Chapter 2. Contents of the Project

2-1. Basic Concept of the Project

Damascus City, the capital of Syrian Arab Republic (hereinafter referred to as "Syria"), plays central role in political, economical and cultural activities. DAWSSA under MoHC is the organization in charge of the water supply for Damascus City and surrounding villages covering approximately 2,822,000 people (2004), which is expected to be increasing about 2.0% per year. The current water supply situation in Damascus City is in chronic deficit. The three-year continuous drought since 1999 caused emergency conditions that more than 12 hours a day of water supply suspension continued for 6 months a year and for 4 years.

The Master Plan Study (1997) by JICA recommended DAWSSA to control wasted water (counter-measures for leakage) as the first priority and then to seek new water sources to mitigate further deficits. DAWSSA followed the recommendation sincerely, however, even in 2003 that was a wet year, planned water supply suspension for 3 to 6 hours a day (in night time) was required to manage the water deficit for demand in the dry season.

Under such circumstance, DAWSSA planned out "The Project for Development of New Water Sources for Damascus City" (hereinafter referred to as "the Project") to improve the water shortage and to mitigate the water supply suspension, and requested to the Government of Japan for its equipment and material supply. The original plan was to develop three new water sources through 25 production wells and to construct two water transmission pipelines, increasing 28,200 m^3/day of water newly and reducing the average daily water supply suspension time from 13 to 12 hours per day.

Through the first field survey by JICA Basic Design Study Team (hereinafter referred to as "Study Team"), it was found that the wells provided by DAWSSA were not satisfactory for the specifications as production wells in the Project. And then, DAWSSA agreed to construct new production wells. The construction works of new wells were, however, completed only for 11 wells in Yaboos site in advance, resulting slimmed down to cover one transmission pipeline from Yaboos site to Takea Pressure Breaker Reservoir (PBR) with 11 well pumps in Yaboos site. The remaining components were rescheduled to the next phase of the Project.

The project is to provide submersible pumps (11 sets), collection pipes (ϕ 250 – 400mm, 1.1km), transmission pipes (ϕ 600mm, 11.5km), and pressure reducing facilities (2 units) by Japanese side and to construct the facilities by Syrian side, aiming to improve the condition of water shortage and to mitigate the water supply suspension time for Damascus City. Through the implementation of the Project, around 13,200 m^3/day of water supply shall be increased and it shall contribute to reduce the water supply suspension time for about 30 minutes a day. Then for DAWSSA, flexibility on selecting water resources shall be expanded because of newly constructed well-field. Further, DAWSSA can have an expert group for EIA in its organization through an execution of EIA process, and it can be expected that the villagers near around the project site shall increase their interest on saving irrigation water and healthy drinking water.

2-2. Basic Design of the Requested Japanese Assistance

2-2-1. Design Policy

Contents of the original request from the Government of Syria was to provide equipment and materials required to implement the Project aiming to mitigate the severe water shortage in and around Damascus City, through development of three sites of new water sources. The major equipment and materials were 25 submersible pumps for production wells, emergency diesel generators, and pipes for collection pipelines and transmission pipelines.

Basic concept on the design policy are (a) the new well fields and their discharge are to be decided carefully taking the consideration of severe water balance over Barada/Awaji Basin into account and taking utmost cares on socio-environmental influence, (b) equipment and materials are to be provided by Japanese side and their installation/construction work are to be done by the Syrian side as a rule, however, availability of procurement on the equipment or materials by the Syrian side is also considered, and (c) the basic design study shall be conducted for the site only where all of the production wells planned out have been constructed.

Based on the request from Syrian side and the basic concept for design policies mentioned above, two times of the field survey by the Study Team had been conducted. Through the field surveys, the request from the Syrian side and the Project components were revised as described below:

(1) Modification of well sites: The sites of the new water sources originally requested were at Yaboos, Maadar and Deir Al Ashayer. However, both sides agreed to change Maadar to adjacent Maadar II at around 7 km southwest, since all wells in Maadar were located on the top of the ridge and not suitable to construct a well field from the fear of lowering groundwater table in and downstream of the area. Hereafter, the word “Maadar” means “Maadar II” unless specially noted as “Maadar I”.

(2) Changes in number of wells at the sites: The Study Team found out that all existing wells were not suitable to be converted into the production wells, because of small casing diameter or inadequate well structures in casing and screen installation, gravel packing, grout sealing, and so on. Therefore, both sides agreed that DAWSSA shall construct the production wells with proper specification. Finally, DAWSSA decided to drill 25 new wells in the following allocation.

Table 2-1 Change of Well Number

Original Request		Revised	
Site	Number of Well	Site	Number of Well
Maadar I	20	Maadar II	8
Yaboos		Yaboos	11
Deir Al Ashayer	5	Deir Al Ashayer	6
Total	25	Total	25

(3) Additional facilities: The differences of elevation between the highest point along the pipeline from Maadar/Yaboos site to the existing Takea PBR (hereinafter referred to as “Maadar/Yaboos Line”) is as large as 269m. Therefore, pressure reducing facilities suitably designed under considerations on hydraulic characteristics, pressure tightness, and safety measures shall be necessary to avoid a leaking from or break down of the pipelines. A booster pump shall be required because the well elevation in the Maadar II well field that is El. 1,064 ~ 1,170m is lower than the highest point of the Maadar/Yaboos Line (El. 1,361m).

(4) Changes in requested items: Original request from the Syrian side included submersible pumps, emergency diesel generators, pipes for collection pipelines and transmission pipelines. However,

through the surveys and discussions with the Study Team, DAWSSA agreed to omit the diesel generators because they are only for supplemental power source and the frequency of power off is rather small, and small size of pipes (below 200mm in diameter) for collection pipeline also because DAWSSA has enough amounts of small diameter pipe materials in their storehouse.

(5) Phasing the procurement: At the end of the second field survey term, DAWSSA agreed to divide the procurement of equipment and materials into two phases, if they could not complete the well construction in any sites by the deadline (November 7, 2004) and the condition was described in the Minutes of Discussions (M/D) on the second field survey (October 20, 2004). Based on the agreement, the procurement was divided into two phases as shown below;

Table 2-2 Phasing of Procurement

Transmission line	Span	Phase
Maadar/Yaboos Line	Yaboos ～Takea	First Phase
	Maadar II ～Yaboos	Second Phase
Deir Al Ashayer Line	All the line	

(6) Revised items finally requested: Through the field surveys in two times (on March and October, 2004) by the Study Team, the contents of the original request were finally revised as follows:

Table 2-3 Project Components Revised

Well Sites	Contents (Original)	Contents (Revised)	
		Phase I	Phase II
Maadar and Yaboos	-Submersible pump ($50m^3$/hr) 20 sets -Collection pipes 1 lot -Diesel generator (300kVA) 4 set -Transmission pipes (500-600mm) 35 km	Yaboos -Submersible pump ($50m^3$/hr) 11 sets -Collection pipes 1 lot -Transmission pipes (600mm) 11.5 km -Pressure reducing valve 2 set	Maadar II -Submersible pump ($50m^3$/hr) 8 sets -Collection pipes 1 lot -Buster pump 1 lot -Transmission pipes (350～500mm) 15.2 km -Pressure reducing valve 1set
Deir Al Ashayer	-Submersible pump ($35m^3$/hr) 5 sets -Collection pipes 1 lot -Diesel generator (200kVA) 1 set -Transmission pipes (300-400mm) 12 km		-Submersible pump ($50m^3$/hr) 6 sets -Collection pipes 1 lot -Transmission pipes (350-400mm) 8.8 km -Pressure reducing valve 3 sets

