICA, during the period from May 2009 to December 2009, In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Montenegro and formulated the most appropriate design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Toshifumi Okaga
Chief Consultant,
Preparatory Survey II Team on
The Project for Urgent Rehabilitation of
Water Supply System in the Capital City
of Podgorica in Montenegro
Tokyo Engineering Consultants, Co., Ltd.

Summary

1. Montenegro is situated in the west-central part of Balkan Peninsula. It borders with Serbia and Kosovo on the east side, Albania on the south side, Croatia and Bosnia & Herzegovina on the north side, and faces the Adriatic Sea on the west side. Montenegro has the total land area of 13,812 Km^2 and population of 620,000. The capital city of Podgorica (hereinafter referred as "Podgorica"), which is the Study Area of this Project, is situated about 15km north of the Skadar Lake and is the largest city of Montenegro which has the land area of 1,442 Km^2. It is enclosed by the hills on the east, west and north side and experiences an annual rainfall of about 1,357 mm. It has abundant spring water and ground water of good quality and these water sources could be utilized for drinking water to the area without any treatment. The weather of Podgorica is of Mediterranean type. Summer is dry with temperature over 30 Degree Celsius, and winter is cold having temperature below zero.

The main industries of Montenegro are agriculture and tourism. Especially the revenue from tourism occupies 20 % of GDP. It is expected to be a growth sector by investment of big foreign capitals. According to the statistic data of World Bank although the statistics shows high unemployment rate, considerable trade deficit, the macro-economy of the country was judged as stable until 2007. However, the current environment surrounding economy of the country is beyond prediction. This is reflected from the facts that the country has high rate of unemployment, substantial drop of investment in tourism and lower level of GDP growth rate in year 2008.

2. According to the data of Podgorica Water-supply and Sewage (hereinafter referred as "PWS") in 2008, the rate of population served in Podgorica is 92 % of total population of 178,000. From 6 locations of wells or springs, water supply for Podgorica city has been conducted by pumping up through distribution pipeline with length of 375km. The ratio of illegal connections and nonpayment (administration loss) is estimated as about 17 %. The water supply to Podgorica is made through the water transmission and distribution pipeline from spring water and ground water resources of six locations inside the city. About 50% of total pipelines is made up of asbestos and are superannuated. The ratio of water leakage (physical loss) is 40.9 %.

The water supply system of Podgorica consists of intake facilities with transmission pump, disinfection facilities and distribution facilities. The vital component, which is the main part of the system, is the pumps for water intake, transmission and distribution. Of these pumping facilities, Mareza 2 pump station has a half of total amount of transmission and distribution, and water transmission flow of Mareza 2 pump has decreased significantly owing to high performance deterioration and ex-ordinary vibration resulting from the pumps of aged about

25 years. The required water supply flow based of water demand is 162,500m^3/day as of year 2008 and the capacity of existing pumping facilities is 145,000m^3/day. As a balance of flow, there is shortage in water supply of 15,500m^3/day. These pumps have been operated on the condition of abnormal vibration and have become superannuated. Based on the result of vibration analysis, it is considered that risk of pump failure is high and its damage could be large.

The unbalance flow in the pipeline occurs due to decrease of distribution water flow and pressure and thereby results into several zones of water failure. According to the result of preparatory survey II, it is proved that four areas in Podgorica has been experienced constant water failure. These water failure areas have total 6,000 households and 24,000 inhabitants and correspond to 14 % of total population served. Water failure occurs in summer season with demand increase and it is one of the most important factors making living conditions worse. Accordingly, urgent countermeasure is required.

Under this situation, PWS formulated the long-term water supply and sewerage improvement plan (2007-17) in year 2007 and set out urgently required 11 projects aiming at safe and sufficient water supply for all citizens until year 2017. Of these, 3 projects were requested to the Government of Japan as grant aid on August 2007. In the based on its request, Government of Japan made decision on implementation of preparatory survey regarding "The Project for Urgent Rehabilitation of Water Supply System in the Capital City of Podgorica in Montenegro" and Japanese International Cooperation Agency (hereinafter referred as "JICA") carried out the Preparatory Survey I from 1st to 23rd December 2008. As a result of it, the following components were confirmed and about this Project it was confirmed that necessity and appropriateness would be high as grant aid project.

- As the pumps in Mareza 2 pump station which is main facility in PWS have become superannuated, the pump performance has dropped remarkably comparison with design capacity. In addition, pump operation is limited to two pumps operation in parallel instead of running three pumps in parallel as specified in the design. For this reason, water failure occurs in summer season with demand increase and it is confirmed that existing capacity of pumps is insufficient to supply water in the future.
- Water transmission by the pumps in six pump stations cannot follow variation of water demand taking into account overall water supply system, and the pump operation control is not made effectively.
- As information on flow and pressure in the pipelines network is not controlled, action for water distribution control and water leakage countermeasure is not taken adequately.

Apart from the above technical issues, it is understood that PWS continues to put in their

own efforts on technical and management aspects. Also, a large amount of capital investment is supported by EC, World Bank or other foreign donors. This Project has significance as financing support as well. In this Study, it was confirmed that PWS would have sufficient capability for operation and maintenance when this Project is implemented.

3. The based on the result of Preparatory Survey I, JICA dispatched survey team as Preparatory Survey II from 5th May 2009 to 20th 2009. The team was studied Project scale and design concepts and Draft Finally Report was finalized. Subsequently, in order to explain its report, the team for explanation of Outline Design was sent from 5th to 14th October and the main concept of the Outline Design was determined and agreed by both parties.

The Project aims to replace four pumps in Mareza 2 pump station to recover water supply capacity as per the original design and also to secure water demand of year 2012 which is the target year of this Project. In addition to improve water flow and pressure by replacement of pump equipments, the Project aims to solve water failure by appropriate distribution management of monitoring system for improvement of living condition. Furthermore, it is possible to establish the effective plan for replacement of distribution pipeline and implement a leakage control by establishment of the monitoring system which can manage water flow and pressure in the pipe network. The based on the result of field survey and domestic works, the Project was designed by following concepts.

3.1 The projected water distribution flow with target year 2012 is 159,400 m^3/d considering water leakage improvement carried out by PWS. The capacity of five (5) pump stations, excluding Mareza 2, is 94,300 m^3/d. Therefore, remaining water flow of 65,100m^3/d (753L/sec.) is proposed to be supplied by Mareza 2 pump station under three (3) sets of parallel operation after renewal of existing pump sets.

3.2 The Project aims to establish a system in which main control center shall acquire operation data from all pump stations and flow/pressure data at the outlet of pump station and based on the collected information shall decide and provide proper direction to each pump station. When proposed measures under this project are completed, it will be possible to supply sufficient water to each distribution area through coordination of operation among all pump stations. Thus, it is expected that the implementation of proposed project activities shall result into stable water supply and improvement in condition of water supply interruption.

3.3 The Project aims to improve the condition of unequal distribution, and to prevent unbalance flow of distribution through application of stop valve arrangement and monitoring of flow/pressure data of 70 % as the District Metering Area (hereinafter

referred as “DMA”) which is clearly demarcated as pipe network block at main control center. Also, the monitoring of residual chlorine at pipe end is very important to secure safe drinking water quality.

3.4 Under this project it is considered that improvement of this ex-ordinary vibration is made through study of the pump and corresponding floor without modification of the existing civil and building structure. The acceptable vibration values for the floor and pump/motor is based on ISO standard. These values shall be limited within 0.6 and 7.1mm/sec. respectively.

3.5 The equipments of the project are as follows;

Pump/Motor

Item	Type	Specification	Quantity
Pump	Vertical shaft mixed flow pump	320 l/s x 90 m	4
Motor	Vertical shaft motor	6 kV x 400 kW or less	4
Fitting	-	Bolt/Nut, Gasket, etc	1 lot

Control system for Pump

No.	Name of Equipment	Quantity
1	Pump control system	
	SCADA PC	3
	22 inch monitor (TFT monitor)	2
	50 inch monitor (LCD monitor)	1
	PLC (programmable logic controller)	1
	UPS (uninterrupted power supply)	1
	Control desk, server rack	1 lot
	I/O Panel	1
2	Field measuring instrument	
	Water level meter for pump suction pit	2
3	Emergency power supply unit	
	Battery	1 lot
	Battery charger	1

Monitoring system

SCADA Equipments		Main Application	Main Control Center (MCC)	Mareza Old Pump Station	Mareza New Pump Station	Zagoric Pump Station	Cemovsko Pump Station	Miljes Pump Station	Dinosa Pump Station	Vuksanlekici Pump Station	DMA (PT and Chlorine)	DMA (PT and FT)	Reservoir	Total
Equipment for Monitoring System	SQL Server	Data storage collected in MCC	2											2
	SCADA Server	Monitoring and collection of operation data in MCC	1											1
	Communication Server	Collection of real-time data	1											1
	SCADA HMI	Display of operational status	2											2
	Fire Wall	Protection from illegal invasion	1	1	1	1								4
	TFT Monitor	20 inch monitor	2											2
	50" Display	50 inch, large size monitor	2											2
	RGB Switch	Mechanical type switch	2											2
	Layer 2 SW	Network relay equipment	1											1
	Laser Printer	Printing of data	1											1
	GPRS Router	Wireless telecommunication equipent					1	1	1	1	7	23	4	38
	UPS	Uninterruptible power supply system	1	1	1	1	1	1	1	1	7	23	4	42
	Touch Panel	Instruction panel		1	1	1	1	1	1	1			1	8
	PLC	Collection and transmission of operation data		1	1	1	1	1	1	1	7	23	4	41
	Server Rack	Sever rack in MCC	1											1
	Control Desk	Control desk in MCC	1											1
	Interface Panel	Storage box of equipments for monitoring and transmission of operation data		1	1	1	1	1	1	1	7	23	4	41
Instrument	Pressure	Measurement of water pressure									7	29		36
	Flow	Measurement of water flow			1	1	1					22		25
	Residual Chlorine	Measurement of residual chlorine									7			7
	Level	Measurement of water level				1	1	1	1	1			8	13

4. The project is planned as a single year project and total period of the implementation is estimated as 22 months. Of this, detail design and tendering period shall take 6.5 months. In addition to it, the period of procurement, installation and handing over shall be 15.5 months.

   The estimated cost to be borne by PWS required for the implementation of the Project is 310,500EUR.

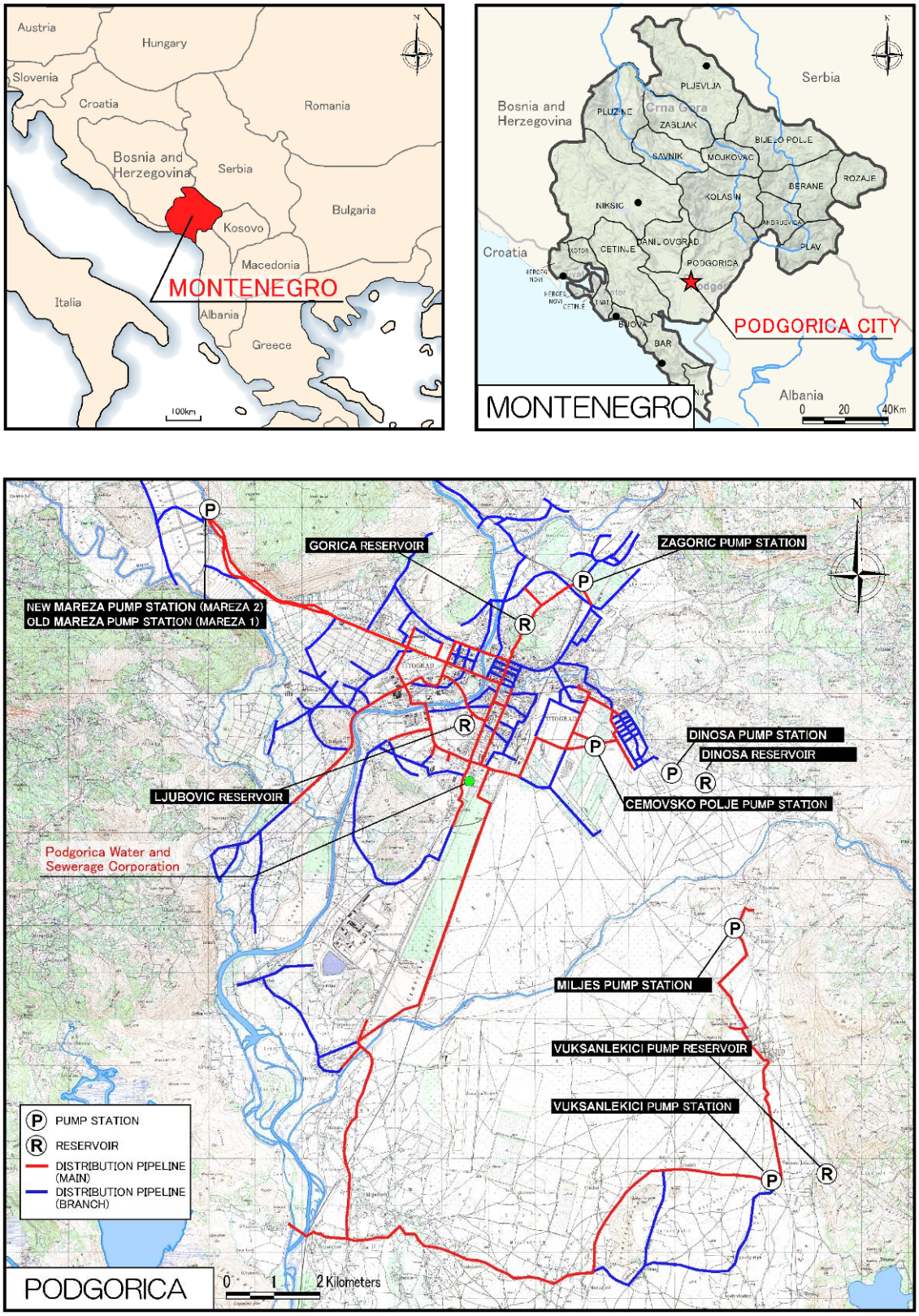
5. The beneficiary of the project would be entire resident of the water service area in Podgorica, mainly an estimated population of 177,410 in 2012, contributing to the improvement of Basic Human Needs. Also, the objective of the project will conform closely to long-term water supply and sewerage improvement plan, 2007-2017, of PWS.

   The instruction of the monitoring system in the project has a stimulating effect on the leakage reduction scheme by PWS. As a result, project sustainability is secured due to increased effective water distribution flow. Annual energy loss of approx. 1.64MW is expected to be curtailed, through 15% increase in efficiency due to replacement of pump set in the project. This will ultimately contribute to global environment conservation.

Preparatory Survey II Report
on
the Project for Urgent Rehabilitation of Water Supply System
in the Capital City of Podgorica
in
Montenegro

Contents

Appendices



PROJECT LOCATION MAP

List of Figures & Tables

Abbreviation

AC pipe	Asbestos Cement pipe
DMA	District Metering Area
€	Euro
EC	European Council
EIB	European Investment Bank
EN	Exchange of Notes
GA	Grant Aid Agreement
GPRS	General Packet Radio Service
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
I/O (list)	Input and Output (list)
ISO	International Organization for Standardization
IT	Information Technology
JICA	Japan international Cooperation Agency
LCD	Liquid Crystal Display
MCC	Main Control Center
NRW	Non-Revenue Water
OECD	Organization for Economic Cooperation and Development
OJT	On the Job Training
PDM	Project Design Matrix
PLC	Programmable Logic Controller
PWS	Public Enterprise Podgorica Water Supply and Sewerage
SCADA	Supervisory Control and Data Acquisition
SCADAPC	Supervisory Control and Data Acquisition・Personal Computer
T-Com	The name of private telecommunication company
UPS	Uninterrupted Power Supply
USAID	United States Agency for International Development

Currency Equivalents

(June 2009)

EUR1.00 = JPY126.66

CHAPTER 1 BACKGROUND OF THE PROJECT

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Montenegro is located in the west-central part of Balkan Peninsula. It borders with Serbia, Croatia and Albania, and faces the Adriatic Sea on the west side. Montenegro is a relatively small country with total land area of 13,812 Km^2, and population of 627,000 (based on Statistical Office in 2008).

The capital city of Podgorica (hereinafter referred as "Podgorica"), which is the Study Area of the project, is situated about 15 km north of Skadar Lake, which is the biggest lake in Balkan Peninsula, and the City extends over an area of 1,441 km^2. Also Podgorica is situated in the north of Zeta Field and has relatively flat topography. On the east, west and north side, Podgorica is enclosed by the hills or mountains and Moraca River flows from north to south through the center of the city.

In the flat areas of Podgorica, the altitude is around 44m high and that of Gorica hills is around 107m. In addition to Gorica, there also exist the hills of Malobrdo, Ljubovic, Cardak, etc. These hills are considerably steep and restrict the urban development in the outskirts of Podgorica. Especially, the hills located in the north side limits the expansion of urban area. The deformed mountains having characteristic of limestone outside the hills can be seen. The flatlands along with the hills and mountains located around Podgorica have spring water of good quality and these water sources could be used to supply water without any treatment.

The weather of Podgorica is of Mediterranean type and usually the city experiences hot and dry summer/autumn and cold winter. The average of daily temperature in Podgorica for year 2007 is 17 Degree Centigrade（Deg. C）, the maximum temperature of 44.8Deg. C occurred in August and the minimum was observed at -4.3 Deg. C in December. The difference of temperature between the hot summer and cold winter is large. Especially water demand in summer rises rapidly influenced by the high temperature in summer. The average annual humidity is 60.4 %, the maximum is observed as 75 % in January and the minimum as 34 % in July. The annual rainfall is 1357mm, the maximum rain of 228mm occurs in February and the minimum is observed as 0.2mm in July. The annual temperature and rainfall are shown in Figure 1-1.

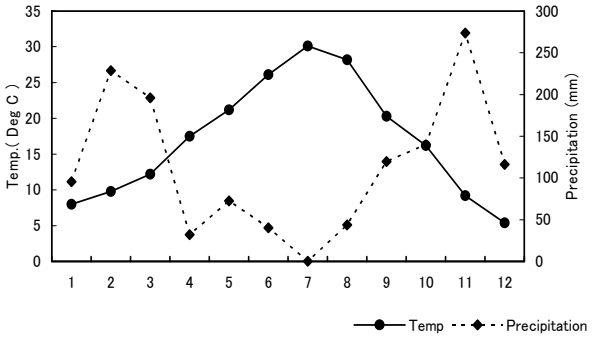

Figure 1-1 Temperature and Precipitation

From the beginning of year 2000 World Bank, USAID, etc commenced aids for Montenegro. As a result, Podgorica Water Supply and Sewerage (hereinafter to be referred as "PWS") has been able to expand the water supply area mainly. Although PWS has prepared plans to improve the conditions of pump stations and reservoirs under financial assistance of Podgorica or its own fund in order to improve the existing water supply system and expand the coverage area water supply in the suburbs of Podgorica in accordance with Long-term Water Supply and Sewerage Plan worked out in year 2007, there is lack of the budgets for further improvement.

Under this circumstance, the Government of Montenegro requested the Government of Japan to implement the project through Grant Aid. The items requested by Montenegro are as follows;

(1) To recover water flow by replacement of the pumps in Mareza 2 pump station in order to improve the ex-ordinary vibration and superannuated pumps
(2) To distribute water adequately to the water service area through appropriate pump operation and management by introduction of monitoring system.
(3) To procure the water quality analysis equipment in order to maintain safe water.

JICA carried out the Preparatory Survey I in December 2008 and realized the following technical problem areas in water supply system of Podgorica;

- The pumps in Mareza 2 pump station have become superannuated and its operating condition has deteriorated significantly. Furthermore, due to ex-ordinary vibration, simultaneous operation is limited to only two pumps and it is impossible to operate three pumps in parallel as is recommended in design.
- Variation of water flow cannot be achieved in six (6) pump stations to fulfill variation in water demand of overall water supply system and as a result, effective pump operation is not carried out.
- Water distribution and leakage control are not undertaken adequately due to the lack of information on flow or pressure in the water distribution pipe networks.

Both Japan and Montenegro side agreed to exclude item (3) listed above (water analysis equipment) from their request. This is because PWS implements construction of water analysis laboratory and procurement of water analysis equipment by their own fund.

Although it is understood that PWS makes its own effort on technical and management aspects in order to cope with increased water demand, the capital investments corresponding to several hundred millions yen are required from donors judging the financial capacity of PWS. At present PWS gets supports from World Bank, EC, etc.
Also it is realized that the project is significant among the projects for which PWS needs

financial assistance.

The PWS carried out operation/maintenance and management of their water supply system and has also introduced SCADA system in case of sewerage system previously. As PWS has successful experience of operation/maintenance of the facilities, it is understood that there shall be no problem in operation/maintenance of equipment to be procured under the project. Under the above situation it is judged that the project has necessity and appropriateness for Japanese Grant Aid.

The based on the result of Preparatory Survey I, JICA dispatched survey team as Preparatory Survey II from 5th May 2009 to 20th 2009. The team was studied Project scale and design concepts of the Project and Draft Finally Report was finalized. Subsequently, in order to explain its report, team for explanation of Outline Design was sent from 5th to 14th October and the main concept of the Outline Design was determined and agreed by both parties. It had discussion and agreed on the following items required to prepare and include in the Draft Final Report;

- Tax exemption
- Components to be implemented under the project, its quantity and specification
- Work demarcation between Japan and Montenegro
- Eligible country for procurement
- Project implementation schedule
- Technical assistance

CHAPTER 2 CONTENTS OF THE PROJECT

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2－1 Basic Concept of the Project

The facilities of water supply system in Podgorica were introduced during period of 1950 to 1980 and most of them are still used. In the 1990s, Montenegro had a bitter relation with Yugoslavia and consequently Yugoslavia was divided which led to independent Montenegro in 2006. However, Montenegro was subjected to economic sanctions by the United Nations. Under this situation, operation and maintenance of the water supply system was not implemented adequately due to financial problem resulting from the political confusion and instability.

After the independence of Montenegro year 2006, the water supply system of Montenegro was decided to be improved under responsibility of each municipality in accordance with the Water Law instituted year 2007 that emphasized on the decentralization of national authority as a policy of Montenegro.

Podgorica prepared a Long-term Infrastructure Scheme (year 2007-17) as a part of the urban development plan in year 2007. Following this scheme, Podgorica Water Supply and Sewerage (hereinafter to be referred as "PWS") worked out a long-term water supply and sewerage plan (year 2007-17) and decided to implement eleven (11) projects for urgent necessity. The total amount required for these projects is estimated as €60,100,000. In this plan, the projects related to the project are shown in Table 2-1.

Table 2-1 Podgorica Water Supply System Improvement Plan (Urgent project)

Object of Improvement	No.	Summary of Improvement	Fund	Schedule
Improvement of Water Supply Rate	1	Mareza 1 pump station rehabilitation plan -Rebuilding pump station -Renewal of pump/motor (5 sets)	€1,500,000 Loan from Podgorica (Podgorica has loan from Dexia bank)	-Design completion year 2007 -Tendering year 2009 (awaited) -Construction period (9 months)
	2	Replacement of pump/motor for Mareza 2 pump station -Replacement of pump/motor (4 sets)	**Under request for Japan's Grant Aid**	
	3	Leakage reduction plan -Renewal of AC pipe, etc -Renewal of water meter (1500 pcs/year)	Own fund €1,400,000 in annual average Year 2017	
Improvement of Water Supply Pressure	4	Installation of monitoring system	**Under request for Japan's Grant Aid**	
	5	Construction of Ljubovic reservoir (new)	FS: €300,000 Construction: EIB, loan from a bank, own fund	FS: EC's grant aid FS completion: Oct. 2009
	6	Construction of reservoirs (2000m^3) at Golubovic and Tuzi (new)	€1,850,000 Own fund	Year 2009-2010
Improvement of Water Quality	7	Installation of central monitoring system (residual chlorine content)	**Under request for Japan's Grant Aid**	
	8	Procurement of water analysis equipment	Analysis equipment: €550,000 Own fund	Year 2009-2010

From Table 2-1, the project requested to Japan is the procurement needed for replacement of pumps including countermeasures against ex-ordinary vibration in Mareza 2 pump station, and installation of central monitoring system. The effect of the project, project objectives and overall goals are listed as PDM in the Table 2-2.

Table 2-2 Project Design Matrix (PDM)

Narrative Summary	Indicator	Means of Verification	Important Assumption
Overall Goal Water supply services of Podgorica are improved and sufficient volume of safe drinking water is supplied to the inhabitants in Podgorica.	It becomes possible to supply sufficient volume of safe drinking water for population of 200 thousands in Podgorica by year 2017.	-Annual performance record -Operation & maintenance record for water facilities -Water meter record	-PWS makes effort of performance improvement by itself continuously.
Project Objective 1.As the facility's operation status・water distribution status can be grasped precisely, it becomes possible to make operation & maintenance for the facilities adequately. 2.Water supply conditions in areas with insufficient water supply are improved. 3.Improvement of energy losses	1-1.The planned water supply capacity (2,051 L/s) for the project area is secured. 1-2.Sufficient volume of safe drinking water for population of 177 thousands in the project area is supplied by year 2012. 2. Twenty-four hour water supply for the inhabitants of 25 thousands in the suspended water supply area becomes possible by year 2012. 3. Due to improve pump performance, the electrical consumption is saved to be 1.64MW per year	1-1.Monitoring record of the facilities 1-2.Water meter record, annual performance record and monitoring record 2.Water meter record, socio-condition survey 3. Water meter recorder and electric consumption recorder	-Podgorica's long-term infrastructure scheme is implemented as planned.
Output (1) The superannuated water distribution pumps are replaced. (2) The adequate water distribution control system is introduced.	(1) Four pumps in Mareza 2 pump station are replaced by year 2012. (2) The monitoring system is installed by year 2012. (3) The monitoring points for 7 pump stations, 7 residual chlorine analyzers, 25 flow meters and 4 reservoirs is set up.	(1) Project record (2) Project record (3) Project record	-The management control for water supply system is carried out adequately by utilizing the monitoring & control system.
Activity 1.Replacement of Mareza 2 pump station 2.Introduction of monitoring system	**Input** *Japan side* <Equipment/Materials> Water distribution pump, monitoring & control system equipment, vibration prevention facilities, installation materials <Human resource> Engineer, technical instructor <Project Cost> Equipment and material cost, installation cost, design and procurement supervision cost	*Montenegro side* <Equipment/Materials> Installation and dismantling materials, communication equipment・wiring materials, kiosk, piping materials <Human resource> Engineer, technician, labor <Project cost> Installation・dismantling work cost, installation material cost, operation/maintenance cost, application cost for authorization	-Works to be done by the recipient country are implemented as planned. **Precondition** -E/N is concluded.

It is expected that upon the installation of four new water distribution pumps in Mareza 2 pump station, three pumps can be operated in parallel as per design conditions under The project, and the projected water distribution flow rate for the target year 2012 can be achieved. In addition, adequate pump operation and water distribution control can be made with introduction of the monitoring system and consequently water supply services in the water failure area can be improved thereby improving the living environment for the inhabitants in the area.

2－2　Outline Design of the Japanese Assistance

2－2－1　Design Policy

The components requested by Montenegro, the items clarified by the Preparatory Survey I, and the items clarified by the Preparatory Survey II are shown in the Table 2-3.

Table 2-3　Clarification of Components Requested

Components Requested by Montenegro	Preparatory Survey I	Preparatory Survey II
1) Equipment requested		
-Water distribution pump in Mare 2 PS – 4 sets	320L/s x 90m, 6kV, within 400kW	Same as left, but pump speed shall be 1500 rpm or less.
-Piping materials, valve, etc in Mareza 2 PS – 1 lot	Installation of check valve, etc	Use of existing check valve, pump is tied in the first flange of the discharge pipe.
-Vibration prevention facilities in Mareza 2 PS – 1 lot	Recommendation; -Change of pump natural frequency -Modification of motor stand -Adoption of 2 floor-supported pump -Inverter control	-Same as left -Same as left -Adoption of 1 floor-supported pump*1 -Non inverter control*2
Pump control panel in Mareza 2 PS – 1 lot	Out of scope for high-tension power distribution panel to be able to use the existing ones	Same as left
Monitoring system – 1 lot	Same as left	Same as left
Water quality analysis equipment – 1 lot	To be procured by Montenegro	Same as left
2) Installation and technical assistance	Same as left	Execution of capacity development for PWS staffs on monitoring system only through OJT

*1: As rigidity of the 1st floor is small, it cannot bear the pump load.
*2: The installation space for high-tension inverter cannot be secured in the existing building.

Based on the above points, the outline design of the project is prepared in accordance with the following policies;

(1) Consideration for natural conditions

The project area is in the basin. It is cold in winter, sometimes below zero, and it is hot in summer over 30Deg. C. Owing to the large temperature difference, especially the monitoring system to be installed in the outdoor place, which Montenegro specifies, shall be designed taking into account atmospheric conditions of the installation area. Meanwhile, the transmitters for pressure or flow to be installed outdoor are required to be designed taking into account the waterproof protection criteria for housing of the instrument.

(2) Consideration for Local conditions, Local contractors and local materials

Pump facilities

The project is to replace the pumps/motors and to provide countermeasures for vibration of the pumps/motors. Approach to countermeasure against vibration of the pumps/motors is different in case of Japanese manufacturers and the third country's manufacturers. Although Japanese manufacturers have their own organization for vibration analysis and countermeasure, almost all the third country's manufacturers entrust it to outside private institute or university. The project includes not only vibration analysis on the pump/motor proper but also dynamic flow analysis in the pump suction pit and vibration analysis for pump-supported floor. As there is a case that the technical responsibility between countermeasure for vibration and pump manufacturing is not specified definitely, in the project the technical specification and tender conditions on countermeasure for vibration are prepared so as to clarify technical responsibility of the tenderer or the pump manufacturer definitely.

Monitoring system

PWS shall provide a part of communication facilities to be used for the monitoring system and shall get authorization for utilization of communication network. It is considered that interface between the monitoring system made by Japan side and the communication system is made without variance of data transmission/receipt.

(3) Capability of PWS for operation and maintenance

PWS has experience in the maintenance work including overhaul of the pump/motor. As the pump to be procured under the project is of the same type as the existing pump, that is; vertical shaft and same size (same capacity and head), PWS will have no problem in terms of capability on operation and maintenance. However it is required to provide sufficient explanation and instruction on design specification of countermeasure for vibration.

Meanwhile as PWS has first experience in the monitoring system, it is required to give instructions on operation and maintenance of hardware and software, for expansion of software, etc. It is considered that capacity development for PWS staffs shall be made through technical

transfer or through a contract that PWS concludes on after-sales service during trial operation.

(4) Grade and standard for equipment and facility

The monitoring system under the project has function of monitoring only and no function of control at the main control center (incomplete SCADA system). Accordingly, the design of the monitoring system under the project shall be considered so that PWS can develop complete SCADA system in future.

Meanwhile the current local products are European products mainly. Also Montenegro contemplates unifying their standard/code with EU standard/code on the premise that Montenegro set forward accession of EU. Therefore, the products to be procured in Japan or the third countries under the project shall comply with the international standard/code such as ISO, IEC.

(5) Procurement method, Installation method and implementation schedule

The project is planned as the single year project (maximum 24 months). The replacement work of pumps includes the dismantling work for the existing pumps done by PWS. As the pump suction pit is divided into 2 tanks by the partition wall, the shutdown of total pumps (4 pumps) can be avoided provided that two pumps in one tank are dismantled at a time.

Accordingly, the dismantling work schedule shall be planned so as to minimize the work schedule including the installation work of pumps to be carried out by Japan side, that is, to minimize the suspended time of two pumps.

2－2－2 Basic Plan

(1) The project component

The project component consists of following 4 items.

1) Improvement of projected water distribution flow and pressure

The project is to be designed so that four pumps in Mareza 2 pump station are replaced to recover water supply capacity as per the original design and also to secure water demand rate year 2012 which is the target year of the project. Furthermore three pumps operation in parallel can be achieved by improving ex-ordinary vibration of the pumps.

Regarding the pump capacity, the result of comparison between water demand including leakage for year 2012 (when the project is expected to be completed) and the current facilities' capacity is shown in the Table 2-4.

Table 2-4 Water Demand Rate and Facilities' Capacity

Year	a	b	c	d	e	f	g	h	i
	Served population	Water Demand	Daily Max.	Hourly Max.	Water Leakage Rate	Projected Water Flow	Facilities' Capacity (l/sec.)		
		m^3/d	m^3/d	m^3/d	%	l/sec	5PS	Mareza 2	Total
2009	167,330	58,035	72,544	97,934	39.4	1,870	1,133	544	1,677
2010	170,640	59,165	73,956	99,841	37.9	1,861	1,119	536	1,655
2011	174,000	60,312	75,390	101,777	36.4	1,852	1,105	528	1,633
2012	177,410	61,477	76,846	103,742	34.9	**1,844**	1,091	520	**1,611**

The items in the above table are explained below;

a. Served population

- Currently the rate of served population is 92%, in future it is considered as 0.9% year by year. In 2012, served population is 95.6%.

b. Water demand

- It is the water demand for the daytime population including the inflow population from the outside of city. However per capita for the settled population including industrial use water is taken as 336 L/c/d and for the case of the inflow population it is estimated as 60 L/c/d.

c. Daily maximum water flow

- It is calculated by multiplying the daily water flow by the seasonal variation factor of 1.25 which is the design criteria in case of Montenegro.

d. Hourly maximum water flow

- It is calculated by multiplying the daily maximum water flow by the peak factor of 1.35 (PWS's specified value).

e. Water leakage rate

- The current water leakage rate of 40.9 % is used and it is estimated on assumption that the rate would be reduced by actual performance from 2007 to 2009 of 1.5 % year by year.

f. Projected water flow

- It is the projected water flow calculated by adding the water demand rate and the leakage water rate

g. Five pump stations

- The overall capacity of five pump stations except for Mareza 2 pump station is estimated on assumption that the pump capacity would be reduced by performance drop of 1.25% year by year.

h. Mareza 2 pump station

- The performance drop of pumps in Mareza 2 pump station is 15% currently and in future it is assumed as 1.25% year by year.

From the Table 2-4, the facilities' capacity of 6 pump station operated currently is 233 L/sec short as compared to the projected water flow rate of year 2012 when the project is scheduled to be completed.

The pumps in Mareza 2 pump station are restricted to two pumps operation in parallel out of four pumps and have a performance drop of 15%. Therefore, the overall capacity of these pumps as of year 2009 is to be 544 L/sec. It is assumed that the overall capacity of these pumps in year 2012 is 520 L/sec due to further increase of performance drop.

Meanwhile the water flow calculated by deducting the facilities' capacity in 5 pump stations except for Mareza 2 pump station from the projected water flow for year 2012 is 753 L/sec and this amount of water shall be supplied by Mareza 2 pump station. The original pump design capacity in Mareza 2 pump station is 320 L/sec per pump and the capacity of 960 L/sec is secured with three pumps in operation. Accordingly, the project considers a policy to procure four pumps (one pump standby) in order to recover the original facilities' capacity.

2) Introduction of monitoring system for the distribution pump

The number of pump stations is 7 at present and numerous pumps have been operated for meeting water demand that has wide daily and hourly variation. However, optimization of pump operation considering entire water supply system has yet not been conducted and each pump station is operated separately in existing condition. This results into delay in taking action and leads to error in control of number of units in operation, in case of the overheating of pump bearing or overload operation. Furthermore, there are many cases of interruption in water supply caused by poor coordination among pump stations at the time of breakdown or shutdown of pump equipments.