Thus, the general plan of the Project is shown as Figure 2-1. Based on the changes of request described above, design policies on procurement of equipment and materials shall be made as follows:

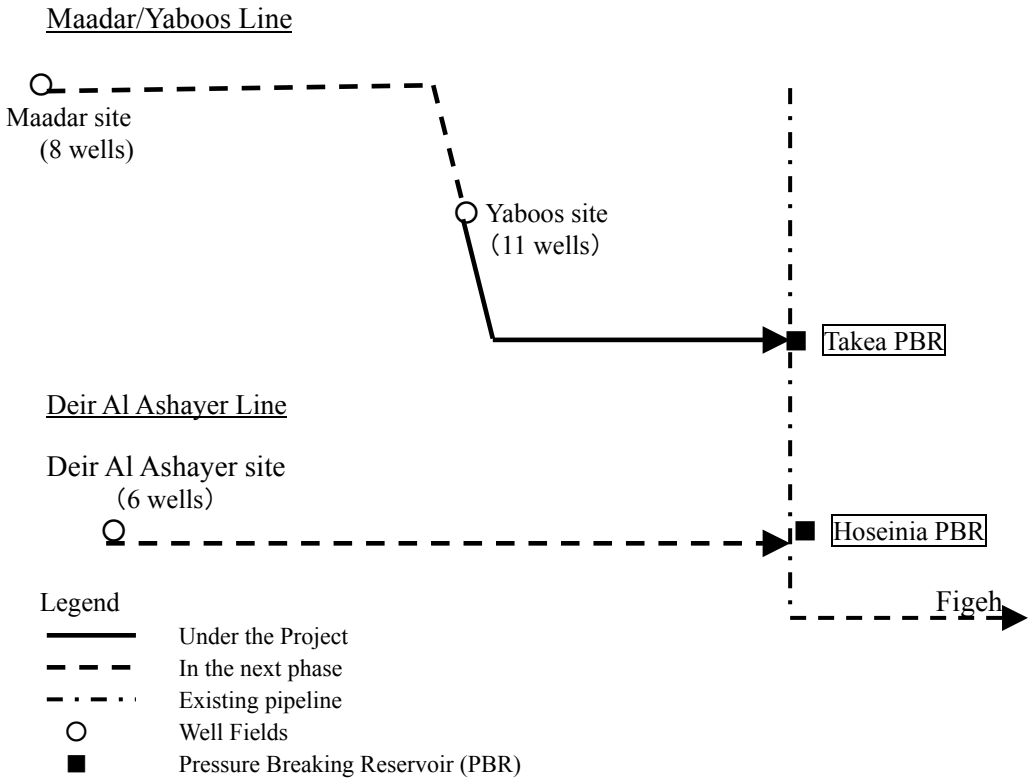


Figure 2-1 General Plan

(1) General Plan

Although the Project consists of constructions of well field in Yaboos site and a transmission pipeline from Yaboos site to Takea PBR, the original request includes development of well fields in Maadar II site and collection and transmission pipelines from there to Yaboos. Then, DAWSSA has a future plan to develop further new water sources besides the three requested sources, and the future plan includes Maadar I in further upstream of Yaboos site. The water from these further new water sources shall pass through the Maadar/Yaboos Line to send water to Damascus City. The transmission pipeline from Yaboos site to Takea PBR (hereinafter referred to as "Yaboos Line") designed in the Project in this phase, thus, limits total water volume of transmission pipeline from water sources locating at further upstream of Yaboos site. Therefore, the Basic Design must be made under the consideration on total water sources development plan including all future plans that DAWSSA has based on both sides of demand/supply balance and water resources development potential.

(2) Policy on Environmental and Social Impact

The target site in this phase of the Project is only Yaboos site with 11 production wells, however, the original request from the Syrian side was three well fields with 25 production wells in total. Possible major environmental impacts by water resources development in these three sites are as follows:

- Hindrance to water usage by private wells around the new water sources,
- Influence to the existing water usage in the border area of Lebanon,
- Change of water balance and drop of the groundwater level in the Barada and Awaj Basin, and
- Influence to the water quality.

The National EIA Guideline (Draft, 1995) in the Government of Syria requires to prepare an EIA Report through a series of EIA process and to submit it to General Commission for

Environmental Affairs (GCEA), for their approval when a project includes groundwater withdrawal of more than 10 million m^3/year. The Project involves around 10.3 million m^3/year of groundwater abstraction when all three well fields have been developed, therefore, the Project needs to follow the EIA process and to obtain the approval from GCEA.

In considering to the situation above mentioned, DAWSSA decided to carry out the EIA in accordance with the related law and regulation, and requested Japanese side to assist them on the process. Based on the request the Study Team cooperated with DAWSSA to conduct the procedures.

(3) Design Policy on natural conditions

Well fields of Yaboos and Maadar II locate in the northwest of Damascus City in open areas with 1,060 to 1,300m of elevation, against the highest elevation of the Maadar/Yaboos Line of 1,361m. Annual average temperature around the water source sites is 15.0℃ but the highest monthly average temperature is 27.8℃ in July and the lowest one is 0.1℃ in February. Annual precipitation is around 1,000 mm and most of the precipitation occurs in winter; from November to March in not only rain but snow. As for Takea, the end of Maadar/Yaboos Line is in the town area with elevation of 1,090m. Annual average temperature around the town is about 20℃ but it has a big difference, as higher than 35℃ in summer and lower than 0℃ in winter.

Based upon such natural conditions mentioned above, a rational transmission system considering the elevation gap effectively, and also suitable control measures against high pressure on pipeline, as well as the means of keeping equipment in proper condition under such severe yearly difference in temperatures and/or precipitation shall be taken into consideration upon planning and design.

(4) Design Policy on Construction/Procurement Conditions

The well field in Yaboos site is an open space far from the town (Jdaite Yaboos), therefore, there is no problem for the works on installing well pumps or laying collection pipes. Although the roads along the planned transmission pipeline were properly paved with enough width to carry out the laying work of transmission pipes, nearly 8 km long of the route is just beneath the highway with heavy traffic so that the pipe material using in this span must have enough durability not only for water pressure but also external pressure.

Exact locations and elevations of the facilities required for the Project shall be decided by topographic and hydraulic conditions, however, these sites shall be selected so as to secure enough space for stock yard of pipe materials during the construction work and for operation/maintenance after completion of the construction.

(5) Policy on Local Contractor/Materials

Equipment and materials provided in the Project are the major component of the new water sources facilities, and all of them shall be imported because they are very difficult to obtain in Syria. Spare parts of them are also hard to be obtained in Syria, therefore, enough number of the spare parts shall be provided.

Construction and/or installation works of these equipment and materials can be implemented by local contractors under supervision of DAWSSA. However, proven contractors shall be mobilized as many as possible to complete the Project on schedule because the work volume is rather large and the work will be interrupted in winter from December to March by snowfall.

(6) Policy on O&M Capacity of Implementation Agency

Operation and maintenance of the facilities constructed in the Project will be carried out by Production Division of DAWSSA. The Division is now operating and maintaining existing transmission pipelines and pressure breaking reservoirs with middle to large diameter (500 ~1,200mm) sourced from Barada spring well field to Figeh spring area. Thus, the O&M capability of DAWSSA can be well evaluated both technically and organizationally. However, they have no pressure reducing facility and deep well pumps installed more than 100 m in depth similar to the

ones designed in this Project, and therefore, a technical assistance on the installation of these facilities shall be considered. Then, training on the operation and maintenance of these facilities shall be planned before their actual operation for long-term and sustainable O&M of these facilities in the future.