The project aims to establish a system in which main control center shall collect operation data from all pump stations and flow/pressure data at the outlet of pump station and based on the collected information shall decide and provide proper direction to each pump station. When proposed measures under the project are completed, it will be possible to supply sufficient water to each distribution area through coordination of operation among all pump stations. Thus, it is expected that the implementation of proposed project activities shall result into stable water supply and improvement of water failure.

3) Installation of monitoring system for distribution area

PWS, which was started in the 1950s, continued to expand the capacity of water supply to meet the demand of increasing population, and consequently, population served has reached 92% at present. In fact, expansion of distribution pipelines was implemented for meeting the increased water demand, but it was not based on the initial plan considering future plan. Thus, it is observed that the head loss in the District Metering Area (DMA) becomes large because of use of inappropriate diameter of the pipelines compared to distributed water flow or water pressure and due to the reduction of coefficient of velocity in old pipelines. Hence, uneven flow occurs in the area where head loss is large and the area where it is small. Therefore, even though water flow is sufficient, interruption in supply which is phenomenon of the area with non water supply is observed.

The project aims to improve the condition of unequal distribution, and to prevent uneven distribution of flow through application of stop valve arrangement and monitoring of flow/pressure data of DMA at main control center.

Even though concentration of residual chlorine, which is consumed in pipelines, has variation depending on temperature, pipe material and level of pipe aging, water quality test is carried out 2 times per month by public health office. Therefore, it is possible to prevent water supply without residual chlorine through application of monitoring system for automatic measurement of residual chlorine. Furthermore, since water leakage and failure in supply occurs frequently, it might result into contamination of water in pipelines due to bacteria underground. Considering this, it is necessary to monitor residual chlorine in the distribution network for safe water supply.

4) Improvement of ex-ordinary vibration of pump/motor

The ex-ordinary vibration of pump/motor is expected to be born by an imbalance mass accompanied with the aged equipment and by resonance with natural frequency of pump/motor and of the upper floor of building (both frequencies are nearly equal). Therefore this civil and building structure is not necessarily most suitable for pump/motor from the point of view of vibration. Under the project it is considered that improvement of this ex-ordinary vibration is made through study of the pump and the said floor without modification of the existing civil and building structure.

Accordingly the vibration improvement design under the project is made based on the followings;

a. Type of pump

- The type of pump is vertical shaft mixed flow pump same as the existing pump

b. Construction of pump

- Although the Mareza 2 pump station have two floors, it is difficult that the lower floor bears the pump load because of existence of 200mm thick slab only. Accordingly, the pump/motor load shall be born by the upper floor (300mm slab in thickness) same as the existing one. However when the two-floors-supported pump is used, the base plate for pump support is considered so that the pump load is not laid on the lower floor directly.
- The natural frequency of the pump differs in case of different pump manufacturers depending on number of impellers, stages of impellers, structure of the motor stand, dimension of pump/motor, etc. Accordingly, the pump manufacturer shall make simulation analysis of vibration based on the natural frequency (25Hz) of the floor to be installed and set adequate design of the pump/motor from the viewpoint of vibration control.
- The pump shall be designed and installed taking into account the opening space (550mm ϕ) of the lower floor where the pump column and bowl, etc passes.

c. Motor stand, base plate

- As vibration level of the motor is higher than the pump, it shall be considered that stiffness of the motor stand and the base plate is more strengthened than the existing one to reduce vibration. Accordingly, the pump manufacturer shall design the optimum motor stand and base-plate based on their pump/motor.

<Reference only>

The following alternative plan 1 is shown as a example (refer to Figure 2-1); The plan is to strength the rigidity of the base-plate for the pump/motor and to support it on the column of the building without contacting the existing floor directly. Accordingly this plan can eliminate the ex-ordinary vibration by avoiding resonance with natural frequency of the floor because vibration of the pump/motor is not propagated to the floor directly. The base-plate for the pump/motor is fabricated with I-beam or H-beam and the steel plate is welded or bolted on the beam.

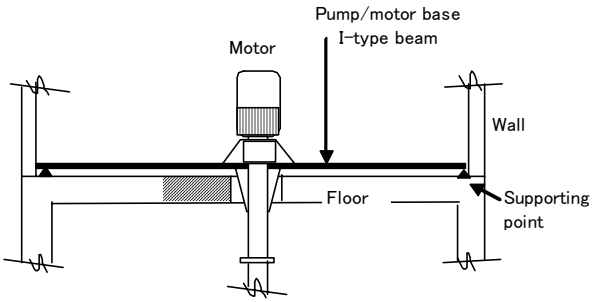


Figure 2-1 Base-plate for Pump/Motor

The following alternative plan 2 is shown as a example (refer to Figure 2-2);

Two-floors-supported pump is used and vibrated force from the pump and motor is broken up to the upper floor and the lower floor. Consequently vibration on the upper floor is less than it of one-floor-supported pump. Accordingly the possibility that vibration velocity on the floor is less than 0.6mm/sec becomes higher. Meanwhile, as the lower floor doesn't have rigidity to bear the pump load, the base-plate to support the pump should be designed newly for two-floors-supported pump.

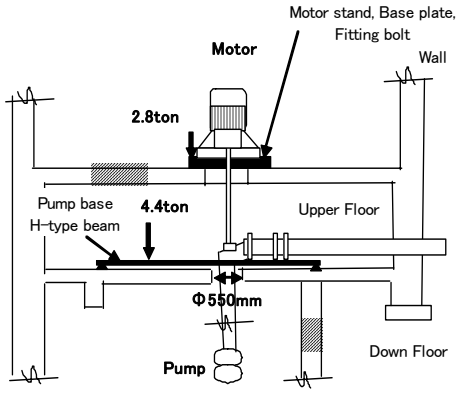


Figure 2-2 Two-floors-supported pump

d. Vibration by dynamic water flow

- The pump suction well is shown in Figure 2-3. PWS has a plan to dismantle the side wall near A2 pump in order to improve suction flow of A2 pump in the pump suction pit, if necessary.

  Therefore, the pump manufacturer shall carry out dynamic water flow analysis in the pump suction pit and incorporate the result of analysis into their design in order to prevent the pump from generating vibration.

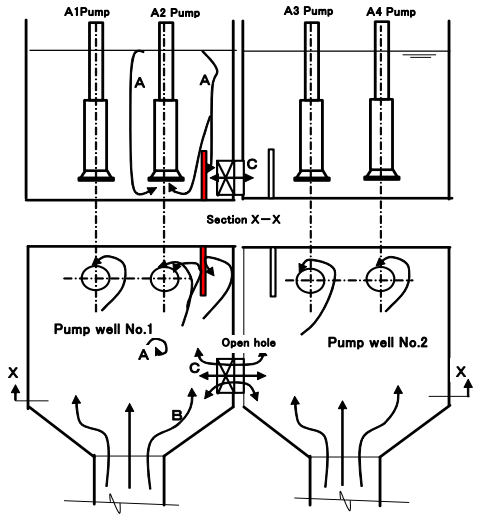


Figure 2-3 Pump suction well

e. Vibration criteria and limit

- The project is to improve the ex-ordinary vibration by countermeasure for the pump/motor side without change of civil and building structure in Mareza 2 pump station as described above. The vibration criteria for the upper floor where the pump/motor is fixed and the vibration limit for the pump/motor under the ordinary operation are shown in Table 2-5.

Table 2-5 Vibration Criteria and Limit

Vibration criteria of the upper floor where the pump/motor is fixed	Vibration limit for the pump/motor during the ordinary operation
0.6 mm/sec or less*	7.1mm/sec or less**

* : From the value measured at vibration test, vibration value at the base fixed on the upper floor was 0.6mm/sec. when vibration value of A3 pump/motor showed below 7.1mm/sec at single operation.

**: Vibration limit specified by ISO 10816-1

The vibration criteria of the upper floor to fix the pump/motor are the value measured at operation of the existing pump. When the existing pumps are replaced with new pumps/motors under the project, its value is expected below 0.6 mm/sec. accordingly the vibration limit for the pump/motor shall be 7.1mm/sec or less.

(2) Equipment plan

1) Quantity and specification of pump/motor

The quantity and specification of pumps/motors to be replaced under the project are shown below. The power supply for the motor shall be made by stepping down 10kV electrical power to 6kV by the existing transformer. The type and quantity of the pump/motor is shown below.

Table 2-6 Type and Quantity of Pump/Motor

Item	Type	Specification	Quantity
Pump	Vertical shaft mix-flow pump	320 l/s x 90 m	4
Motor	Vertical shaft motor	6 kV x 400 kW or less	4
Fitting		Bolt/Nut, Gasket, etc	1 lot

a. Specification of pump

Applicable code	: ISO
Type of pump	: Vertical shaft mix-flow pump
Connection with motor	: Direct connection
Rotating speed	: 1,500 rpm or less
Bearing temperature detector	: 2 pcs x Pt 100 Ohm at 0Deg. C
Material of main parts	: Casing – Cast iron
	: Impeller – Cast bronze
	: Shaft – Carbon steel
	: Sleeve – Cast bronze

b. Specification of motor

Applicable code	: IEC
Type of motor	: Totally enclosed fan cooled 3 phase squirrel cage induction motor
Nominal voltage	: 6,000 V
Frequency	: 50 Hz
Output	: 400 kW or less
Insulation	: Class F
Coil temperature detector	: 3 pcs x Pt 100 Ohm at 0Deg C
Bearing temperature detector	: 2 pcs x Pt 100 Ohm at 0Deg C

2) Pump control system

The pump control system for new four (4) pumps/motors in Mareza 2 pump station can include the following main items. The electrical system related to the pump/motor is shown in drawing no. 4.

- Operation and monitoring for 10 kV incoming feeder, 10 kV/6kV transformer, 6 kV switchgear and circuit breaker, etc. can be made.
- Power-on/off for the motor can be made.
- Electrical power consumption, voltage and current for the motor can be monitored.
- Coil temperature and bearing temperature for the motor can be monitored and the motor can be stopped at abnormal high temperature by use of the interlock circuit.
- Bearing temperature for the pump can be monitored and the pump can be stopped at abnormal high temperature by use of the interlock circuit.
- Water level in the pump suction pit can be monitored and the pump can be stopped at abnormal low water level by use of the interlock circuit.
- Pressure and flow rate in the pump discharge header piping can be monitored.
- Operation status and residual chlorine contents for the chlorine injection facilities can be monitored.
- Water level and air pressure in the air chamber of water hammer protection facilities can be monitored.

The scope of procurement under the project for pump control system is shown in the Table 2-7.

a. Quantity

Table 2-7 List of Quantity for Pump Control System

No.	Name of Equipment	Quantity
1	Pump control system	
	SCADA PC	3
	22 inch monitor (TFT monitor)	2
	50 inch monitor (LCD monitor)	1
	PLC (programmable logic controller)	1
	UPS (uninterrupted power supply)	1
	Control desk, server rack	1 lot
	I/O Panel	1
2	Field measuring instrument	
	Water level meter for pump suction pit	2
3	Emergency power supply unit	
	Battery	1 lot
	Battery charger	1

b. Specification

System configuration

System configuration of the pump control system is shown in drawing no. 4. The pump control system shall be installed in the control room of Mareza 2 pump station.

Function of pump control system

The pump control system has the following functions;

<Data collection and monitoring>

The data from various contact points are collected from the electrical power receiving/distribution facilities, pump/motor, etc. The signals of RTD (resistance temperature device), voltage/current, etc are converted to the adequate data with the signal converter and then transmitted to PLC for input

The collected data are compiled and processed with SCADA PC and are monitored with the graphics displayed on the monitors. The graphic monitors have the following functions;

- To monitor the main electrical trunk line of the electrical power receiving and distribution facilities with mimic trunk line on the monitor
- To monitor operation status of Mareza 2 pump station
- To monitor operation status of each pump/motor
- To monitor operation status of the ancillary facilities for the pump station.
- To monitor status of various kind of failures
- To monitor various kind of operation parameters such as flow rate, pressure, temperature, etc
- To monitor real-time trend in graph of various measured process values

<Pump and electrical operation and control>

The pump control system integrates the condition of pump initial start and/or interlock circuit, and is used to change pump and electrical circuit breaker in on/off mode using a mouse on the monitor. These operations are carried out through duplex PLC in order to take redundancy to the system. The electrical facilities possible to be operated from this control system shall be as follows;

- For 10kV power receiving and distribution panels – Switchgear for power receiving x 2 sets and switchgear for power distribution x 2 sets
- For 6 kV power receiving and distribution panels – Switchgear for power receiving x 2 sets and switchgear for motor of pump x 4 sets

Function of computer and PLC

The computer and PLC to be used in this system have the following functions;

<SCADA PC>

SCADA PC collects and stores data to be monitored for the facilities and indicates operation status, alarm, process values, etc in the form of graphic display. In addition, it outputs operation signals to switchgear and/or circuit breaker of the power receiving and distribution facilities and

start/stop signals to the pumps/motors by using a mouse on the monitor in two (2) steps

<PLC>

PLC collects process data in the pump station and transmits those to SCADA PC. In addition, it outputs signals of on/off to the pump start-up panel and the power receiving facilities.

Duplex PLC shall be used in order to secure input/output.

Input/output signals are shown in drawing no. 5.

Specification of monitoring equipment

All equipment, control desk, server rack, etc shall be of high-performance and heavy duty type designed for continuous industrial service. This monitoring system shall contain products of a single manufacturer as far as possible taking into account consistency of system and easiness of maintenance, and shall consist of equipment models which are currently in production.

- Control Desk

Quantity	: 1 lot
Type	: Indoor use, OA desk type
Accessory	: 2 chairs

- Server Rack

Quantity	: 1
Type	: Indoor type, computer rack type
Accessory	: Table tap

- SCADA PC

Quantity	: 3
CPU	: Intel Xeon Processors 2, 4GHz (Quad Core)
Memory	: 4 GB (with ECC)
HDD	: 450 GB x 2 pcs (with RAID 1)
Optical Drive	: 24 x CD-ROM/RW, 8 x DVD-R, 6 x DVD-RW
Network Interface	: 100 Base-TX / 1000 Base-TX
Operating System	: Windows 2003 Server Standard

- TFT Monitor

Quantity	: 2
Type	: TFT
Size	: 22 inch wide size
Resolution	: 1,680 x 1,050 dots

- LCD Monitor

Quantity	: 1
Type	: LCD
Size	: 50 inch
Resolution	: 1,920 x 1,080 dots

- PLC

Quantity	: 1

CPU	: 64 ksteps or more
Function	: Duplex function
I/O Unit	: Digital / Analog
No. of I/O	: Refer to I/O Lists (Drawing no. 5)
Interface	: 100 Base-TX

- I/O Panel

Quantity	: 1
Type	: Indoor use, metal-enclosed, self standing type
Main Parts	: MCCB, Isolator, RTD Converter (Pt 100 / Current), Power Distributor, Current Converter, Duplex PLC(refer to item "vi")
Panel Protection	: IP 43 or more

- UPS

Quantity	: 1
Type	: Continuous inverter power supply
Capacity	: 5 kVA
AC Input	: AC 230 V, 50 Hz
AC Output	: AC 230 V, 50 Hz
Back-up Time	: 120 minutes
Interface	: Ethernet

Specification for measuring instrument

- Water Level Instrument

Quantity	: 2
Type	: Ultrasonic type
Measuring Range	: 0-5m
Non-detectable Range	: 0.6m or less
Accuracy	: Within +/-1 cm
Power Supply	: AC 230 V, 50 Hz or DC 24 V
Output	: DC 4-20 mA

Specification for battery and battery charger

- Battery

Quantity	: 1 set
Type	: Vent type lead battery, high rate discharge characteristics paste type, HS type
Capacity	: 135 Ah / 5 hours
Nominal Voltage	: 48.0 V
No. of cells	: 24 cells
Accessory	: Battery cells stand, electrode for low liquid level alarm, connection cable for cells

- Battery charger

Quantity	: 1
Type	: Indoor use, metal-enclosed, self standing type
Power Supply	: 3 phase, 3 wires, 400 V, 50 Hz
Cooling System	: Natural cooling

Rating	: Continuous
Voltage Adjustable System	: Thyristor type automatic constant voltage
Charging System	: Automatic (floating or equalizing charge) and manual
Silicon Dropper	: More than 10 A
Output Signal	: Charging current / voltage, charging system selection, failure

3) Monitoring system

Currently six (6) pump stations are operating to cater to the needs of hourly and daily variation in water demand. Each pump station is operated independently and is not operated optimally taking into account overall water supply system. This results into problems, such as delay in action for overload on pump or overheating of bearing which causes pump failure, and difficulty in selection of number of operating pumps. Also, the communication with other pump stations is poor in case when pump failure occurs, and hence overall water supply is not carried out in smooth manner.

Under this situation, this monitoring system aims at development of the system that would be able to grasp pump operation status and pump discharge flow rate/pressure in all the pump stations in real time in the main control center. Based on the observed real time data, the operator in the main control center can give appropriate instructions to each pump station in order to operate the pumps based on the need. As a result, coordinated operation can be made, and optimum water supply flow rate can be supplied to each District Meter Area (hereinafter to be referred as DMA) resulting into more stable water supply.

The monitoring system for the distribution network monitors inflow rate/pressure in each DMA and the operator in the main control center can give instructions for opening/closing of the valve in DMA based on need. This aims at improving water distribution by prevention of biased flow and makes the distribution more even.

The monitoring system for residual chlorine contents at the end of piping network monitors its contents automatically because chlorine rate consumed in the network piping is different depending on water temperature or scales accumulated in the pipe. Accordingly, the bacteria in the pipe are disinfected and through this the occurrence of non chlorine condition could be avoided. This mentoring system can put the following items into action mainly;

- To monitor water flow /pressure of the main header for pump discharge line and operation status of pump/motor at each pump station, and to make adequate control of pumps through the pump operator by grasping pump operation status
- To monitor inflow and pressure of DMA and to make adequate valve control through PWS employee so as to make inflow suitable for each DMA

- To monitor residual chlorine contents at the end of network piping and to set up chlorine injection rate through operator in each pump station
- To monitor water level of water reservoir and to control water level by operation of valve in the reservoir through PWS employee
- To accumulate and analyze data monitored at the main control center

a. The location for the monitoring

The locations to be monitored by this monitoring system are as follows;

- 7 pump stations
- 4 reservoirs
- 14 DMAs
- 7 points at end of network piping

The locations to be monitored by this monitoring system are shown in Figure 2-4.