(7) Policy on the Extension and Grade of Equipment and Materials

The facilities to be constructed under the Project shall be operated in one system as a whole from the water sources to the existing PBR via pressure reducing facilities with very long route length with heavy elevation gap through. To determine the specifications on these facilities, an easy maintenance and a similarity with the facilities presently operated by DAWSSA shall be taken into consideration, as well as the organization and technical level of DAWSSA. Since the civil works to construct receiving tanks or pressure reducing facility and design/construction of electrical facility are to be made by DAWSSA, dimension, allocation plan, space required etc. of the structures shall be discussed with DAWSSA sufficiently for effective construction and efficient O&M by them.

(8) Policy on Procurement/Work Schedule

All of the equipment and materials provided under the Project shall be imported because they are hard to be procured in Syria. Source of the procurement, such as, Japan, third countries like Europe, etc., shall be decided through comprehensive examinations on economical efficiency including transportation cost, specification/quality, actual achievement of delivery, delivery period, after services and easiness to provide spare parts, etc. On the other hand, the period required to make a detail design, tendering and manufacturing/procurement shall be planned to be completed within one year after the conclusion of Exchange of Note (E/N) on the Project.

2-2-2 Basic Plan

2-2-2-1.Water sources plan

According to the JICA development study on "The Study on Water Resources Development in the Northwestern and Central Basins in the Syrian Arab Republic" (hereinafter referred to as "the Development Study") executed in 1998-2000, the target site of Yaboos, the target sites of a part of Maadar II in the next phase project, and whole area of Maadar I and Sergaya in the future project belong to the Barada/Awaj Basin which includes Damascus City. Most part of Maadar II site is included in the Litani Basin running through the Bekaa basin in Lebanon.

Groundwater resources are, in general, the total water volume stored in the ground in a certain area (usually groundwater basin), which was historically accumulated and huge amount in most of the cases. While, a part of rainfall which recharges groundwater to increase a groundwater storage is called as "recharging amount". Recharging is repeated every year in the natural water circulation, therefore, the recharging amount is called as "renewable water resources". Target of water resources for so-called "sustainable water resources development" is usually classified in this category. A groundwater resources development potential is generally means this volume, however, the volume of the current water use shall be deducted from such development potential in exact definition.

Groundwater recharge amount (Q) can be estimated by following equation, and the results are presented as Table 2-4:

$$Q = A \times R \times P$$

Where,
- A: Recharging area (m^2), the extension of same hydro-geological unit,
- R: Average rainfall of recharging area (m/year), taken from the Master Plan Study (1997), and
- P: Recharging coefficient, 0.246 taken from the Development Study (2000).

Table 2-4 Estimation of Groundwater Recharge

Site	(a) R. Area (km^2)	(b) Rainfall (mm/a)	(c)=(a)*(b) Amount (MCM/a)	(d) Infiltration Ratio	(e)=(c)*(d) Recharge/year (MCM/a)	(f)=(e)/365 Recharge/day (m^3/d)
Sergaya	46	700	32.2	0.246	7.921	21,702
Maadar I	32	900	28.8	0.246	7.085	19,410
Maadar II	46	1100	50.6	0.246	12.448	34,103
Yaboos	67	1000	67.0	0.246	16.482	45,156
Deir Al Ashayer	51	800	40.8	0.246	10.037	27,498

Note: Recharge amount in the table includes existing spring or pumping amount.

The infiltration ratio of the area (P) is applied the value of 0.246 which is figured out from the Development Study as the average infiltration ratio in the Barada Basin. The target sites are located in the upstream area of the basin having large precipitation, around 4 times of the basin average, therefore, the infiltration amounts of theses sites may be quite large than the average but the infiltration rate. Here, however, the average value of the basin shall be adopted because there is no other proper value available. Then, it is difficult to estimate the area of recharging. In the area underlain by karstic carbonates like the Project area, the recharging area for groundwater does not coincide with the catchment area for surface water. In this study, the area of groundwater recharging for each site was evaluated taking into consideration the extension of same hydrogeological unit to the upper stream and large topographic relieves. Details on these considerations are shown in the References -8, "Technical Note on Hydrogeology". The figures shown in Table 2-4 are, however, only the estimation on groundwater recharge amount and the actual development potential shall be examined through the systematic monitoring results.

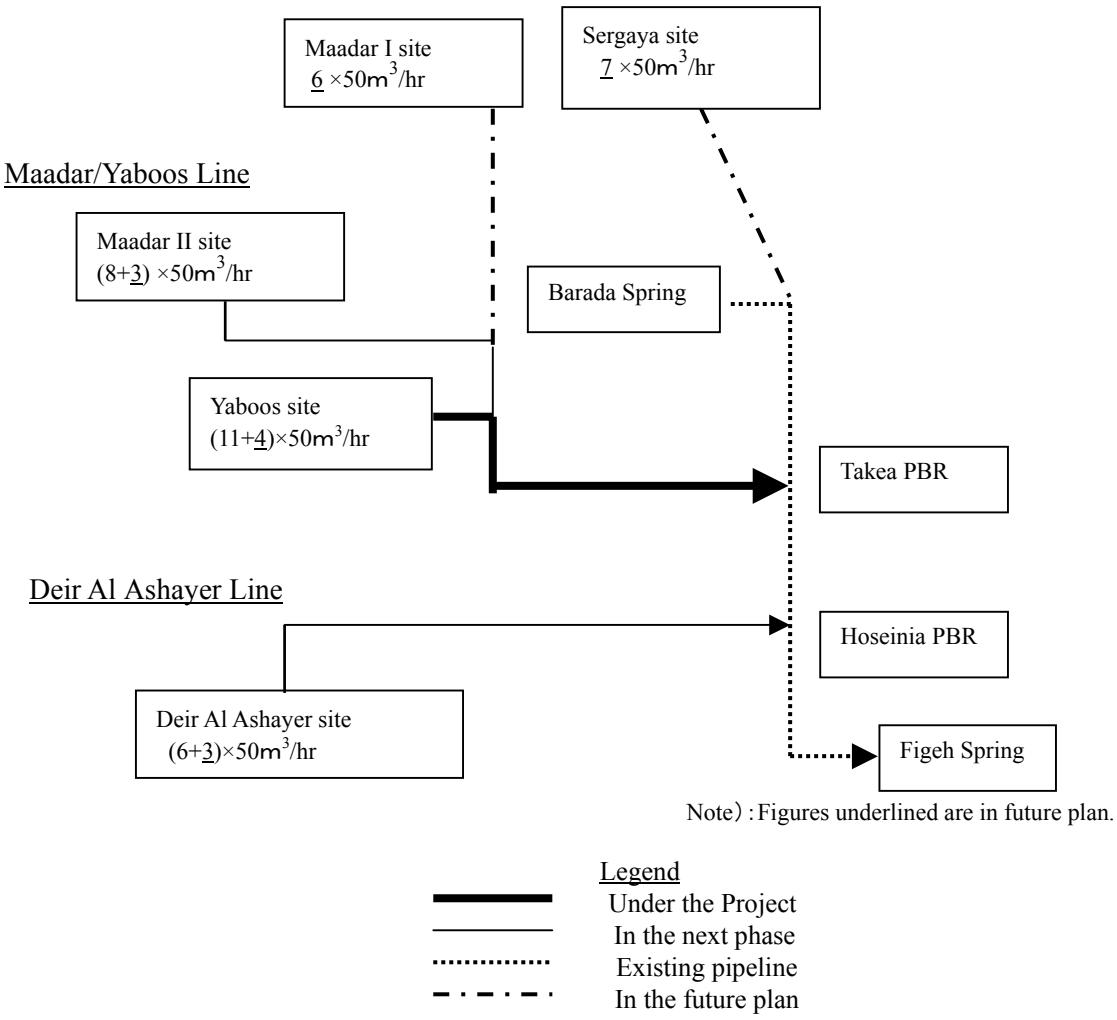
The recharge amount in Yaboos site comes out to the ground again as Kfere Yaboos spring and utilized for irrigation water and domestic water supply for Jdate Yaboos through some wells. The total water volume by adding these springs with usage is estimated as around 4.0 MCM/year (1.6 MCM/year by spring, 2.1 MCM/year for irrigation and 0.3 MCM/year for domestic water), and the volume is around 25% of the recharge. And then, considering the yearly variety of precipitation and further private use in the future, the new water resources development shall not exceed 40% of the recharge. Thus, the permissible pumping rate in Yaboos site shall be 209 lit/sec (522.6 x 0.4), or 753 m^3/hr, from the recharging condition, and it means the site allows increasing a number of standard production wells (pumping 50m^3/hr) up to 15 wells.

Based on the consideration, the permissible pumping rate in water sources in Barada/Awaj basin shall be around 40% of the recharge amount, because the hydrogeological conditions in the basin are not so much different. While, Maadar II site belongs to Litani Basin and there is no private well around the site. However, there are two large and famous springs of Anjar and Chamshine beneath the well field, and therefore, the pumping rate shall be one third or 40% in the maximum to avoid severe influence to those springs. Thus, the number of production wells permissible to be developed in proposed water sources is estimated as shown in Table 2-5, considering the future plan together. Sergaya site proposed by DAWSSA has a recharge zone overlapped with the recharging zone of Barada Spring, so the new water sources development can not be recommended. Even though the development is permissible, it is not reasonable to connect to the Maadar/Yaboos Line beyond high mountains. It can simply be connected to the existing Barada-Figeh main pipeline. Thus, the planned numbers of production wells along these pipe-lines are shown in Figure 2-2.

Table 2-5 Permissible Number of Production Wells

Site	(a) Recharge (l/s)	(b)=(a)*0.4 ditto (l/s)	(c)=(b)*3.6 ditto (m^3/h)	(d)=(c)/50 Nos. of well (well)	Note
Sergaya	251.2	100.5	362	7	Not connect.
Maadar I	224.7	89.9	324	6	
Maadar II	394.7	157.9	568	11	
Yaboos	522.6	209.1	753	15	
D. A. Ashayer	318.3	127.3	458	9	

Note): Pumping rate is 50 m^3/hr



Note): Figures underlined are in future plan.

Figure 2-2 General Plan (include future plan)

2-2-2-2 Pipeline Plan

(1) Basic Condition

The facilities of the Project consist of collection pipelines which first deliver underground water to the receiving tank by pumping system of well pumps in new water sources, and the transmission pipeline which then convey water to the existing Takea PBR by the gravity system. Since the highest elevation in Maadar/Yaboos Line is EL 1,316m against elevations in water source area of from 1060m to 1300m, a booster pump is necessary.

Hazen-William's formula will be applied for the hydraulic design of pipeline, as shown below. In case of gravity system, pipe diameter will be selected to make the most use of deferent elevations. In case of pumping system, on the other hand, the pipe diameter will be selected by the economical velocity (V=1.0m/s～1.5m/s) and hydraulic calculations. The diameter of both systems shall be selected to assure the necessary dynamic water pressure (0.03 MPa of minimum dynamic water pressure) under consideration on the additional wells in future.

$$H = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$$

Where H : friction loss head (m)
C : flow index (C = 110)
D : pipe diameter (m)
Q : discharge (m^3/s)
L : length (m)

(2) Collection Pipeline

The collection pipeline is the pumping system connected between well pumps and the receiving tank. The collection pipeline shall be planned to shorten the length between wells and the receiving tank efficiently. The discharge of well is $0.83 m^3/min$ ($=50 m^3/h$). The pipe diameters and these lengths in Yaboos well site are shown in Table 2-6 while the detail calculation is shown in the References 7-(2).

Table 2-6 Collection Pipeline

Diameter	Length	Remarks
150 mm	624.0 m	Procured by the Syrian side
200 mm	407.0 m	Ditto
250 mm	290.0 m	Procured by Japanese side
300 mm	526.0 m	Ditto
350 mm	300.0 m	Ditto
400 mm	7.0 m	Ditto

(3) Transmission Pipeline

Water sources of Maadar/Yaboos Line are Maadar II well site and Yaboos well site. Total length of Maadar/Yaboos Line is 26,680m to convey water to the existing PBR in Takea. There are 11 wells in Maadar II (8 wells near the Maadar II water source and 3 wells at the highest points along the transmission pipeline) including future plan and 15 wells in total in Yaboos well site (6 wells in the east side of the highway and 9 well in the west side). Furthermore, there is a future plan that water source of 6 wells in Maadar I will be connected to Maadar/Yaboos Line. The rough profile of Maadar/Yaboos Line is shown in Fig 2-3.

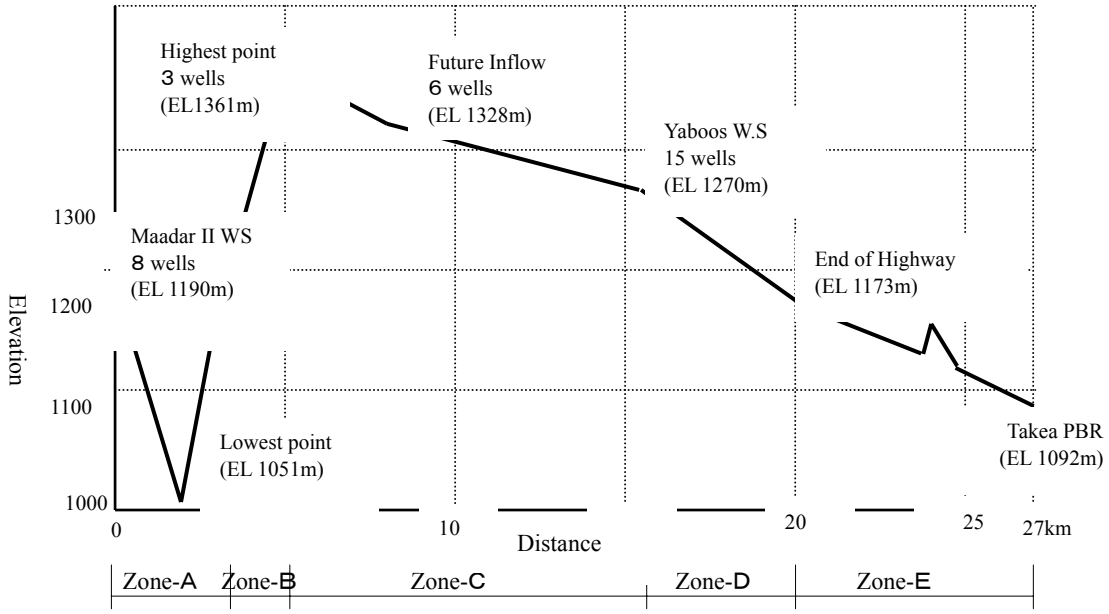


Fig 2-3 Profile of Maadar/Yaboos Line

Based on this profile, Zone-A is a siphon system by gravity, Zone-B is a pumping system by a booster pump, and on and after Zone-C is a gravity system. However, there are 269m difference in the elevation from the highest point of Zone-C to the end of Zone-E, it is needed to provide pressure reducing facility to avoid the ejection of or leakage from the joints and to defend security of pipeline.