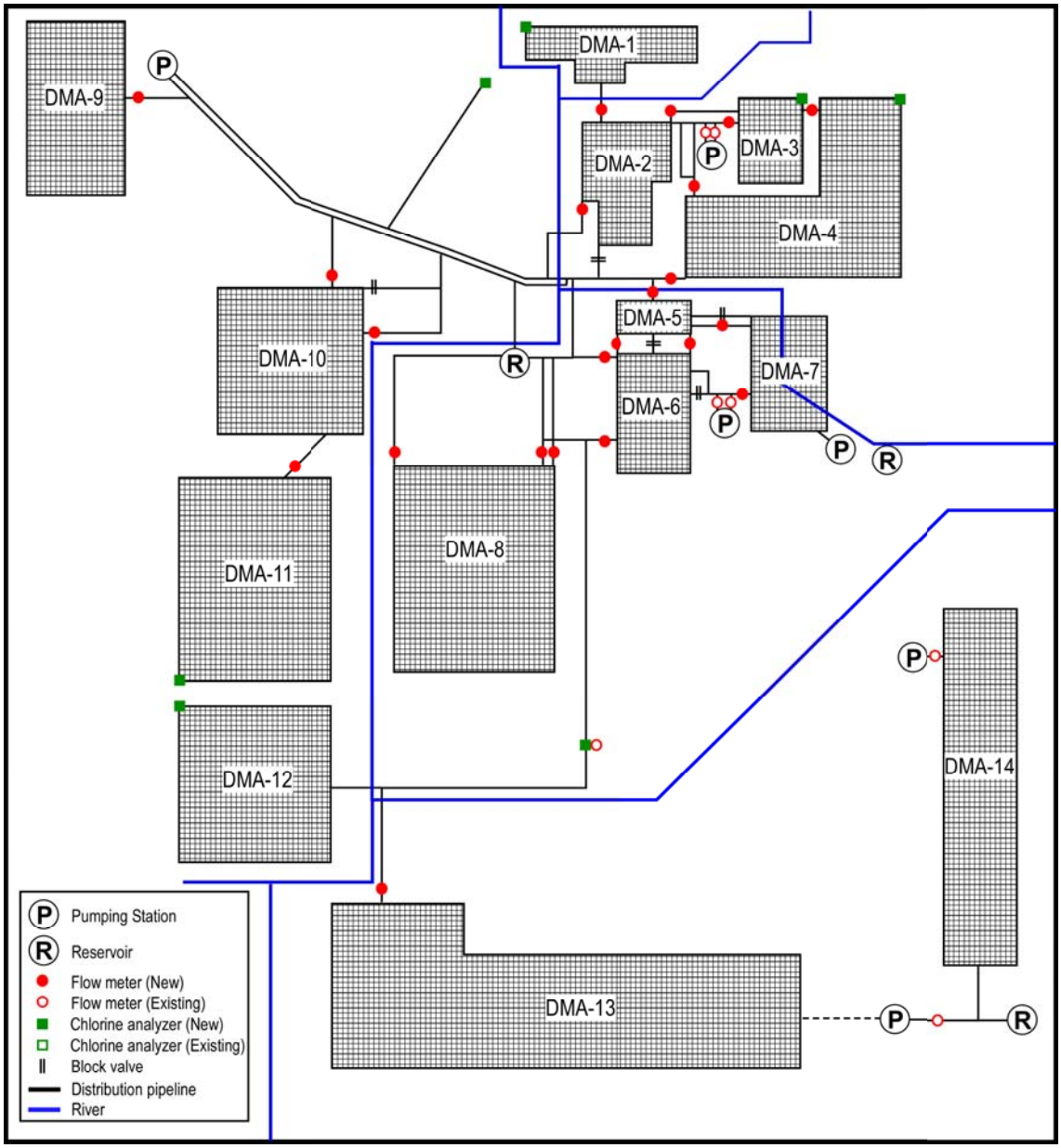


Figure 2-4 Facilities to be monitored

b. Quantity of Monitoring Equipment

The quantities of equipment to be procured under the project are shown in Table 2-8.

Table 2-8 List of Quantity of Monitoring Equipment

SCADA Equipments		Main Application	Main Control Center (MCC)	Mareza Old Pump Station	Mareza New Pump Station	Zagoric Pump Station	Cemovsko Pump Station	Miljes Pump Station	Dinosa Pump Station	Vuksanlekici Pump Station	DMA (PT and Chlorine)	DMA (PT and FT)	Reservoir	Total
Equipment for Monitoring System	SQL Server	Data storage collected in MCC	2											2
	SCADA Server	Monitoring and collection of operation data in MCC	1											1
	Communication Server	Collection of real-time data	1											1
	SCADA HMI	Display of operational status	2											2
	Fire Wall	Protection from illegal invasion	1	1	1	1								4
	TFT Monitor	20 inch monitor	2											2
	50" Display	50 inch, large size monitor	2											2
	RGB Switch	Mechanical type switch	2											2
	Layer 2 SW	Network relay equipment	1											1
	Laser Printer	Printing of data	1											1
	GPRS Router	Wireless telecommunication equipent					1	1	1	1	7	23	4	38
	UPS	Uninterruptible power supply system	1	1	1	1	1	1	1	1	7	23	4	42
	Touch Panel	Instruction panel		1	1	1	1	1	1	1			1	8
	PLC	Collection and transmission of operation data		1	1	1	1	1	1	1	7	23	4	41
	Server Rack	Sever rack in MCC	1											1
	Control Desk	Control desk in MCC	1											1
	Interface Panel	Storage box of equipments for monitoring and transmission of operation data		1	1	1	1	1	1	1	7	23	4	41
Instrument	Pressure	Measurement of water pressure									7	29		36
	Flow	Measurement of water flow			1	1	1					22		25
	Residual Chlorine	Measurement of residual chlorine									7			7
	Level	Measurement of water level				1	1	1	1	1			8	13

In addition to the above listed items, the following equipment shall be procured;

i) One portable type ultrasonic flow meter to calibrate the fixed type flow meter to be installed in each DMA

ii) Two manual shut-off valves to divide DMA

c. Specification for monitoring system

System configuration for the monitoring system is shown in drawing no.6. The location to install the monitoring equipment is as follows;

- Main control center : 1 place
- Pump stations* : 7 places
- Reservoir** : 1 place

Note: *Each pump station monitors its own operations only.
**In only Ljubovic reservoir, it is monitored its own operation.

The locations to collect data are as follows;

- Pump stations : 7 places

- Reservoirs : 4 places
- DMA : 23 places
- Ends of network piping : 7 places

Telecommunication system for monitoring system

Data transfer shall be made applying the following two telecommunication systems;

- Wireless System: GPRS (General Packet Radio Service)
- Wired System: MIP Net (Montenegrin IP Network: Optical Fiber Network)

The telecommunication system to be used at each location is shown in drawing no. 6.

d. Function of monitoring system

The monitoring system has the following functions;

SCADA HMI (Human Machine Interface)

The SCADA HMI shall include full-graphic technology and proprietary Windows based on SCADA software. It shall also have interface activities between an operator and computer system. Interface activities shall be made with tool bar, dialog box and icon operation using a mouse and keyboard through Windows. The graphic supervision shall have the following functions;

- Display of operational status
- Display of process/operation data for wide area
- Display of process/operation data for each pump station, DMA and reservoir

Data acquisition and storage

The measured values and contact points data from each facility shall be collected. The digital and analog data of various signals collected from each facility shall be stored in the database for monitoring of real time operation, preparation of trend graphs and report, engineering analysis, etc. Operation and failure logs shall be indicated in a chronological list in the form of date and time-stamped message.

Historical information system

The monitoring system shall be provided with the capability to generate historical trend graphs and daily, monthly and annual reports. These reports shall be prepared and printed by efficient and easy-to-use software tools.

e. Server and PLC

The severs and PLC to be used in the monitoring system shall have the following functions;

Communication server

The communication server shall collect real-time data from PLC connected to GPRS or optical fiber network and will be able to implement remote operation command for the pumps in the pump stations in future. Also this sever shall be used as a relay server between GPRS and Ethernet communication. The collected data shall be relayed to the SCADA server.

- Data sampling frequency: every one minute or more (per facility)
- Communication system between PLC and this server: GPRS network (approx. 64 Kbps)
- Communication system between this sever and SCADA server: TCP/IP Socket

SCADA server

The SCADA server shall collect all data of pump stations, DMAs and reservoirs through the communication server and shall store these data. In addition, it can automatically prepare daily, monthly and annual reports from the collected data.

- Data sampling frequency: every 10 seconds
- Communication system: TCP/IP Socket
- Report data form: Microsoft EXCEL XP or more

SQL server

The SQL server shall store the last one year data for each facility collected from the SCADA server. These stored data can be sent to the SCADA HMI and can be monitored there.

- Process data storage period: 1 year
- Historical data storage period: 1 year
- Report data storage period: 10 year
- Basic sever software: Microsoft SQL Server 2000

Fire wall

The fire wall supervises communication with the computer located out of the network in order to protect illegal invasion from outside to the SCADA system and strengthens security of computer network for the SCADA system. This fire wall shall be used for optical fiber network.

PLC

The PLC shall collect various process data of pump stations, reservoirs and DMAs, and shall add these data to date and time-stamped message, and send to the communication server through the network. Input/output items for monitoring are shown in Drawing No. 7

f. Specification for monitoring equipment

All equipment shall be of high-performance and heavy duty type suitable for long-term

continuous industrial uses. The SCADA system shall contain products of a single manufacturer, as far as possible, and shall consist of equipment models which are currently in production.

- Control desk

Quantity	: 1 lot
Type	: Indoor use, OA desk type
Accessory	: 2 chairs

- Server rack

Quantity	: 1
Type	: Indoor type, computer rack type
Console for maintenance	: 15 inch TFT
Accessory	: Table tap

- Communication server

Quantity	: 1
CPU	: Intel Xeon Processors 2, 4GHz (Quad Core)
Memory	: 4 GB (with ECC)
HDD	: 450 GB x 2 pcs (with RAID 1)
Optical Drive	: 24 x CD-ROM/RW, 8 x DVD-R, 6 x DVD-RW
Network Interface	: 100 Base-TX / 1000 Base-TX
Operating System	: Windows 2003 Server Standard

- SCADA server

Quantity	: 1
CPU	: Intel Xeon Processors 2, 4GHz (Quad Core)
Memory	: 4 GB (with ECC)
HDD	: 450 GB x 2 pcs (with RAID 1)
Optical Drive	: 24 x CD-ROM/RW, 8 x DVD-R, 6 x DVD-RW
Network Interface	: 100 Base-TX / 1000 Base-TX
Operating System	: Windows 2003 Server Standard

- SQL server

Quantity	: 2
CPU	: Intel Xeon Processors 2, 4GHz (Quad Core)
Memory	: 4 GB (with ECC)
HDD	: 450 GB x 2 pcs (with raid 1)
Optical Drive	: 24 x CD-ROM/RW, 8 x DVD-R, 6 x DVD-RW
Network Interface	: 100 Base-TX / 1000 Base-TX
Operating System	: Windows 2003 Server Standard

- Fire wall

Quantity	: 1 set for MCC, 3 sets for terminal
Max. Throughput of FW	: 300 MBps for MCC, 150 MBps for terminal
Max. No. of Sessions for VPN	: 250 sessions for MCC, 25 sessions for terminal
Function	:VPN (IP Sec), Packet Filtering, Invasion Protection
Network Interface	: WAN side/100 Base-TX, LAN side/100 Base-TX

- SCADA HMI

Quantity	: 2
CPU	: Intel Core 2 Duo E4500 Processor (2.2 GHz, 2 MB L2 cache, 800 MHz)
Memory	: 2 GB
HDD	: 250 GB
Optical Drive	: 24 x CD-ROM/RW, 8 x DVD-R, 6 x DVD-RW
Network Interface	: 100 Base-TX / 1000 Base-TX
Operating System	: Windows XP Professional
Application	: Office 2007

- TFT monitor

Quantity	: 2
Type	: TFT
Size	: 22 inch wide size
Resolution	: 1,680 x 1,050 dots

- LCD monitor

Quantity	: 2
Type	: LCD
Size	: 50 inch
Resolution	: 1,920 x 1,080 dots

- Laser printer

Quantity	: 1
Type	: Color / Semiconductor Laser + Electronic Photo Type
RAM Size	: 96 MB
Paper Size	: A3, A4
Network Interface	: 100 Base-TX / 1000 Base-TX

- RGB switch

Quantity	: 2
Type	: Mechanical type switch
No. of Port	: More than 3 ports for Input
Accessory	: 2 Port RGB Distributor-3 sets

- Interface panel

Quantity	: 41
Type	: Indoor use, metal-enclosed, self standing or wall hanging type
Main Parts	: MCCB, Isolator, GPRS router, PLC, UPS, Touch Panel
Panel Protection	: IP 43 or more

- Touch panel

Quantity	: 8
Type	: TFT, color
Resolution	: 800 x 600 dots

- PLC

Quantity	: 41
CPU	: 64 ksteps or more
I/O Unit	: Digital / Analog
No. of I/O	: Refer to I/O Lists (drawing no. 7)
Interface	: 100 Base-TX

- GPRS router

Quantity	: 38
Type	: Industrial Use
Interface	: Ethernet

- UPS

Type	: Continuous inverter power supply
Quantity / Capacity	: 1 set / 5 kVA for MCC, 3 sets / 1.5 kVA for terminals w/FW, 38 sets / 750 VA for terminals w/o FW
AC Input	: AC 230 V, 50 Hz
AC Output	: AC 230 V, 50 Hz
Back-up Time	: 120 minutes
Interface	: Ethernet or serial port

- Layer 2 switch

Quantity	: 1
Type	: Layer 2 (Data Link Layer)
Network Interface	: 100 Base-T
No. of Port	: 8 or more

g. Specification for measuring instruments

- Pressure instrument

Quantity	: 36
Type	: Weather proof type
Mounting	: Stem mounting
Housing	: Stainless steel or aluminum alloy
Power Supply	: DC 24 V
Output Signal	: 4-20 mA DC, 2-wires
Accuracy	: Within +/－1 % at full scale
Measuring Range	: 0-1.6 Mpa

- Flow instrument

Quantity	: 25
Type	: Ultrasonic flow meter, Clamp-on mounting, both flow measuring type
Measuring range	: 0.5-20 m/s
Accuracy	: +/－1.0 % at the maximum flow
Power Supply	: AC 230 V, 50 Hz
Annouciator	: LC display
Analog Output	: 4-20 mA
Digital Output	: More than 1 point

Panel Protection : IP 65 or more

- Flow instrument (portable type)

Quantity : 1
Type : Ultrasonic flow meter, Clamp-on mounting, both flow measuring type
Accuracy : +/－ 1.0 % at the maximum flow
Power Supply : AC 230 V, 50 Hz or Battery
Annouciator : LC display
Analog Output : 4-20 mA
Interface : RS232C
Pipe Size to be measured : 25-800 mmφ

- Residual chlorine analyzer

Quantity : 7
Method of Analysis : Polarographic method
Measuring Range : 0-3 mg/l or more
Minimum Detection Value : 0.05 mg/l or less
Minimum Flow for Detection : 350 ml/min or less
Sample Flow : 200-500 ml/min
Sample Pressure : 0.2 Mpa or less
Power Supply : AC 230 V, 50 Hz
Output : 4-20 mA

- Water level instrument

Quantity : 8
Type : Ultrasonic type
Measuring Range : 0-5m
Non-detectable Range : Less than 0.6m
Accuracy : Within +/- 1cm
Power Supply : AC 230 V, 50 Hz or DC 24 V
Output : DC 4-20 mA

- Water level instrument

Quantity : 5
Type : Pressure type
Measuring Range : 0-20m
Accuracy : 0.3%

- Shut-off valve for DMA

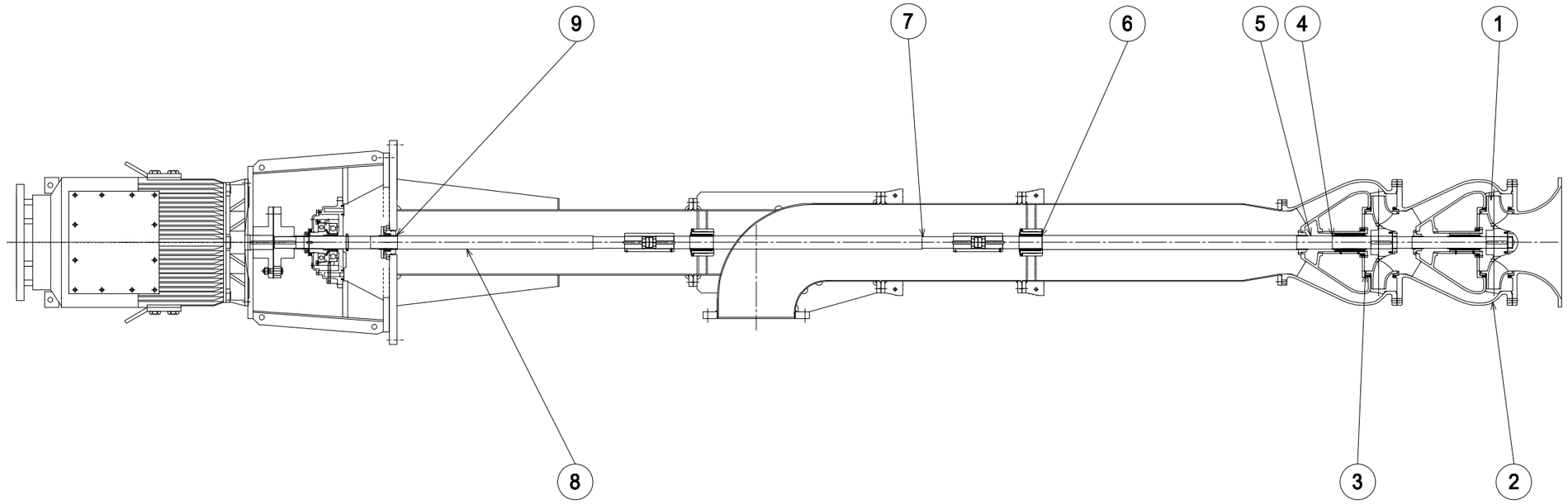
Quantity : 1set (80 mmφ), 1set (150 mmφ)
Type : Flange type manual sluice valve
Material for main parts (body) : Ductile cast iron

2－2－3　Outline Design Drawing

The drawings listed in the Table 2-9 are prepared based on the outline design.