To sellect the location of the pressure reducing facility, there is a topographical restriction in Maadar/Yaboos Line. Both sides of the highway of Damascus- Beirut at approximately 4.9km in length (Zone-D) from Yaboos well site are steep slope and there are no spaces to construct the pressure reducing facility and to operate/maintain it in the future. Therefore, pressure reducing facilities can not be planned in this zone, while it can be planned at the both end of Zone-D. In this case, three pressure reducing facilities will be planned in nearly 100m interval of elevation and these locations are at Yaboos well site (station 15 km), at the end of highway (station 20km) and at Takea PBR.

Based on these situations, pipe diameter will be determined by the hydraulic calculation, shown in the References 7-(3). Discharges, pipe diameter and length of each zone will be shown in Table 2-7. However, pipe materials to be procured by the Project are limited only from Yaboos well site to Takea PBR.

Table 2-7 Result of the Determination of Transmission Pipeline

Zone	Discharge (l/s)	Diameter (mm)	Length (m)	Remarks
Maadar II WS～BPS	0.111	ϕ 350	2,750	Next Phase
BPS～The highest Point	0.111	ϕ 350	2,230	- ditto -
The Highest Point～Future Inflow	0.153	ϕ 350	2,750	- ditto -
Future Inflow～Yaboos WS	0.236	ϕ 500	7,450	- ditto -
Yaboos WS～PBR No.2	0.444	ϕ 600	4,930	This Phase
PBR No.2～Takea PBR	0.444	ϕ 600	6,570	- ditto -

Note) WS: Water source, BPS: Booster pumping station, PBR: Pressure breaker reservoir

2-2-2-3 Equipment and Materials Plan

Main equipment and materials provided in the Project are pipe materials of collection pipeline and transmission pipelines, well pumps and pressure reducing facility.

(1) Well pumps

Specification of well pump in the Project are 0.83m^3/min of the discharge and 150m～216m of total head as a consequence of the result of well pumping test and simulation analysis of group pumping test, refer to Table 2-8. The most popular type of well pump is a submersible pump as this specification and also DAWSSA has many of these pumps as their actual achievements. Therefore, submersible pump will be selected as the well pump type.

Total head of the pump, motor output, and detail pump specification are shown in the Reference 7-(4), and summarized as Table 2-8 and 2-9, respectively.

Table 2-8 Head of the Submersible Pump and Motor Output

Well No.	Elevation in well (m)	Water Level (m)	Draw Down (m)	Pipeline Loss (m)	Actual Head (m)	Riser-pipe Length (m)	Riser-pipe Loss (m)	Total Head (m)	Head (m)	Motor Output (kW)
Y-1	1280.62	97.0	20	31.1	148.1	120	5.8	154	160	37
Y-2	1285.32	101.5	16	26.6	144.1	120	5.8	150	160	37
Y-3	1277.69	93.2	33	33.5	159.7	132	6.4	167	170	45
Y-4	1308.59	111.6	34	3.4	149.0	150	7.2	157	160	37
Y-5	1282.13	99.3	23	27.3	149.6	126	6.1	156	160	37
Y-6	1268.49	87.0	16	39.8	142.8	108	5.2	149	160	37
Y-7	1272.07	90.7	35	34.1	159.8	132	6.4	167	170	45
Y-8	1281.20	100.0	19	26.4	145.4	126	6.1	152	160	37
Y-9	1287.19	107.0	32	21.1	160.2	144	6.9	168	170	45
Y-10	1299.33	117.8	78	9.8	205.6	198	9.5	216	220	55
Y-11	1307.99	127.7	73	1.6	202.3	204	9.8	213	220	55

Table 2-9 Specification of Well Pump

Type	Submersible motor pump		
Diameter	ϕ 100mm		
Discharge	0.83 m^3/min		
Head	160m	170m	220m
Motor Output	380v、37kW	380v、45kW	380v、55kW
Unit	6 units	3 units	2 units

Manufacturing and installation of the electric facility will be made by the Syrian side, and the normal operation system of the pump is as follows:

- Power circuit : AC380V 50Hz 3 ϕ
- Control circuit : Manual, automatic
- Normal operation : Manual (running/stopping switch operated by manual)
- Protection circuit : Lowest Low-Water Level (LLWL) of deep well
  Highest High Water Level (HHWL) of the receiving tank
  Transmitting LLWL and HHWL of the receiving tank and well to control panel for protection of pumps
- Instrumentation circuit : Transmitting LWL and HWL of the receiving tank to control panel for protection of pumps

(2) Pipe materials

Diameter of pipes in the Project is 250mm～400mm in collection pipelines and 600mm in the transmission pipelines, and maximum working pressure is 0.98 MPa. Pipe materials of these pipe diameters in waterworks are Steel Pipe (SP) and Ductile Cast Iron Pipes (DCIP).

The table below shows a comparison between SP and DCIP. DAWSSA uses DCIP in the pipelines and it occupies 80% of pipe materials. Also, installation of DCIP is easier than SP. Therefore, DCIP is selected as main pipe materials but SP may also selected as special parts of the pipeline, such as, inlet and outlet pipe of pumps, aqueduct bridge, etc. because of easy construction at the site.

Table 2-10 Pipe Materials

Materials	Characteristic	Judgment
SP	- Intensive, corrosion resistance, strong to impact and easy manufacturing, - No need of countermeasure to joint remove by welding joint, - Take much time on welding and lining, difficult to construct in spring ground, - Weak to electric corrosion	
DCIP	- Intensive, corrosion resistance, strong to impact and easy to construct, - Many kind of joints, and flexible and expansive - Heavy - Need special protection against joint remove	○

T-type (Push-on) joint will be used for the straight pipe, while K-type (Mechanical) joint will be used for fittings, because straight pipes of T-type joint is cheaper than that of K-type joint, and fittings of K-type joint is stronger than that of T-Type joint on possible removal at joints. Special joint will be used at the joints in the pipelines where traffic closure is necessary and where detour and narrow road width exists, to shorten the construction period.

(3) Pressure Reducing Facility

The table below shows the conditions of pressure reducing facility in the Project.

Table 2-11 Condition of Pressure Reducing Facility

Location	Pipe Dia.	Primary Pressure	Secondary Pressure	Remarks
Yaboos WS	500mm	0.71 ～ 0.94 MPa	0.05 MPa	Next Phase
End of Highway	600mm	0.86 ～ 0.98 MPa	0.05 MPa	This Phase
Takea PBR	600mm	0.71 ～ 0.85 MPa	0.05 MPa	This Phase

Pressure reduction means to dissipate residual energy of elevation difference (static pressure) after subtracting head losses in the pipeline by use of pressure reducing valve. However, the following issues may emerge.

- Cavitations by a large pressure difference may damage valve, and need valve protection work,
- Water hammer by valve open/close may require some measure for reduction and protection of pipeline, and
- Careful examination on reliability of function and safety of the pressure reducing facilities is required.

Methods of applicable pressure reduction are as follows.