Table 2-9　Drawing List

Drawing Title	Drawing No.
Vertical Pumps Outline & Sectional Drawing	1
Vertical Pump/Motor Installation Drawing	2
Electrical Single Line Diagram for Mareza 2 Pump Station	3
Pump Control System Configuration Drawing	4
Pump Control System Input/Output list	5
Monitoring System Configuration Drawing	6
Monitoring System Input/Output List	7



NO.	NAME OF PART	NAME / MATERIAL NO.			QUANT. FOR 1 SET	REMARKS
1	IMPELLER	BRONZE CASTING			2	
2	DISCHARGE BOWL	CAST IRON			2	
3	CASING RING	BRONZE CASTING			4	
4	UPPER BUSH SLEEVE	BRONZE CASTING			2	
5	LOWER SHAFT	CARBON STEEL			1	
6	INTERMEDIATE BEARING SLEEVE	BRONZE CASTING			2	
7	INTERMEDIATE SHAFT	CARBON STEEL			1	
8	UPPER SHAFT	CARBON STEEL			1	
9	UPPER BUSH SLEEVE	BRONZE CASTING			1	

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IN THE CAPITAL CITY OF PODGORICA IN MONTENEGRO

Vartical Pump Outline & Sectional Drawing

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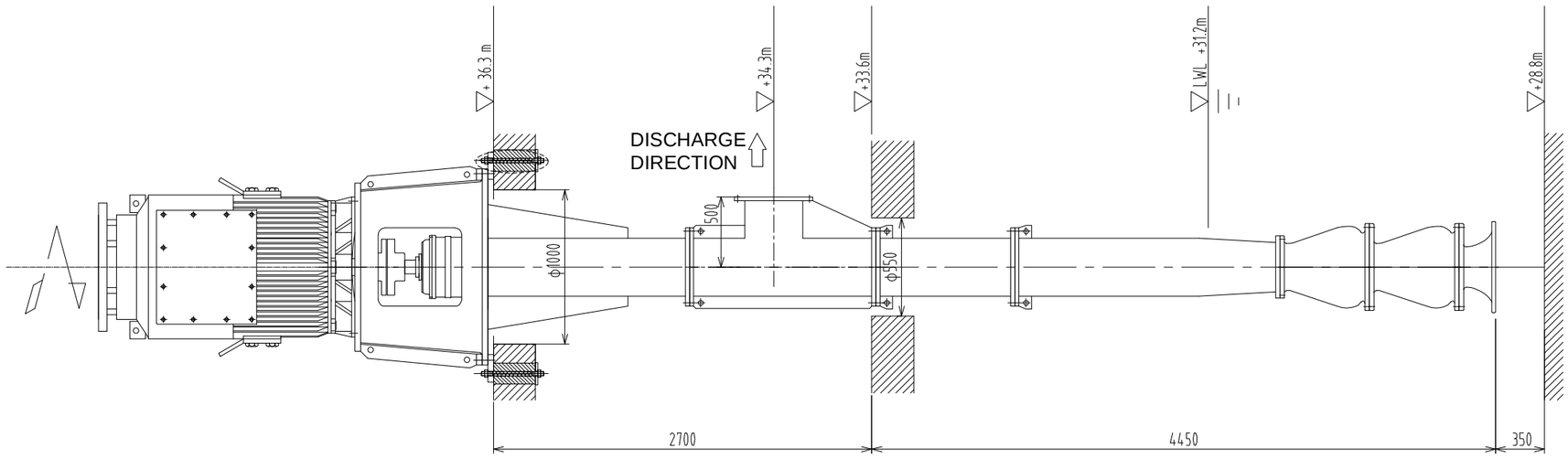
SCALE	
DWG. NO.	(1) 2-27◇



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Vartical Pump / Motor Installation Drawing

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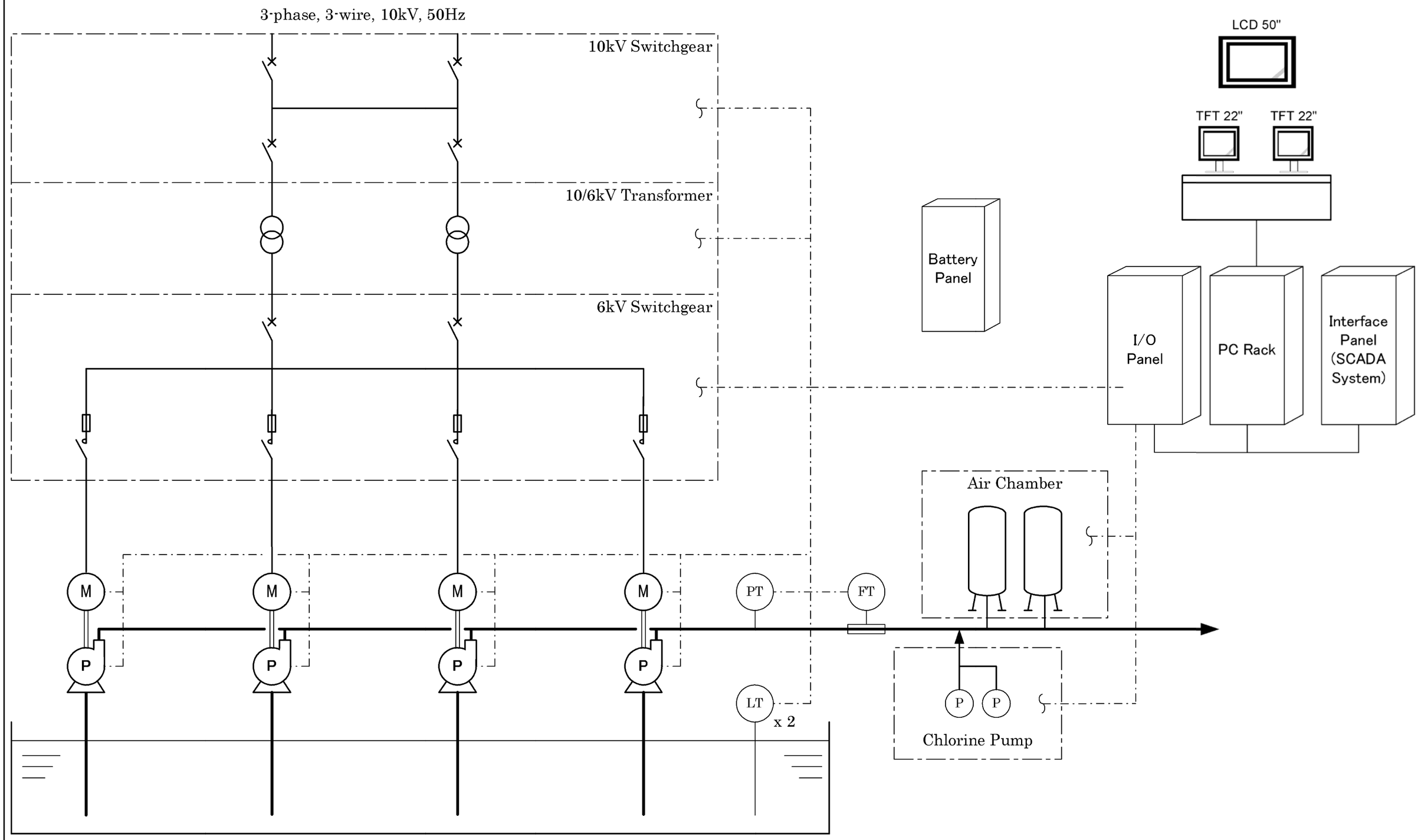
DWG. NO.	(2) 2-29◇

Electrical System in Mareza New Pump Station



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Electrical Signal Line Diagram for Pump Station

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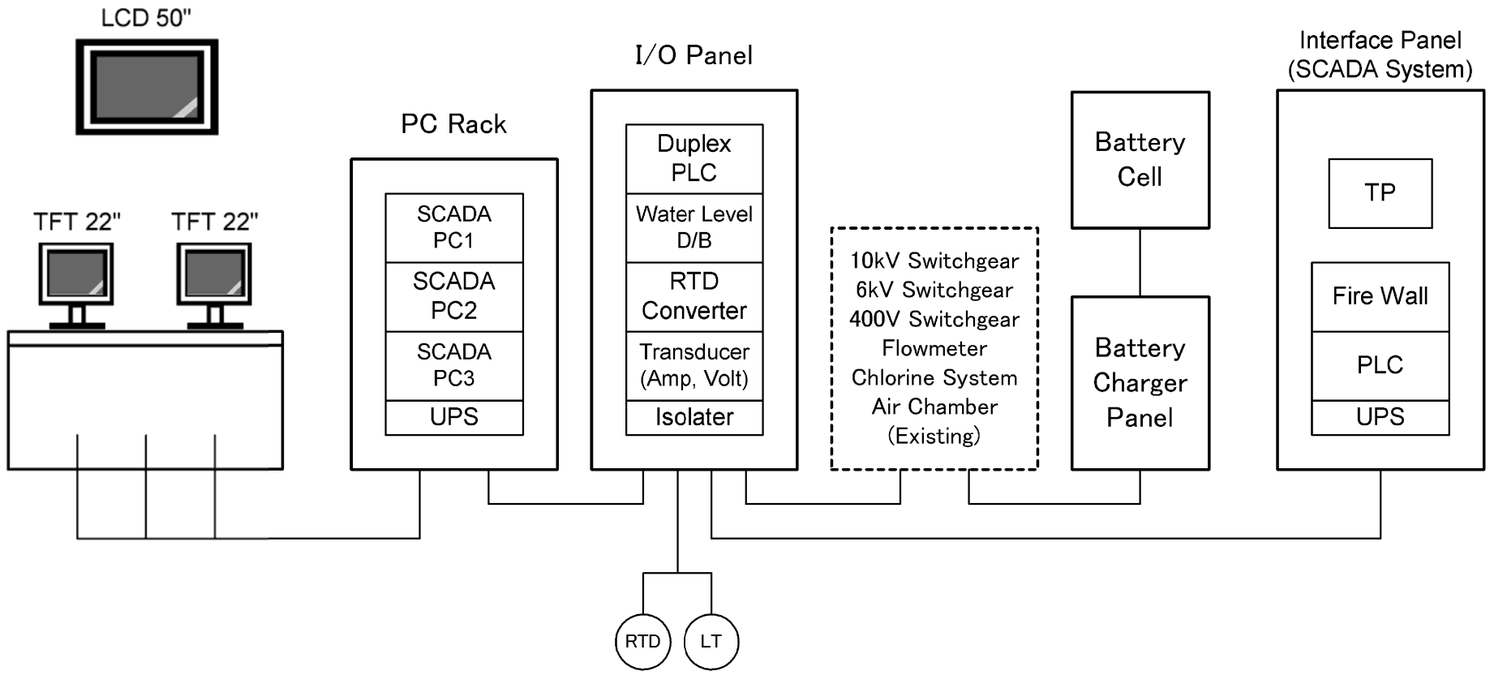
SCALE	
DWG. NO.	(3) 2-31◇



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Pump Control System Configration Drawing

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DWG. NO.	(4) 2-33◇

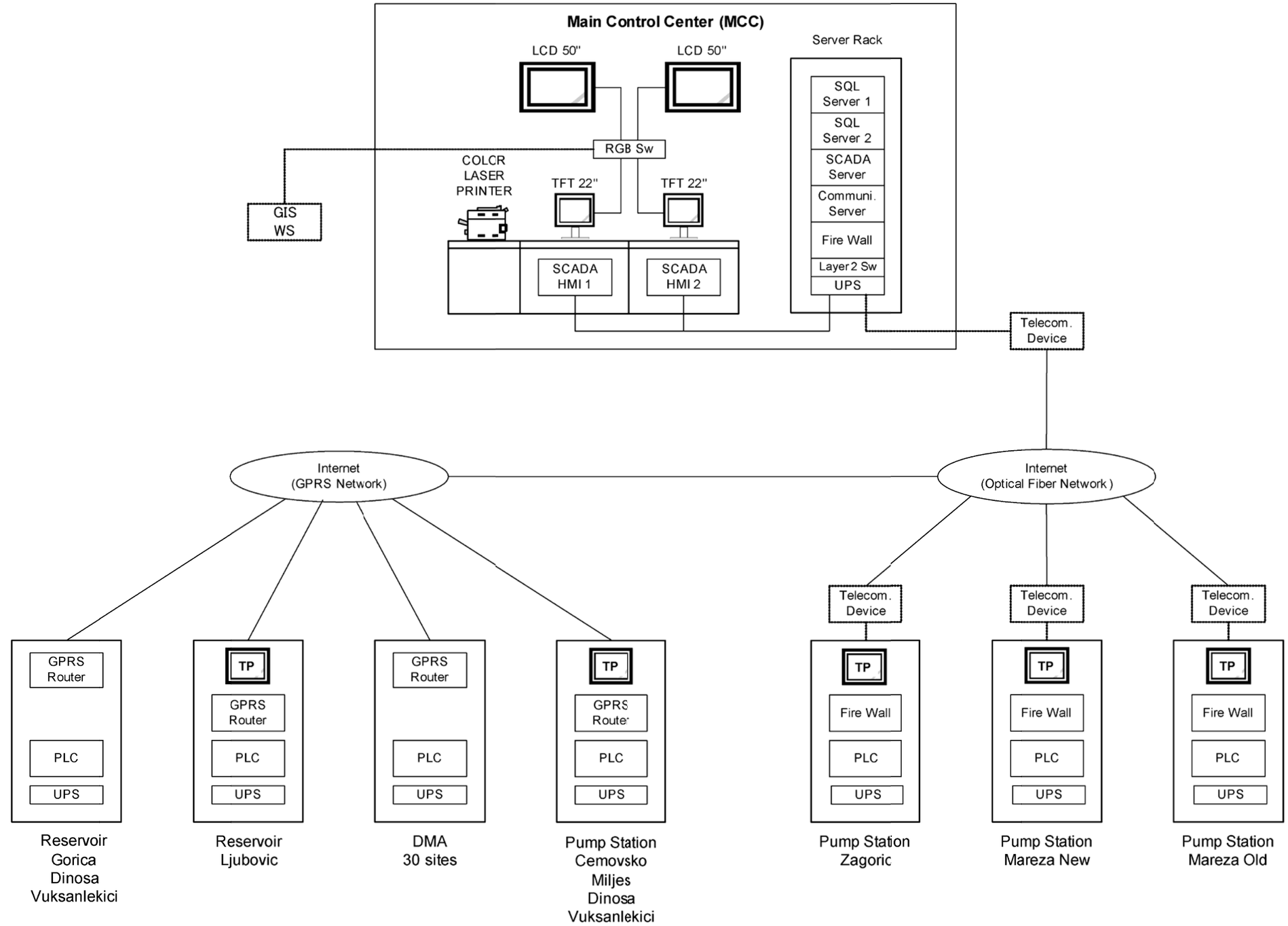
I/O List for Pump Monitoring and Operation Device (1/2)

No.	Item	Input		Output	Remarks
		Digital	Analog	Digital	
Mareza New PS					
	Electrical System				
1	10kV Incoming voltage		1		0 - 110V
2	10kV Incoming Current		2		0 - 5A
3	10kV Outgoing Current		2		0 - 5A
4	10kV Incoming Overcurrent	2			
5	10kV Oovervoltage	1			
6	10kV Outgoing Overcurrent	2			
7	Incoming frequency		1		4 - 20mA
8	Power factor		1		4 - 20mA
9	Electric power (kW)		1		4 - 20mA
10	Electric energy (kWh)	1			
11	10kV Incoming CB ON	2		2	
12	10kV Incoming ES ON	2			
13	10kV Incoming LBS	4			
14	10kV GPT DS ON	1			
15	10kV Outgoing CB ON	2		2	
16	10kV Outgoing LBS ON	2			
17	Transformer Overcurrent Alarm	2			
18	Transformer Overcurrent Trip	2			
19	Transformer Buchholtz Alarm	2			
20	Transformer BuchholtzTrip	2			
21	Transformer Temperature Alarm	2			
22	Transformer Temperature Trip	2			
23	6kV Incoming Current		2		0 - 5A
24	6kV Voltage		1		0 - 110V
25	6kV Incoming Overcurrent	2			
26	6kV Undervoltage	1			
27	6kV Incoming CB ON	2		2	
28	6kV Motor Feeder ES ON	4			
29	6kV Motor CB ON			4	
30	Battery Voltage		2		4 - 20mA
31	Battery Current		1		4 - 20mA
32	Battery Fault	2			
	Pump Signal/Measurement				
1	Suction water level		2		4 - 20mA
2	Suction water level low alarm	2			
3	Suction water level low low trip	2			
4	Motor current		4		0 - 5A
5	Motor winding temperature		12		RTD
6	Motor winding temperature high	12			
7	Motor winding temperature trip	12			
8	Motor upper bering temperature		4		RTD
9	Motor upper bering temperature high	4			
10	Motor upper bering temperature trip	4			
11	Motor lower bering temperature		4		RTD
12	Motor lower bering temperature high	4			
13	Motor lower bering temperature trip	4			
14	Pump bearing temperature		4		RTD
15	Pump bearing temperature high	4			
16	Pump bearing temperature trip	4			
17	Pump stop	4			
18	Pump running	4			
19	Pump fault	4			