① Use of Self-control Reducing valve (SR-Valve)

② Use of combination of Constant Water Level Self-control valve (CWLS-Valve) and Pressure Breaker Reservoir (PBR)

③ Reduction by Flow Control valve (FC-Valve)

Advantages and disadvantages of the methods and applicability to the project are examined and presented in Table 2-12.

By taking into consideration the reliable action, safety to the whole system and past performance, the combined method by use of CWLS-Valve and PBR is employed.

Table 2-12 Evaluation of Pressure Reducing Methods

Method	SR-Valve	CWLS-Valve & PBR	FC-Valve
Theory	Installation in the pipeline at every 120m elevation difference. Valve maintains pressure constant downstream side irrespective of changing flow in the downstream.	Installation of a tank at every 120m elevation difference. Valve controls WL in reducing tank by float action or by pressure difference sensor methods.	Installation of a flow control valve and a tank at every 120m elevation difference. The control valve is settled at upstream of tank and reduces pressure by adjustment of valve opening. Valve operation adjustment by manual or electric. To prevent cavitation, orifice valve or sleeve valve are popularly employed.
Characteristics	- No reducing tank required. - Compact in size - In case the valve fails functioning, excessive pressure is directly given to the downstream pipes. - Right-of-way for reducing valve can be small in size.	- Pressure reducing tank required. - Land for both tank and valve required. - Free water surface at each location. No excessive pressure to downstream when valve failure. - Overflows from tanks when valve failure.	-Pressure reducing tank required. - Large sized facilities required - Power source for flow adjustment by valve required. - If manual valve control, difficult for timely adjustment by flow change.
Evaluation	Pipeline may be damaged by excessive pressure when valve failure.	Land for the facilities required but pressure reduction assured. Most reliable and safe. To be employed.	-Pressure reducing tank required. - Large sized facilities required. - Power source for flow adjustment by valve required. - If manual valve control, difficult for timely adjustment by flow change.
Judgment	△	○	×

2-2-2-4 Summary of Equipment and Materials

The summary of items and quantity of equipment and materials provided by the Japanese side are shown in Table below.

Table 2-13 Summary of Equipment/Materials

Item	Quantity	Purpose
DICP	Collection pipes (250mm～400mm, 1.1km)	Collection of water source from 11 wells
	Transmission pipes (600mm, 11.5km)	Transfer water from Yaboos water site to Takea PBR
Submersible motor pump	Q=0.83m3/min, 11sets	Well pumps in Yaboos water site
CWLS-Valve	600mm, 2sets Accessoires : Strainer, Butterfly valve, etc.	To protect pipelines from high water pressure

2-2-3 Basic Design Drawings

Basic design drawings of the above mentioned equipment and materials are shown in the following pages. The dimensions of the civil work facility for procured equipment and materials require the following capacity.

(1) Receiving Tanks (RT)

Purpose of the receiving tank is to storage and regulate water collected from well pump temporarily and to send to the transmission pipeline. The receiving tank has the capacity of one hour of well pump discharge.

Table 2-14 Capacity of Receiving Tank

RT	Location	Well number	Capacity	Remarks
No. 1	Maadar II WS	8 sets	400 m^3	Next phase
No. 2	The highest point	3sets	150 m^3	Ditto
No. 3	Yaboos WS	15sets	750 m^3	This phase

(2) Pressure Breaker Reservoir (PBR)

PBR shall be made to keep the necessary capacity to ensure the operation of CWLS-Valve. The necessary capacity is 5～10 minutes volume of inflow from the transmission pipeline and effective depth is 3 meters.

Table 2-15 Capacity of Pressure Breaker Reservoir

PBR	Location	Discharge	Capacity	Surface area	Remarks
No. 1	Yaboos WS	0.236 m^3/s	75 m^3	25 m^2	Use RT No.3
No. 2	The end of highway	0.444 m^3/s	210 m^3	70 m^2	
No. 3	Existing Takea PBR	0.444 m^3/s	210 m^3	110 m^2	Use Takea PBR

Note: Discharge shows future plan.
Surface area of the PBR No.3 needs 1.5 times of other PBR.

List of Drawings

No. of Drawing	Title of Drawing	Sheet
1	General Plan	1
2	Well Plan	1
3 ～ 5	Collection Pipes	3
6 ～ 14	Transmission Pipes	9
15 ～ 16	Pressure Reducing Facility	2
Total		16

Drawing No.1

GENERAL PLAN

MAADAR1

MAADAR2

Future Plan

Lebanon boundary

φ350
L = 2.75 km

P

φ350
L = 2.23 km

φ400
L = 10.20 km

Existing Facilities

Code: BM Name: BaradaMainRe
E.TWL=1122 Year 1996
E.BWL=1118 Vol=3000m3

YABOOS/MAADAR PIPELINE

YABOOS

R

φ600
L = 11.50 km

TAKEA

Existing Facilities

HOSAINIA

To FIGEH

FIGEH

Code: FIPBT Name: Figeh(Re)

Code: Hu- PBT Name: Husaynieh(re)
E.TWL=949 Year
00m3

DEIR AL ASHAYER PIPELINE

DEIR ALASHAYER

φ400
L = 3.57 km

φ350
L = 5.27 km

SCALE
0 1 2 3 4 5 (km)

LEGEND

- Plan of Transmission Pipeline
- Existing Facilities
- Future Plan
- Receiving Reservoir
- (P) Booster Pumping Station
- [R] Pressure Breaker Reservoir
- Existing Pressure Breaker Reservoir

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GENERAL PLAN	DRW. NO 01
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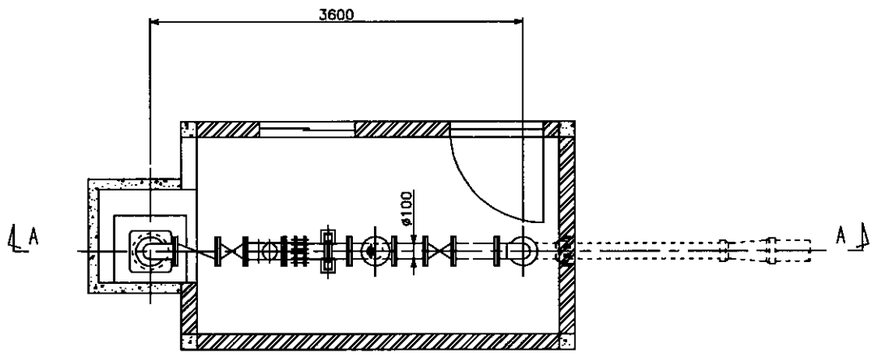
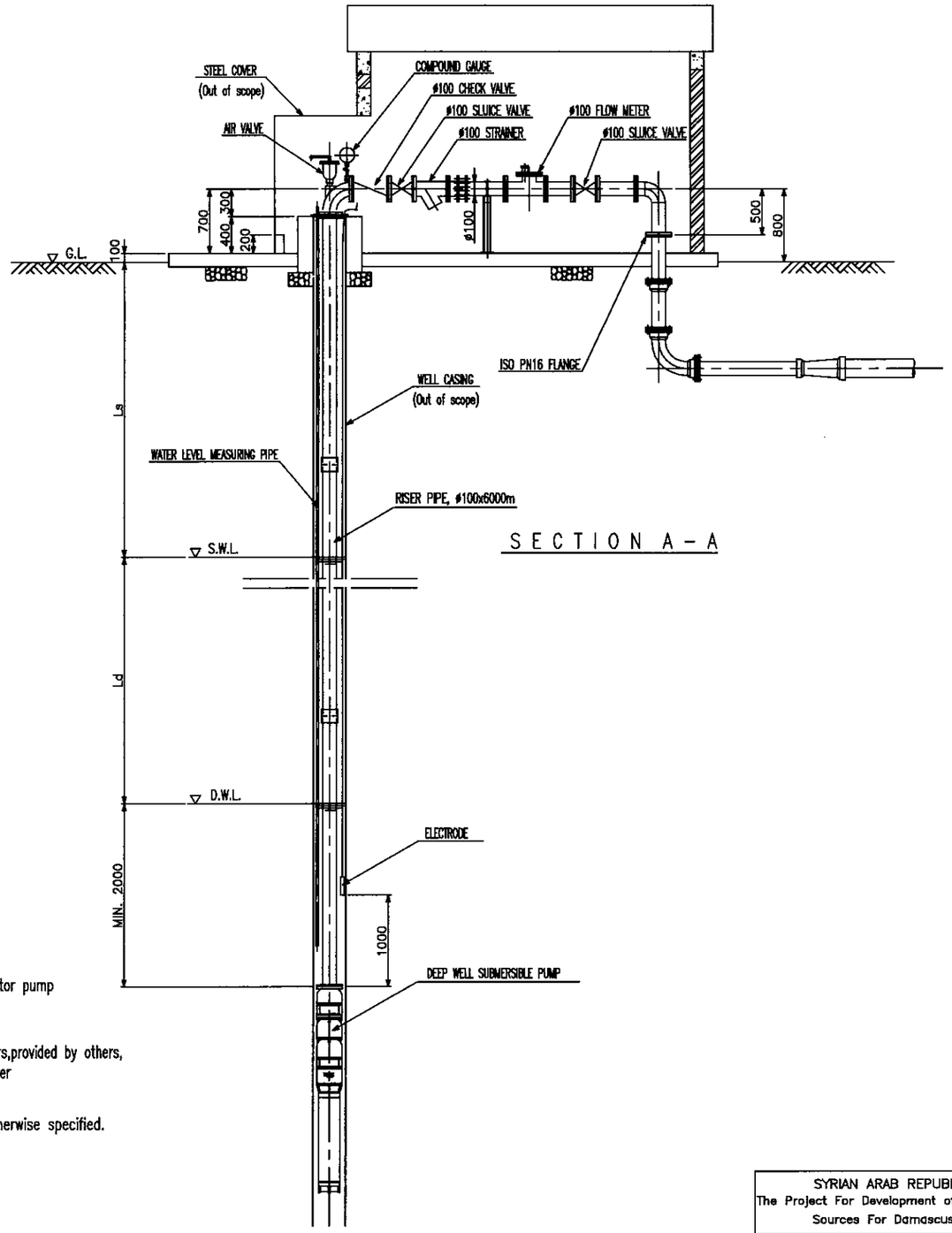
Drawing No.2



PLAN



SECTION A-A

Well No.	Discharge (m³/min)	Total Head (m)	G.L. (EL.m)	Ls (EL.m)	Ld (EL.m)	No. of Riser Pipe	Well diameter (inch)
Y1	0.83	160	1280.62	97.0	20.0	20	12
Y2	0.83	160	1285.32	101.5	16.0	20	12
Y3	0.83	170	1277.69	93.2	33.0	22	12
Y4	0.83	160	1308.59	111.6	34.0	25	12
Y5	0.83	160	1282.13	99.3	23.0	21	12
Y6	0.83	160	1268.49	87.0	16.0	18	12
Y7	0.83	170	1272.07	90.7	35.0	22	12
Y8	0.83	160	1281.20	100.0	19.0	21	12
Y9	0.83	170	1287.19	107.0	32.0	24	12
Y10	0.83	220	1299.33	117.8	78.0	33	12
Y11	0.83	220	1307.99	127.7	73.0	34	12

Note,

1, Installation and maintenance of the submersible motor pump will be carried out by a mobile crane through the opening of the steel cover.

2, The pump room will be heated up by electric heaters,provided by others, to protect the air valve,compound gauge,flow indicater and valves from fleezing in winter season.

3, All dimensions are given in milimeter, unless otherwise specified.

4, G.L. : Ground Level

ø : Nominal diameter (mm)

D.W.L. : Draw-down water level

S.W.L. : Static water level

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YABOOS WELL PUMP HOUSE	DRW. NO 02
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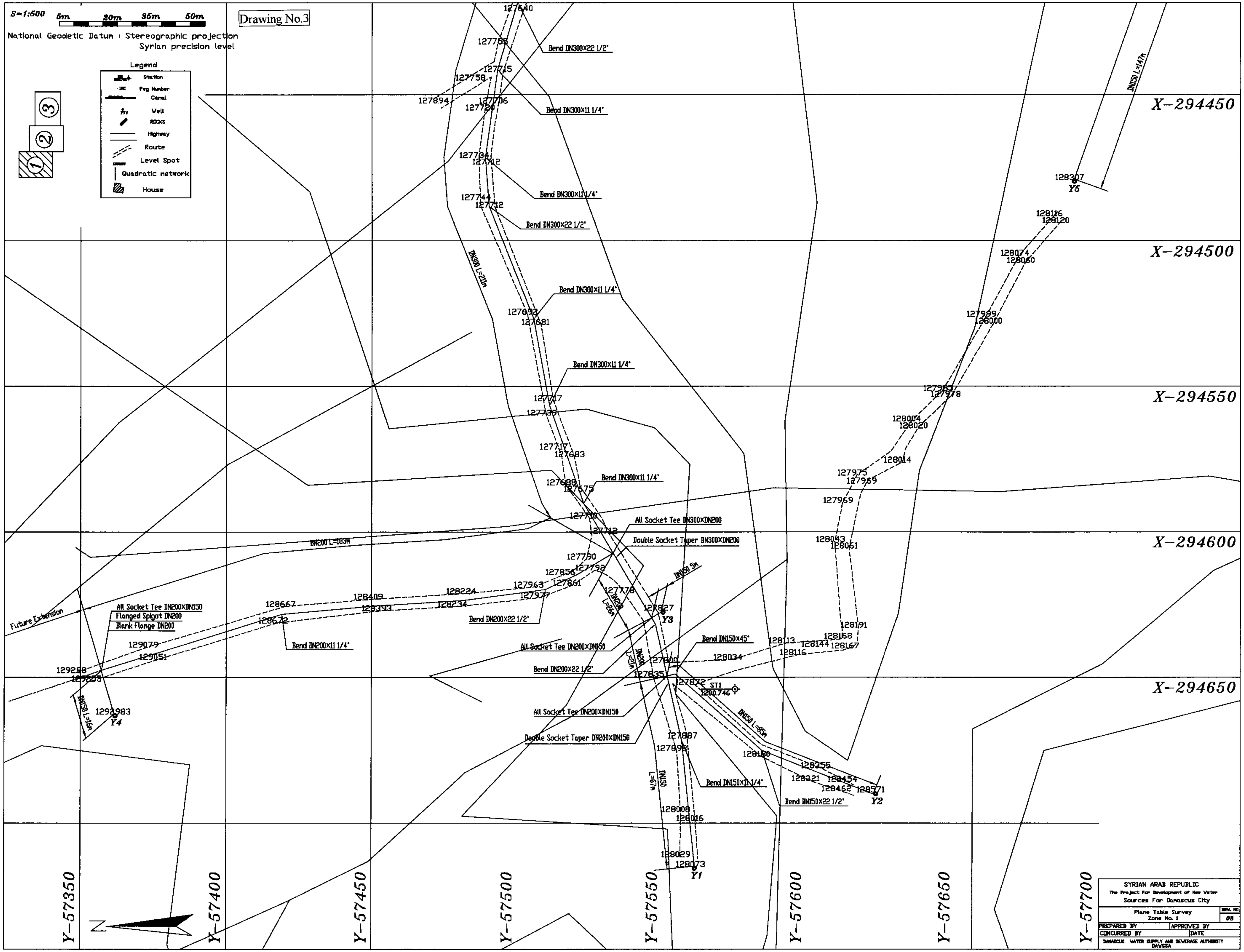