I/O List for Pump Monitoring and Operation Device (2/2)

No.	Item	Input		Output	Remarks
		Digital	Analog	Digital	
20	Chlorine pump discharge pressure		1		4 - 20mA
21	Chlorine pump stop	2			
22	Chlorine pump running	2			
23	Chlorine pump fault	2			
	Station Signal/Measurment				
1	Pump discharge header pressure		1		4 - 20mA
2	Compressor running	1			
3	Compressor stop	1			
4	Compressor fault	1			
5	Pump discharge header flow		1		4 - 20mA
6	Residual chlorine contents		1		4 - 20mA
7	Chlorine gas leakage alarm	1			
8	Air chamber pressure		2		4 - 20mA
9	Air chamber pressure low	2			
10	Air chember water level		2		4 - 20mA
	TOTAL:	118	52	10	

SCADA System Configuration



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THE PREPARATORY SURVEY II ON THE PROJECT FOR URGENT REHABILITATION OF WATER SUPPLY SYSTEM IN THE CAPITAL CITY OF PODGORICA IN MONTENEGRO

Monitoring System Configration Drawing

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DWG. NO.	(6) 2-37◇

I/O List for SCADA System in Mijes P/S (1/2)

No.	Item	Input		Output	Remarks
		Digital	Analog	Digital	
Milješ PS					
	Electrical System				
1	Incoming voltage	1	1		4-20mA
2	Incoming current (A)	1	1		4-20mA
3	Incoming frequency	1	1		4-20mA
4	Power factor	1	1		4-20mA
5	Electric power (kW)	1	1		4-20mA
6	Electric energy (kWh)	1			
7	Overcurent	1			
8	Overvoltage	1			
9	Undervoltage	1			
10	Earth fault	1			
11	Circuit breker ON	1			
12	Load break switch ON	1			
13	Disconnecting switch ON	1			
	Pump Signal/Measurement				
1	Pump stop	3			
2	Pump running	3			
3	Pump fault	3			
4	Motor current		3		4-20mA
5	Motor power	3	3		4-20mA
6	Motor winding temperature		3		RTD
7	Motor winding temperature high	3			
8	Motor winding temperature trip	3			
9	Well water level		3		4-20mA
10	Well water level low alarm	3			
11	Well water level low low trip	3			
12	Chlorine pump discharge pressure		1		4-20mA
13	Chlorine pump stop	2			
14	Chlorine pump running	2			
15	Chlorine pump fault	2			
	Station Signal/Measurment				
1	Pump discharge header pressure		2		4-20mA
2	Pump discharge header flow		2		4-20mA
3	Residual chlorine contents		2		4-20mA
4	Chlorine gas leakage alarm	1			
	Frequency converter (1 set)				
1	FC start	1			
2	FC stop	1			
3	Runing mode local	1			RS 485
4	Runing mode remote	1			RS 485
5	Level set point (m)	1			RS 485
6	Pressure set point (bar)	1			RS 485
7	Flow set point (l/s)	1			RS 485
8	Actual setup	4			RS 485
9	Frequency converter running	1			RS 485
10	Frequency converter sleep mode	1			RS 485
11	Frequency converter stoped	1			RS 485
12	Frequency converter failure	1			RS 485
13	Frequency (Hz)	1			RS 485
14	Frequency converter warning	1			RS 485
15	Frequency converter alarm	1			RS 485
	Soft starter (2 set)				
1	SS start	2			
2	SS stop	2			

I/O List for SCADA System in Mijes P/S (2/2)

No.	Item	Input		Output	Remarks
		Digital	Analog	Digital	
3	Runing mode local	2			RS 485
4	Runing mode remote	2			RS 485
5	Soft starter starting	2			RS 485
6	Soft starter by passed	2			RS 485
7	Soft starter ready	2			RS 485
8	Soft starter failure	2			RS 485
	TOTAL:	78	19		

I/O List for SCADA System in Cemovsko P/S (1/2)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
Čemovsko Polje PS					
	Electrical System (Električni sistem)				
1	Incoming voltage	1	1		4-20mA
2	Voltage	1	1		4-20mA
3	Incoming frequency	1	1		4-20mA
4	Power factor	1	1		4-20mA
5	Electric power (kW)	1	1		4-20mA
6	Electric energy (kWh)	1			
7	Overcurent	1			
8	Overvoltage	1			
9	Undervoltage	1			
10	Earth fault	1			
11	Circuit breker ON	1			
12	Load break switch ON	1			
13	Disconnecting switch ON	1			
14	Transformer winding temperature high	1			
15	Transformer buchholtz relay operated	1			
	Pump Signal/Measurement				
1	Well water level		5		4-20mA
2	Well water level low alarm	5			
3	Well water level low low trip	5			
4	Motor current		5		4-20mA
5	Motor power	5	5		4-20mA
6	Motor winding temperature		5		
7	Motor winding temperature high	5			
8	Motor winding temperature trip	5			
12	Pump stop	5			
13	Pump running	5			
14	Pump fault	5			
15	Chlorine pump discharge pressure		1		4-20mA
16	Chlorine pump stop	3			
17	Chlorine pump running	3			
18	Chlorine pump fault	3			
	Station Signal/Measurment (Signal stanice/mjerenja)				
1	Pump discharge header pressure		2		4-20mA
2	Pump discharge header flow		2		4-20mA
3	Residual chlorine contents		2		4-20mA
4	Chlorine gas leakage alarm	1			
	Frequency converter (1 set)				
1	FC start	1			
2	FC stop	1			
3	Runing mode local	1			RS 485
4	Runing mode remote	1			RS 485
5	Level set point (m)	1			RS 485
6	Pressure set point (bar)	1			RS 485
7	Flow set point (l/s)	1			RS 485
8	Actual setup	4			RS 485
9	Frequency converter running	1			RS 485
10	Frequency converter sleep mode	1			RS 485
11	Frequency converter stoped	1			RS 485
12	Frequency converter failure	1			RS 485
13	Frequency (Hz)	1			RS 485
14	Frequency converter warning	1			RS 485
15	Frequency converter alarm	1			RS 485
	Soft starter (1 set)				
1	SS start	1			

I/O List for SCADA System in Cemovsko P/S (2/2)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
2	SS stop	1			
3	Runing mode local	1			RS 485
4	Runing mode remote	1			RS 485
5	Soft starter starting	1			RS 485
6	Soft starter by passed	1			RS 485
7	Soft starter ready	1			RS 485
8	Soft starter failure	1			RS 485
	TOTAL:	91	27		

I/O List for SCADA System in Mareza Old P/S (1/2)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
Mareza Old PS					
	Electrical System				
1	Incoming voltage (10 KV)	2	1		4-20mA
2	Voltage (0,4 KV)	2	1		4-20mA
3	Incoming frequency	1	1		4-20mA
4	Power factor	1	1		4-20mA
5	Electric power (kW)	1	1		4-20mA
6	Electric energy (kWh)	1			
7	Overcurent	1			
8	Overvoltage	1			
9	Undervoltage	1			
10	Earth fault	1			
11	Circuit breker ON	1			
12	Load break switch ON	1			
13	Disconnecting switch ON	1			
14	Transformer winding temperature high	1			
15	Transformer buchholtz relay operated	1			
	Pump Signal/Measurement				
1	Pool water level		1		4-20mA
2	Pool water level low alarm	1			
3	Pool water level low low trip	1			
4	Motor current		5		4-20mA
5	Motor power	5	5		4-20mA
6	Motor winding temperature	15			
7	Motor winding temperature high	15			
8	Motor winding temperature trip	15			
9	Motor bering temperature		10		RTD
10	Motor bering temperature high	10			
11	Motor bering temperature trip	10			
12	Pump bearing temperature		5		RTD
13	Pump bearing temperature high	5			
14	Pump bearing temperature trip	5			
15	Pump stop	5			
16	Pump running	5			
17	Pump fault	5			
18	Chlorine pump discharge pressure		1		4-20mA
19	Chlorine pump stop	4			
20	Chlorine pump running	4			
21	Chlorine pump fault	4			
	Station Signal/Measurment				
1	Pump discharge header pressure		3		4-20mA
2	Pump discharge header flow		3		4-20mA
3	Residual chlorine contents		3		4-20mA
4	Chlorine gas leakage alarm	1			
	Frequency converter (2 set)				
1	FC start	2			
2	FC stop	2			
3	Runing mode local	2			RS 485
4	Runing mode remote	2			RS 485
5	Level set point (m)	2			RS 485
6	Pressure set point (bar)	2			RS 485
7	Flow set point (l/s)	2			RS 485
8	Actual setup	8			RS 485
9	Frequency converter running	2			RS 485

I/O List for SCADA System in Mareza Old P/S (2/2)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
10	Frequency converter sleep mode	2			RS 485
11	Frequency converter stoped	2			RS 485
12	Frequency converter failure	2			RS 485
13	Frequency (Hz)	2			RS 485
14	Frequency converter warning	2			RS 485
15	Frequency converter alarm	2			RS 485
	Soft starter (3 set)				
1	SS start	3			
2	SS stop	3			
3	Runing mode local	3			RS 485
4	Runing mode remote	3			RS 485
5	Soft starter starting	3			RS 485
6	Soft starter by passed	3			RS 485
7	Soft starter ready	3			RS 485
8	Soft starter failure	3			RS 485
	TOTAL:	187	41		

I/O List for SCADA System in Mareza New P/S (1/1)

No.	Item	Input		Output	Remarks
		Digital	Analog	Digital	
Mareza New PS					
	Electrical System				
1	Incoming voltage (10 KV)	2	1		PLC Network
2	Voltage (6 KV)	2	1		PLC Network
3	Incoming frequency	1	1		PLC Network
4	Power factor	1	1		PLC Network
5	Electric power (kW)	1	1		PLC Network
6	Electric energy (kWh)	1			PLC Network
7	Overcurent	1			PLC Network
8	Overvoltage	1			PLC Network
9	Undervoltage	1			PLC Network
10	Earth fault	1			PLC Network
11	Circuit breker ON	1			PLC Network
12	Load break switch ON	1			PLC Network
13	Disconnecting switch ON	1			PLC Network
14	Transformer winding temperature high	1			PLC Network
15	Transformer buchholtz relay operated	1			PLC Network
	Pump Signal/Measurement				
1	Pool water level		2		PLC Network
2	Pool water level low alarm	2			PLC Network
3	Pool water level low low trip	2			PLC Network
4	Motor current		4		PLC Network
5	Motor winding temperature		12		PLC Network
6	Motor winding temperature high	12			PLC Network
7	Motor winding temperature trip	12			PLC Network
8	Motor upper bering temperature		4		PLC Network
9	Motor upper bering temperature high	4			PLC Network
10	Motor upper bering temperature trip	4			PLC Network
11	Motor lower bering temperature		4		PLC Network
12	Motor lower bering temperature high	4			PLC Network
13	Motor lower bering temperature trip	4			PLC Network
14	Pump bearing temperature		4		PLC Network
15	Pump bearing temperature high	4			PLC Network
16	Pump bearing temperature trip	4			PLC Network
17	Pump stop	4			PLC Network
18	Pump running	4			PLC Network
19	Pump fault	4			PLC Network
20	Chlorine pump discharge pressure		1		PLC Network
21	Chlorine pump stop	2			PLC Network
22	Chlorine pump running	2			PLC Network
23	Chlorine pump fault	2			PLC Network
	Station Signal/Measurment				
1	Pump discharge header pressure		1		PLC Network
2	Compressor running	1			PLC Network
3	Compressor stop	1			PLC Network
4	Compressor fault	1			PLC Network
5	Pump discharge header flow		1		PLC Network
6	Residual chlorine contents		1		PLC Network
7	Chlorine gas leakage alarm	1			PLC Network
8	Air chamber pressure		2		PLC Network
9	Air chamber pressure low	2			PLC Network
10	Air chember water level		2		PLC Network
	TOTAL:	93	43		

I/O List for SCADA System in Zagoric P/S (1/2)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
Zagorič PS					
	Electrical System				
1	Incoming voltage (10 KV)	2	2		4-20mA
2	Voltage	2	2		4-20mA
3	Incoming frequency	1	1		4-20mA
4	Power factor	1	1		4-20mA
5	Electric power (kW)	1	1		4-20mA
6	Electric energy (kWh)	1			
7	Overcurent	1			
8	Overvoltage	1			
9	Undervoltage	1			
10	Earth fault	1			
11	Circuit breker ON	1			
12	Load break switch ON	1			
13	Disconnecting switch ON	1			
14	Transformer winding temperature high	1			
15	Transformer buchholtz relay operated	1			
	Pump Signal/Measurement				
1	Well water level		5		4-20mA
2	Well water level low alarm	5			
3	Well water level low low trip	5			
4	Motor current		5		4-20mA
5	Motor power	5	5		4-20mA
6	Motor winding temperature		9		RTD
7	Motor winding temperature high	9			
8	Motor winding temperature trip	9			
9	Motor bering temperature		4		RTD
10	Motor bering temperature high	4			
11	Motor bering temperature trip	4			
12	Pump stop	5			
13	Pump running	5			
14	Pump fault	5			
15	Chlorine pump discharge pressure		1		4-20mA
16	Chlorine pump stop	2			
17	Chlorine pump running	2			
18	Chlorine pump fault	2			
	Station Signal/Measurment				
1	Pump discharge header pressure		1		4-20mA
2	Compressor running	1			
3	Compressor stop	1			
4	Compressor fault	1			
5	Pump discharge header flow		2		4-20mA
6	Residual chlorine contents		2		4-20mA
7	Chlorine gas leakage alarm	1			
8	Air chamber pressure		1		4-20mA
9	Air chamber pressure low	1			
10	Air chember water level		1		4-20mA
	Frequency converter (1 set)				
1	FC start	1			
2	FC stop	1			
3	Runing mode local	1			RS 485
4	Runing mode remote	1			RS 485
5	Level set point (m)	1			RS 485
6	Pressure set point (bar)	1			RS 485
7	Flow set point (l/s)	1			RS 485

I/O List for SCADA System in Zagoric P/S (2/2)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
8	Actual setup	4			RS 485
9	Frequency converter running	1			RS 485
10	Frequency converter sleep mode	1			RS 485
11	Frequency converter stoped	1			RS 485
12	Frequency converter failure	1			RS 485
13	Frequency (Hz)	1			RS 485
14	Frequency converter warning	1			RS 485
15	Frequency converter alarm	1			RS 485
	Soft starter (4 set)				
1	SS start	4			
2	SS stop	4			
3	Runing mode local	4			RS 485
4	Runing mode remote	4			RS 485
5	Soft starter starting	4			RS 485
6	Soft starter by passed	4			RS 485
7	Soft starter ready	4			RS 485
8	Soft starter failure	4			RS 485
	TOTAL:	134	43		

I/O List for SCADA System in Dinosa P/S (1/1)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
Dinoša PS					
	Electrical System				
1	Incoming voltage	1	1		4-20mA
2	Incoming current (A)	1	1		4-20mA
3	Incoming frequency	1	1		4-20mA
4	Power factor	1	1		4-20mA
5	Electric power (kW)	1	1		4-20mA
6	Electric energy (kWh)	1			
7	Overcurent	1			
8	Overvoltage	1			
9	Undervoltage	1			
10	Earth fault	1			
11	Circuit breker ON	1			
12	Load break switch ON	1			
13	Disconnecting switch ON	1			
14	Transformer winding temperature high	1			
15	Transformer buchholtz relay operated	1			
	Pump Signal/Measurement				
1	Pump running mode auto	1			
2	Pump running mode manual	1			
3	Pump stop	2			
4	Pump running	2			
5	Pump fault	2			
6	Motor current		2		4-20mA
7	Motor power	2	2		4-20mA
8	Motor winding temperature		2		RTD
9	Motor winding temperature high	2			
10	Motor winding temperature trip	2			
11	Well water level		2		4-20mA
12	Well water level low alarm	2			
13	Well water level low low trip	2			
14	Chlorine pump discharge pressure		1		4-20mA
15	Chlorine pump stop	2			
16	Chlorine pump running	2			
17	Chlorine pump fault	2			
	Station Signal/Measurment				
1	Pump discharge header pressure		2		4-20mA
2	Pump discharge header flow		2		4-20mA
3	Residual chlorine contents		2		4-20mA
4	Chlorine gas leakage alarm	1			
5	Water level reservoir		1		4-20mA
6	Water level reservoir high	1			
7	Water level reservoir low	1			
	Soft starter (2 set)				
1	SS start	2			
2	SS stop	2			
5	Soft starter starting	2			RS 485
6	Soft starter by passed	2			RS 485
7	Soft starter ready	2			RS 485
8	Soft starter failure	2			RS 485
	TOTAL:	54	21		

I/O List for SCADA System in Vulsanlekici P/S (1/1)

No.	Item	Input		Output	Napomene
		Digital	Analog	Digital	
Vuksanlekici PS					
	Electrical System				
1	Incoming voltage	1	1		4-20mA
2	Incoming current (A)	1	1		4-20mA
3	Incoming frequency	1	1		4-20mA
4	Power factor	1	1		4-20mA
5	Electric power (kW)	1	1		4-20mA
6	Electric energy (kWh)	1			
7	Overcurent	1			
8	Overvoltage	1			
9	Undervoltage	1			
10	Earth fault	1			
11	Circuit breker ON	1			
12	Load break switch ON	1			
13	Disconnecting switch ON	1			
14	Transformer winding temperature high	1			
15	Transformer buchholtz relay operated	1			
	Pump Signal/Measurement				
1	Pump stop	2			
2	Pump running	2			
3	Pump fault	2			
4	Motor current		2		4-20mA
5	Motor power	2			4-20mA
6	Motor winding temperature		2		RTD
7	Motor winding temperature high	2			
8	Motor winding temperature trip	2			
9	Well water level		2		4-20mA
10	Well water level low alarm	2			
11	Well water level low low trip	2			
12	Chlorine pump discharge pressure		2		4-20mA
13	Chlorine pump stop	2			
14	Chlorine pump running	2			
15	Chlorine pump fault	2			
	Station Signal/Measurment (				
1	Pump discharge header pressure		2		4-20mA
2	Pump discharge header flow		2		4-20mA
3	Residual chlorine contents		2		4-20mA
4	Chlorine gas leakage alarm	1			
	TOTAL:	38	19		

I/O List for SCADA System in DMA (1/1)

No.	Item	Input		Output	Remarks
		Digital	Analog	Digital	
DMA					
1	Flow rate		23		4-20mA
2	Pressure-1		23		4-20mA
3	Pressure-2		7		4-20mA
4	Residual chlorine contents		7		4-20mA
5	Water level		8		4-20mA
6	Water level high	8			
7	Water level low	8			
	TOTAL		68		

JICA JAPAN INTERNATIONAL COOPERATION AGENCY	THE PREPARATORY SURVEY II ON THE PROJECT FOR URGENT REHABILITATION OF WATER SUPPLY SYSTEM IN THE CAPITAL CITY OF PODGORICA IN MONTENEGRO	DATE
	Monitoring System Input / Output List (12/12)	DWG. NO. (7-12)

2－2－4　Implementation Plan

2－2－4－1　Implementation Policy

The project is implemented in accordance with the conditions specified in Exchange of Notes (EN) and Grant Aid Agreement (GA) exchanged between the Capital City of Podgorica or the Government of Montenegro and the Government of Japan or JICA. The implementing agency in Montenegro is PWS affiliated to Podgorica. On the implementation of the project, PWS shall carry out operation and maintenance of the equipment. In addition, PWS should employ a consultant to receive services such as detail design, preparation of tender document, assistance of tender, supervision of procurement, etc during implementation of the project. Also PWS should consider making use of local contractors capable of installation work of equipment during implementation.

2－2－4－2　Implementation Conditions

The installation schedule of pumps shall be prepared taking into account operation plan of the existing pumps prepared by PWS. Currently PWS operates two (2) existing pumps. Accordingly two (2) out of four (4) pumps shall be replaced at a time so as to be able to operate two (2) existing pumps continuously during the replacement work with new pumps.

Regarding the communication system in the monitoring system to be carried out by PWS, it is required that PWS concludes an agreement with T-Com (private telecommunication company) in order to use their GPRS and/or Optical Fiber Cable. This agreement shall be concluded a few months ahead of commencement of the installation work done by PWS taking into account procurement period of T-Com.

Also, the installation and/or wiring work for interface panels, field instrument/transmitters (flow meters, pressure transmitters and residual chlorine analyzers) in the pump stations, reservoirs and DMA has to be undertaken in many places, their installation schedule shall be prepared taking into account sufficient time for installations.

Taking into account the local technical level, ease of maintenance work after handing over, availability of spare parts and services for the equipment, the products that are most suitable for PWS shall be selected out of the available local products, the third country products or Japanese products.

The implementing agency is PWS.

The Montenegrin side shall take care of implementation of the scope, import permission, tax

exemption, custom clearance and any other procedures for importing the equipment in timely manner.

The Japanese side is required to make sure of transportation status of the equipment, and take care of the equipment for custom clearance, receiving and installation so as to be executed promptly. Furthermore, the contractor shall take care of trial operation, operation/maintenance instruction and turn-over/hand over so as to be executed without delay.

2－2－4－3 Scope of Works

The work demarcation of procurement and installation between Japan side and Montenegro side under the project is presented in Table 2-10.

Table 2-10 Scope of Work

Items	Procurement	Installation
1. Mareza 2 pump station		
(1) Water distribution pump/motor and fitting	Japan	Japan/Montenegro*[1]
(2) Countermeasure for pump vibration prevention (if required)		
-For pump/motor	Japan	Japan
-For pump suction pit	-	Montenegro
(3) Pump control system and field instrument	Japan	Japan/Montenegro*[2]
2. Monitoring system		
(1) Monitoring system	Japan/Montenegro*[3]	Japan*[4]/Montenegro*[4]
(2) Field instrument (flow meter, pressure instrument, residual chlorine analyzer	Japan/Montenegro*[5]	Montenegro
(3) Telecommunication system	Montenegro	Montenegro

Note: *[1] Montenegro carries out dismantling work for cable and pumps/motors
*[2]Montenegro carries out dismantling work for pump control panel and cables connected to the panel
*[3]Montenegro carries out procurement work for power cable, control cable and kiosk for interface panel.
*[4]Japan carries out installation work in the main control center and Montenegro carries out all the remaining installation work.
*[5]Montenegro carries out procurement work for cables and piping materials to mount the field instruments.

2－2－4－4 Consultant Supervision

The project shall be implemented under Grant-Aid Cooperation System of Japan. The consultant shall prepare detail design and carry out procurement/installation supervision.

Detail Design

The consultant shall prepare detail design, carry out preparation of tender document, and other documents required for smooth implementation of the project, etc.

Tender

The consultant shall assist PWS in order to execute tender. The contract concluded after tender shall be effective after authorization of JICA.

Procurement・Installation Supervision

The consultant shall assist PWS and make an arrangement for the meeting with the procurement contractor, and shall execute inspections of the equipment before delivery from the factory. Furthermore, the consultant shall supervise the procurement contractor so as to give technical instruction to PWS and hand over maintenance manual to PWS securely, and shall assist the PWS in completing procurement・installation work of the equipment within the period specified in EN.

2－2－4－5 Quality Control Plan

The factory tests for the equipment shall be executed before delivery to ensure its quality. As for pump/motor, it shall be confirmed that the vibration value after installation・commissioning work is below vibration limit specified. As for the monitoring system, the Site Acceptance Test (SAT) in addition to the Factory Acceptance Test (FAT) shall be executed after delivery at site and upon installation to make sure that the system is working properly.

The criteria for test shall comply with the international codes and/or standards such as ISO, etc.

2－2－4－6 Procurement Plan

From the point of view of procurement including vibration countermeasure for pumps, capability of supplying hardware/software for monitoring system, provision of after-sales-services, etc, it is expected that the eligible countries for procurement are Japan, Serbia and countries belonging to Organization for Economic Cooperation and Development (OECD). As for pump/motor, the products of Japanese manufacturer made by their own overseas factories or their subsidiary companies holding stocks of more than 51% are accepted. These factories or company are located in Indonesia, Viet Nam, China, Brazil, etc. Also for the case of monitoring system, the products of the manufacturers in OECD countries made by their own overseas factories or their subsidiary companies holding stocks of more than 51% are accepted. These factories are located in China, India, Malaysia, Indonesia, Thailand, etc.

(1) Procurement including vibration countermeasure of pump

As the existing pumps in Mareza 2 pump station have problem of vibration, the scope of procurement for the pumps/motors replaced by Japan side includes the installation and commissioning work of pumps/motors in order to secure vibration limit: 7.1 mm/s (r.m.s) shown in ISO 10816-1 that is used internationally.

(2) Procurement for monitoring system

The monitoring system in the main control center consists of hardware/software of the main equipment for this system. Meanwhile it is required to substantiate function・performance of the

monitoring system by making overall tests with the interface panels installed in the pump stations, reservoirs and DMA. Accordingly, the installation work for the monitoring system in the main control center and overall tests for the monitoring system are included in the scope of procurement to be undertaken by Japan side.

(3) After-sales service

Pump/Motor

The replacement of bearing or gasket at the minor breakdown or the regularly scheduled repair can be carried out by PWS having maintenance skill if these spare parts are available. Procurement of the spare parts can be done through the agent of pump/motor manufacturers as usual. Meanwhile it is considered as one of the tender conditions that the agents of spare parts for the pump/motor shall be located in Montenegro or Serbia.

It is expected that the repair of impeller and/or shaft of the pump, motor, etc caused by the major breakdown shall be carried out at the factory designated by the manufacturer or under witness of a supervisor dispatched from the manufacturer. Accordingly, it is considered in tender that for the use in case of major breakdown, all the tenderers submit the information on organization chart to be contacted in case of major breakdown, and the distance until their repair shops or the location of the company at which a supervisor works.

Monitoring System

Although the agents of the equipment manufacturers from where the monitoring equipment could be purchased exist in Montenegro, they cannot install and commission the monitoring system, and also cannot provide instruction for its operation/maintenance. The agents or branch offices of the major system equipment manufacturer exist in the city of Belgrade. All these companies can provide not only equipment but can also undertake system installation, adjustment, provide operation instruction and carry out after-sales services. However, for the purpose of system construction・adjustment, it is required to dispatch engineers from the head or branch office located in EU countries. In addition, it is requested to submit the company organization, contact information, and the organization chart for repair, for all the tenderers in the tender. Taking into account the contract on after-sales services between PWS and the procurement contractor if possible, the operation/maintenance section of PWS shall be strengthened.

2－2－4－7 Operational Guidance Plan

The operation and maintenance instruction shall be provided related to all the equipment to be procured by the procurement contractor in principle. The operation instruction shall be given

based on the instruction manual and troubleshooting manual when the equipment is handed over. The key point of operation /maintenance instruction for the equipment is shown in the Table 2-11.

Table 2-11 Operation and Maintenance Instruction Plan

No.	Equipment	Description of Instruction	Days
1	Pump/Motor and Pump Control System	-how to operate pump/motor -how to handle pump bearing temperature detector -how to handle motor coil・bearing temperature detector -how to make daily inspection for pump/motor and how to repair it -how to handle water level meter, pressure instrument, valve, etc. -how to operate pump control system -how to operate pump control system in emergency -to explain function of pump control system -to explain system configuration of software and how to improve it -how to make troubleshooting for pump control system	15 days
2	Monitoring System	-how to operate monitoring system -to explain function of monitoring system -to explain system configuration of software and how to improve it -how to make troubleshooting for monitoring system -how to handle ultrasonic flow meter -how to handle water level meter -how to handle residual chlorine analyzer -how to handle pressure transmitter	15 days

After the procurement contractor provides instruction for installation, handling, operation and maintenance of the equipment as shown in the table 2-8, additional OJT shall be provided by the consultant before the handover of the project and shall include the following main items;

- Development of water management system and expansion of software
- Supervision of water quality and water supply system
- Improvement of DMA and water leakage
- Advice to PWS where PWS concludes the contract on after-maintenance with the local IT company

The items of operation/maintenance instruction provided by the procurement contractor shall be added corresponding to skill level of PWS staffs suitably.

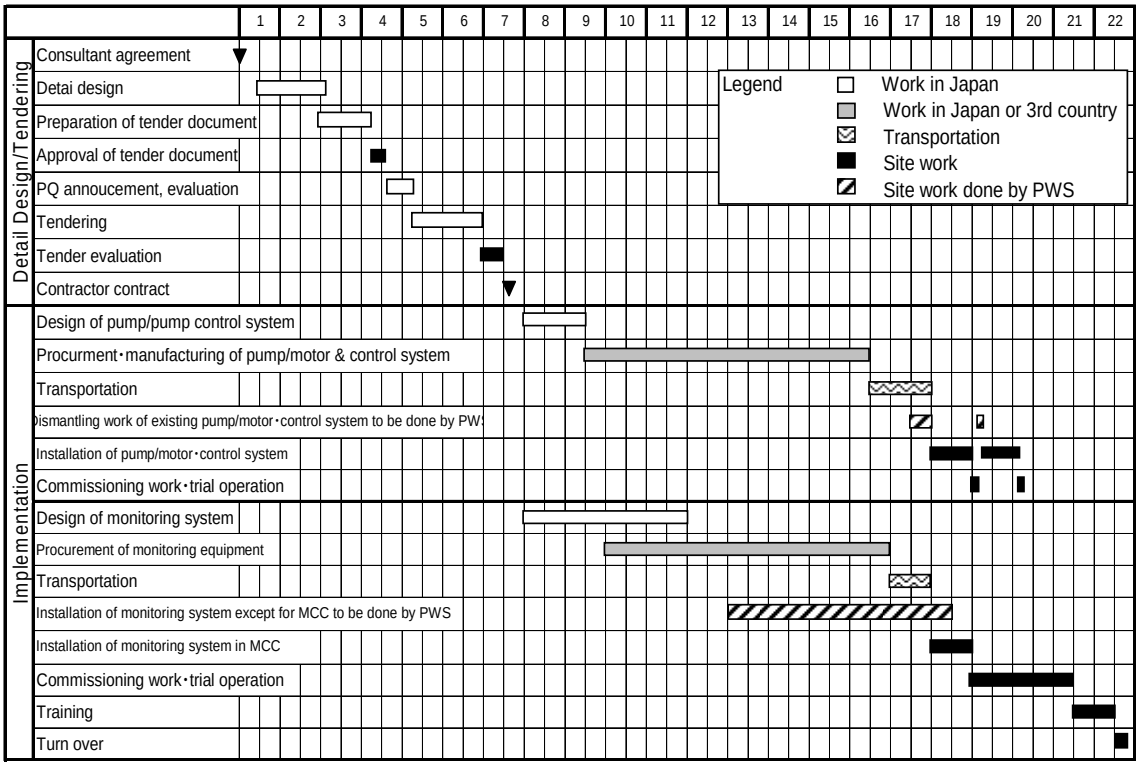
2－2－4－8 Soft Component (Technical Assistance) Plan

As the capacity development for PWS's staffs under the project needs cooperation of the procurement contractor, it shall be carried out at the same time while operation/maintenance instruction is provided instead of the soft component.

2－2－4－9　Implementation Schedule

The project is planned as a single year project. The implementation schedule is presented in the table 2-12. Detail design and tendering period takes 6.5 months. In addition to it, the period of procurement, installation and turnover shall be 15.5 months. Pump manufacturing and installation works shall require the longest period. After installation of the pumps/motors, commissioning work of the monitoring system shall be carried out and then overall tests including the signals from the pumps/motors shall be implemented. As the pump suction tank consists of two (2) pits, every two (2) pumps/motors out of four (4) pumps/motors can be installed. After installation of two (2) pumps/motors, cable shall be connected to the motors and then two (2) pumps/motors can be operated locally. After installation of four (4) pumps/motors, these pumps shall be commissioned with the monitoring system.

Table 2-12　Implementation Schedule



As for vibration countermeasure of the pumps/motors, during detail design the procurement contractor shall submit to the consultant the document for approval on vibration analysis for the pumps/motors and on dynamic flow analysis in the pump suction tank, and after getting approval on these documents, the procurement contractor can commence manufacturing. After completion of installation works, the consultant shall carry out vibration test and make sure on the improvement in vibration conditions and then the equipment shall be handed over to PWS.

The dismantling work of the pumps/motors and the procurement/installation work related to the monitoring system in the network piping to be implemented by PWS shall be completed before commencement of the installation work done by Japan side.

The training for PWS staffs based on OJT shall be carried out within four (4) months after commencement of installation work of the procurement contractor.

2－3　Obligations of Recipient Country

The obligations of the recipient country are summarized below.

Table 2-13　Obligation of Recipient Country

Item	Work Responsibility	
	Procurement	Installation
1.Mareza 2 Pump Station (Pump/Motor, Pump Control System)	None	-Dismantling work of cable to connected with the existing motors -Dismantling work of the existing pump/motor -Dismantling work of the existing pump control panel and the connecting cable
2.Monitoring System	-Power cable, control cable, earth cable, RGB cable -Kiosk -Piping materials for connection with pressure transmitters -Piping materials for connection with residual chlorine analyzer -Contract on telecommunication system with T-Com -Telecommunication equipment (by T-Com)	-Wiring work for power cable, earth cable and RGB cable in MCC -Construction work of kiosk -Installation and wiring work for all the monitoring equipment except for MCC -Installation and wiring work for telecommunication equipment (by T-Com) -Construction work of concrete pits for field instruments (flow detectors and pressure transmitters or residual chlorine analyzer) -Installation work of piping materials for connection with pressure transmitters or residual chlorine analyzers -Installation and wiring work for field instruments -Wiring work from the existing field instruments to the interface panels

Note: The water hammer prevention facilities are not used currently. PWS intends to use them after rehabilitation in future. Accordingly the signals from water level meter or air pressure instrument in the pressured air tank of the said facilities shall be connected to the pump control system by PWS after rehabilitation of the said facilities.

The dismantling work for the existing pumps/motors is done by the operation maintenance and construction department of PWS. The operation/maintenance department consists of the pump station section (25 employees) and the electrical section (13 employees). They have done many dismantling works for the pumps/motors at the routine repair work or emergency repair work.

Therefore they have experiences and staffs enough for pump repair.

The materials for monitoring system to be procured by PWS are cables, kiosks and piping materials. These materials can be procured in Montenegro or Serbia. The equipment/materials for telecommunication system are procured and installed by T-Com after the contract is concluded between PWS and T-Com.

The installation work for monitoring system can be divided as follows;

(1) Civil and building work for kiosk and concrete pit
(2) Piping work for pipe, fitting, valve, etc.
(3) Installation work for monitoring equipment
(4) Wiring work for various kinds of cables

The works (1) & (2) are done by the water supply piping maintenance section of the technical department of PWS mainly and the civil/building work is entrusted with the contractor, if necessary. The work (3) & (4) are done by the contractor under supervision of the system maintenance/development section (4 employees) and the electrical maintenance section (13 employees) as the sections in charge of PWS have experience for these works, PWS can do them smoothly.

2－4 Project Operation Plan

The operation/maintenance of the pump/motor is made by the operation/maintenance department of PWS. This department has 38 employees and much experience for repair of pumps/motors. As the pumps/motors to be procured under the project are the same capacity/head and type as the existing ones, this operation/maintenance can be done as usual.

Meanwhile as the pump control system is updated from the mimic panel type to the computer graphic type, the procurement contractor makes technical transfer for the pump operators through OJT. The operation function of the pump control system is the same as it of the existing control panel but operation manner is different (difference between working operation switch by view of mimic panel and working mouse by view of monitor). Accordingly the pump operators can master operation manner during trial operation time of the pumps/motors.

The maintenance work for the pump control system is required to be supported by the system maintenance/development section of IT department. As this section has only 4 system engineers currently, PWS has a plan to augment the system engineers together with the maintenance work of the monitoring system. The procurement contractor makes technical transfer for hardware and software of the system to all of the system engineers through OJT during the installation・

commissioning work.

PWS has a plan to assign the full-time operator for the monitoring system in MCC. As abovementioned, the system maintenance/development section of IT department is in charge of the maintenance work for hardware and software of the system and assigns the full-time system engineer for it. As the system engineers registered in IT department are acquainted with SCADA system, the procurement contractor can make technical transfer to them through the collaboration work with the engineers of the procurement contractor during the installation/commissioning work. Meanwhile the procurement contractor does OJT during the installation/commissioning work in order to make the operators master operation manner of the monitoring system.

2－5　Project Cost Estimation

2－5－1　Initial Cost Estimation

The cost to be burdened by PWS under the project is shown in the Table 2-14.

Table 2-14　Cost burdened by Montenegro Side

No	Items to be burdened by PWS	Quantity	Amount (EUR)
1	Dismantling cables from the existing motors	1 lot	0*
2	Dismantling the existing pumps/motors	1 lot	0*
3	Trial operation of new pumps/motors	1 lot	0*
4	Modification work of pump pit for vibration countermeasure (if required)	1 lot	10,000
5	Dismantling the existing pump operation panel	1 lot	5.000
6	Procurement/Installation for monitoring system(kiosk, cable, piping materials)		289,500
7	Bank commission		6,000
Total			310,500

Note: *These works are done by PWS staffs.

From the financial data of PWS year 2008, total assets of PWS are25, 000,000EUR. The new investment cost of 310,500EUR accounts for only 3.4% against annual sales amounts. The depreciation cost of approximately 1,000,000EUR is withheld. Meanwhile as PWS has investment experience of 1,000,000EUR by own finance in the past time, it is judged within range possible to paid with own fund financially.

Condition of estimate

Estimated on: end June, 2009

-Procurement period : Please refer to the project implementation schedule for the required period of detail design and construction.

-Others : The project shall be implemented in accordance with the Guideline for Grant Aid Cooperation of the Government of Japan

2－5－2　Operation and Maintenance Cost

The operation and maintenance cost for “before Project” and “after Project” is made based on the financial data of PWS year 2008 and shown below.

Table 2-15 Comparison for Annual Operation and Maintenance Cost

Unit: x 1,000 EUR

Items	Before Project	After Project	Items for Increase Amount	Increase/Decrease
Material cost	663	663	-	0
Energy cost (electric power)	1,209	1,530	20 hours operation/pump	160
Telecommunication/transportation cost	45	78	-Optical cable (512Kbyte) -Optical cable (1Mbyte) -GPRS(2.5Gbyte)	33
Personnel expenses	2,863	2,897	New employment for 4 engineers	34
Consumables cost	116	116	-	0
Total expenditure	4,896	5,284	-	388
Total income	9,264	9,814	water charge (increase of water supply amount)	550
Total cost	4,896	5,123	-	162

The above costs are compared for the first year after completion of the project. Accordingly as the materials cost and consumables cost is included in initial equipment cost of the project, these costs are not appropriated. The personnel expenses can be reduced by use of the monitoring system, but it is not considered in this table due to PWS personnel matter.

Although PWS expenses increase by approximately 388,000 EUR, it is expected that PWS can compensate them by the following reasons;

(1) PWS appropriates profit of approximately 100.000 EUR year 2006, 30,000 EUR year 2007 and 250,000 EUR year 2008 these three years. These profits deduct the depreciation cost.
(2) The operation and maintenance cost year 2008 is approximately 5,000,000 EUR Although PWS is burdened with about 7.9 % increases of this operation and maintenance cost; it is not excessive burden for PWS.

It is expected that improvement of 162 thousands is possible by the increased revenue water.

2－6　Other relevant Issues

The project is required to maintain the project implementation schedule by coordinating the procurement/construction schedule of PWS and the procurement/installation schedule of the procurement contractor prior to commencement of the project. As the works to be implemented by Japan side and those to be undertaken by Montenegro side have close relation and both

parties are to work together, the project is required to make risk management sufficiently by defining works and responsibilities of each party clearly.

For the monitoring system, PWS is required to pay attention to the following main points;

- To complete the construction work for concrete pits and piping work for installation of field instruments before delivery of equipment by the procurement contractor
- To conclude the contract with T-com a few months prior to the delivery of equipment by the procurement contractor
- To make study on contract with the procurement contractor for annual maintenance work after completion of the project in order to find troubles of system and/or equipment in early stage, to clear up the cause of troubles and to restore the system and/or equipment promptly to its normal working conditions.

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

CHAPTER 3 PROJECT EVALUATION AND RECOMMENDATIONS

3－1 Project Effect

Existing condition and problem areas before the project implementation, and direct and indirect effects expected after proposed project implementation are summarized in the table below.

Table 3-1 Effects after Project Implementation

	Current Status and Problem Area	Countermeasures	Impact of Project
Direct Effects			
1	Capacity of the existing water distribution pumps lowers due to overage and the water distribution flow rate is not sufficient to fulfill the demand. (required water distribution flow rate : 1,844 L/sec) (existing pump facilities capacity : 1677 L/sec)	Replacement of pump facilities in Mareza 2 pump station	Water supply rate for population of 177,410 in the objective area is secured stably until year 2012. (capacity of pump facilities after improvement : 2,051L/sec)
2	Water supply suspension occurs in some area. Population in the suspension area : 23,911 (actual value on May 2009)	-Same as above in item 1 -Introduction of monitoring system	24 hours water supply for inhabitants of 25,370 in the constant water supply failure area is possible until year 2012.
3	Safety of water supply for inhabitants in water supply area is not secured. (safety : residual chlorine contents)	Introduction of monitoring system	Safe water for population of 177,410 in the objective area is supplied until year 2012.
4	Efficiency of superannuated pumps has decreases to 15%.	Same as above 1	Efficiency of 15% is improved due to replacement of pumps. (annual energy loss of approx. 1.64MW is curtailed)
Indirect Effects			
1	It is requisite to grasp information on water leakage ratio in each DMA by monitoring flow rate/pressure in piping network in order to carry out replacement work for superannuated water distribution pipes (mainly AC pipes) efficiently, which is done by PWS independently	Introduction of monitoring system	As the order of priority for replacement of water pipes in DMA can be given by introduction of the monitoring system, it is possible to replace them efficiently. As a result of it, it is possible to secure water demand rate for the inhabitants of 199,917 in the water supply area until year 2017 which is the objective year for long term water supply and sewerage plan of Podgorica

2	Water leakage occurs as a result of damages by aging of asbestos pipelines. The rate of water leakage is 40.9% in 2008.	Introduction of monitoring system	The reduction rate of 15% for water leakage is possible by leakage reduction scheme until year 2017. As a result of it, it is possible to supply revenue water valued at the equivalent of approx.3.8 million EUR which has a stimulating effect on sustainability of the Project.

3－2 Recommendations

Montenegro side should tackle the following items independently so that the system and/or equipment procured under the project can be used effectively and the problem of insufficient water supply in project areas can be resolved, which is a target of the project;

(1) Effective use of equipment

The monitoring system for flow and pressure in DMA can be used for the preparation of water leakage reduction plan by PWS in order to reduce the current level of water leakage ratio of 43%. The water leakage rate has significant influence on water demand and water supply. Accordingly PWS should carry out water leakage reduction activities as planned.

(2) Project sustainability

Japan and Montenegro side should collaborate on the project from installation to commissioning work for the monitoring system. Montenegro side should master the technology on monitoring system as a part of technical transfer through OJT to be undertaken by Japan side and is required to transfer it to other related staff members within the organization.

(3) Project expandability

The monitoring system under the project aims at monitoring and accumulating data at the main control center. This is the first step towards the application of SCADA system in the project area. Subsequently, PWS is required to expand it based on The project in future in order to establish the complete SCADA system including remote operation, control operation by using accumulated data, etc.

(4) Financial improvement

The ratio of non-revenue water (NRW*) in the existing state is about 60%. PWS is required to reduce the level of water leakage and cases of illegal connections which are assumed to be main causes of NRW and also to strengthen financial aspect by cutting down manning cost due to assignment of adequate personnel based on the introduction of monitoring system. (* NRW means total losses as physical and administration.).

APPENDICES

1. Member List of the Study Team
2. Study Schedule
3. List of Parties Concerned in the Recipient Country
4. Minutes of Discussions
5. Calculation of Design Water Supply
6. Socio-Condition Survey
7. Evaluation of Water Hammer
8. Drawings for Distribution Network

Appendix 1: Member List of the Study Team

Team for Preparatory Survey

No.	Name	Job title	Occupation	Period (arr. – dep.)
1	Mr. OKIURA Fumihiko	Team Leader	Director, Water Resources Management I, Water Resources and Disaster Management Group, Global Environment Dep.	17 to 24 May 2009
2	Mr. KAWASE Tomohiro	Survey Planning	Program Officer, Water Resources Management I, Water Resources and Disaster Management Group, Global Environment Dep.	17 to 24 May 2009
3	Mr. OKAGA Toshifumi	Chief Consultant/ Water Supply Planning	Senior Project Manager, Overseas Department, Tokyo Engineering Consultants Co.,Ltd.	17 May to 20 June 2009
4	Mr. NAKATAKE Shunichi	Machine Maintenance Planning	Overseas Department, Tokyo Engineering Consultants Co.,Ltd. (Aqua Tech Consultants Co., Ltd.)	17 May to 20 June 2009
5	Mr. MASUI Isao	Electric Facility/ System Planning	Senior Project Manager, Overseas Department, Tokyo Engineering Consultants Co.,Ltd.	17 May to 20 June 2009
6	Mr. OKADA Ken	Vibration Measurement/ Analysis	Overseas Department, Tokyo Engineering Consultants Co.,Ltd. (SI Technology Inc.)	15 May to 20 June 2009
7	Mr. KOBAYASHI Hiroshi	Procurement Planning/ Cost Estimation	Overseas Department, Tokyo Engineering Consultants Co.,Ltd.	17 May to 20 June 2009
8	Mr. KAWAMURA Masashi	Water Distribution Planning/ Monitoring Data Use	Overseas Department, Tokyo Engineering Consultants Co.,Ltd.	17 May to 20 June 2009

Team for Explanation of Outline Design

No.	Name	Job title	Occupation	Period (arr. – dep.)
1	Mr. YAMADA Ken	Team Leader	Deputy Resident Representative, Balkan Office, Japan International Cooperation Agency	8 to 9 Oct, and 12 Oct
2	Ms. KANDA Miki	Survey Planning	Assistant Director, Planning and Coordination Division, Global Environment Dep, Japan International Cooperation Agency	5 to 11 Oct
1	Mr. OKAGA Toshifumi	Chief Consultant/ Water Supply Planning	Senior Project Manager, Overseas Department, Tokyo Engineering Consultants Co.,Ltd.	5 to 14 Oct
2	Mr. MASUI Isao	Electric Facility/ System Planning	Senior Project Manager, Overseas Department, Tokyo Engineering Consultants Co.,Ltd.	5 to 14 Oct
3	Mr. KAWAMURA Masashi	Water Distribution Planning/ Monitoring Data Use	Overseas Department, Tokyo Engineering Consultants Co.,Ltd.	5 to 14 Oct

Appendix 2: Study Schedule

<Preparatory Survey>

No.	Date		Team member						
			*Official	Water supply	Mechanical equipment	Electrical equipment	Transmission and distribution	Procurement	Vibration measurement and analysis
			Okiura Kawase	Okaga	Nakatake	Masui	Kawamura	Kobayashi	Okada
1	17-May	Sun	Arriving at Belgrade						
2	18	Mon	Meeting with JICA and Courtesy call to EOJ, Arriving at Podgorica						
3	19	Tue	Courtesy call to City and PWSC, Explanation of IC/R						
4	20	Wed	Courtesy call to MOED, Discussion with PWSC, Discussion for MD					Meeting with C/P	
5	21	Thu	Site survey of existing water supply system, Discussion with WB					Preparation for vibration test	
6	22	Fri	Signing of MD						
7	23	Sat	Podgorica - Vienna	Internal meeting					
8	24	Sun	Japan						
9	25	Mon		Survey for existing master plan, questionnaire		Basic plan for SCADA system	Social condition survey	Verification test for abnormal vibration at the pump station	
10	26	Tue							
11	27	Wed		Survey for water demand and water supply flow rate					
12	28	Thu					Confirmation of GIS data		
13	29	Fri							
14	30	Sat		Internal meeting					
15	31	Sun							
16	1-Jun	Mon		Survey for current conditions for water supply system		Equipment for SCADA system	Confirmation of GIS data	Procurement information survey	Suvey for existing pump conditions and analysis of the test data
17	2	Tue							
18	3	Wed				Input/Output List for monitoring			
19	4	Thu		Survey for current financial conditions			Confirmation of Autocad data	Pump maintenance factory of water and sewerage corporation	
20	5	Fri		Discussion about current status of water supply system					
21	6	Sat		Internal meeting					
22	7	Sun							
23	8	Mon		Confirmation of design conditions for improvement of water supply		Confirmation of Telecommunication system	Selection of DMA	Survey for IT company, import conditions, transportation conditions, installation of pump and SCADA	Analysis of the test data
24	9	Tue							
25	10	Wed				Confirmation of monitoring panel and pump control panel			
26	11	Thu					Cheking of distribution network analysis		
27	12	Fri		Discussion of the test results and design conditions		Discussion of SCADA system design		Survey for eligible country and vendor	Discussion of the test results and design conditions
28	13	Sat		Internal meeting					
29	14	Sun							Podgorica - Munichi
30	15	Mon		Meeting for Technical Notes					Japan
31	16	Tue		Meeting for Technical Notes					
32	17	Wed		Signing of Technical Notes					
33	18	Thu		Report to JICA and EOJ					
34	19	Fri		Belgrade - Munich					
35	20	Sat		Japan					

< Explanation of Outline Design >

No	Date		JICA Study Team				
			Leader	Survey Planning	Chief Consultant/ Water Supply Planning	Electric Facility/ System Planning	Water Distribution Planning/ Monitoring Data Use
			Mr. Yamada	Ms. Kanda	Mr. Okaga	Mr. Masui	Mr. Kawamura
1	10/5	mon	-	NRT(12:20) → MUC(17:40/19:25) → BEG(20:50)	NRT(12:20)→MUN(17:35/19:25)→BEG(20:50)		
2	10/6	tue		BEG(8:30) → TGD(9:20) Explanation of D/BD to PWS			
3	10/7	wed		M/D with PWSC			
4	10/8	thu	BEG → TGD	Field Survey, if necessary M/D with PWS			
5	10/9	fri	TGD → BEG	D/BD Explanation to Capital City of Podgorica and Ministry of Economic Development M/D Sign			
6	10/10	sat	-	TGD(8:35)→ VIE(9:55/14:00)→	Supplementary Survey		
7	10/11	sun		→NRT(8:10)			
8	10/12	mon	Report to EOJ	-	TGD(17:40) → BEG(18:30)		
9	10/13	tue	-		Report to JICA Balkan Office & EOJ BEG(14:25) →FRA(16:25/20:45)		
10	10/14	wed			→ NRT(15:00)		

Code:

1.Airports : NRT (Narita), MUC (München), BEG (Belgrade), TGD (Podgorica), VIE (Vienna), FRA(Frankfurt)
2. Visits : EOJ (Embassy of Japan), JICA (JICA Balkan Office), PWS (Podgorica Water Supply and Sewerage)
3.Others : D/BD (Draft Report of Basic Design), M/D (Minutes of Discussion)

Appendices 3: List of Parties Concerned in the Recipient Country

(1) Ministry of Economic Development

Ms. Ivana Gardašević, Advisor, Department for International Economic Relations

(2) Statistical Office of Montenegro

Mr. Radomir Durović, Director

(3) Institute of Public Health, Center for Health Ecology

Mrs, Nada Mališić, Director of the Center

(4) Capital City of Podgorica

Dr. Miomir Mugoša, Mayor

Mr. Pavle Radulović, City Manager

(5) Podgorica Water and Sewerage Corporation : PWS

Mr. Mladen Brajović,	Director of the Corporation
Mr. Filip Makrid,	Head of Technical Sector
Ms. Dijana Pejović,	Head of Maintenance and Construction (Investment and Development)
Mr. Božo Jukić,	Counterpart for vibration survey and mechanical group
Mr. Jovo Božović,	Counterpart for vibration survey and mechanical group
Mrs. Željka Jakovljević	Counterpart for water supply plan group
Ms. Darinka Radojičić	Counterpart for water supply plan group
Mr. Nikola Lazarević	Counterpart for SCADA system group
Ms. Dragana Popović	Counterpart for SCADA system group
Mrs. Ljiljana Mićanović	Counterpart for pipe network and mapping group
Ms. Irena Raonić	Counterpart for pipe network and mapping group

(6) EC (European Council), Infrastructure Projects Facility in the Western Balkans

Mr. Veljko Karadžić	Country Manager, WYG International
Mr. Sohail Hassan	Environmental Sector Key Expert, WYG International

(7) Embassy of Japan in Serbia

Mr. Toshio SUMIZAKI,	Ambassador
Mr. Teruhiko SHINADA,	Deputy Head of Mission, Counsellor
Mr. Hiroyuki YAMASHITA,	Second Secretary

(8) JICA Balkan office

Mr. Masao SHIKANO,	Resident Representative
Mr. Satoru KUROSAWA,	Resident Representative
Mr. Ken YAMADA,	Deputy Resident Representative
Mr. Yohei TAKAHASHI,	