S=1:500 5m 20m 35m 50m
Drawing No.3
National Geodetic Datum : Stereographic projection
Syrian precision level
Legend
Station
Peg Number
Canal
Well
ROCKS
Highway
Route
Level Spot
Quadratic network
House
X-294450
X-294500
X-294550
X-294600
X-294650
Y-57350
Y-57400
Y-57450
Y-57500
Y-57550
Y-57600
Y-57650
Y-57700
Bend DN300×22 1/2°
Bend DN300×11 1/4°
DN300 L=211m
All Socket Tee DN300×DN200
Double Socket Taper DN300×DN200
DN150 5m
DN200 L=183m
Future Extension
All Socket Tee DN200×DN150
Flanged Spigot DN200
Blank Flange DN200
Bend DN200×22 1/2°
Bend DN200×11 1/4°
All Socket Tee DN200×DN150
Double Socket Taper DN200×DN150
Bend DN150×45°
Bend DN150×11 1/4°
Bend DN150×22 1/2°
DN150 L=85m
DN150 L=147m
DN150 L=69m
ST1
1280.746
Y1
Y2
Y3
Y4
Y5
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Plane Table Survey
Zone No. 1
DRW. NO
03
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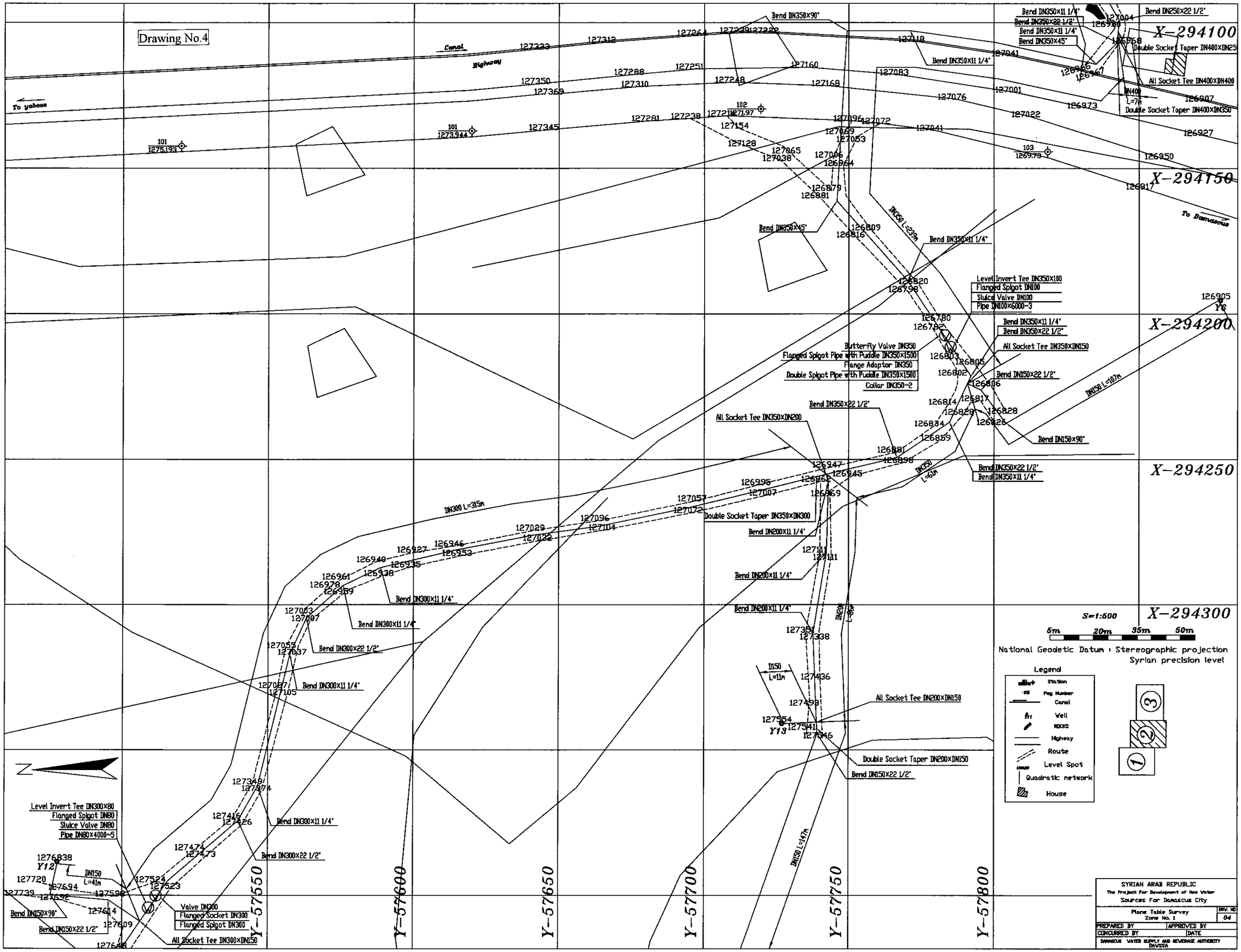
Drawing No.4


To yabous
Canal
Highway
To Damascus
X-294100
X-294150
X-294200
X-294250
X-294300
Bend DN350×90°
Bend DN350×11 1/4°
Bend DN350×22 1/2°
Bend DN350×45°
Bend DN250×22 1/2°
Double Socket Taper DN400×DN250
All Socket Tee DN400×DN400
Double Socket Taper DN400×DN350
Level Invert Tee DN350×100
Flanged Spigot DN100
Sluice Valve DN100
Pipe DN100×6000-3
Butterfly Valve DN350
Flanged Spigot Pipe with Puddle DN350×1500
Flange Adaptor DN350
Double Spigot Pipe with Puddle DN350×1500
Collar DN350-2
All Socket Tee DN350×DN150
Bend DN150×22 1/2°
Bend DN150×90°
All Socket Tee DN350×DN200
Double Socket Taper DN350×DN300
Bend DN200×11 1/4°
Bend DN300×11 1/4°
Bend DN300×22 1/2°
All Socket Tee DN200×DN150
Double Socket Taper DN200×DN150
Level Invert Tee DN300×80
Flanged Spigot DN80
Sluice Valve DN80
Pipe DN80×4000-5
Valve DN300
Flanged Socket DN300
Flanged Spigot DN300
All Socket Tee DN300×DN150
DN300 L=315m
DN350 L=239m
DN350 L=36m
DN350 L=347m
DN150 L=107m
D150 L=11m
Y-57550
Y-57600
Y-57650
Y-57700
Y-57750
Y-57800
S=1:600
5m 20m 35m 50m
National Geodetic Datum : Stereographic projection
Syrian precision level
Legend
Station
Peg Number
Canal
Well
ROCKS
Highway
Route
Level Spot
Quadratic network
House
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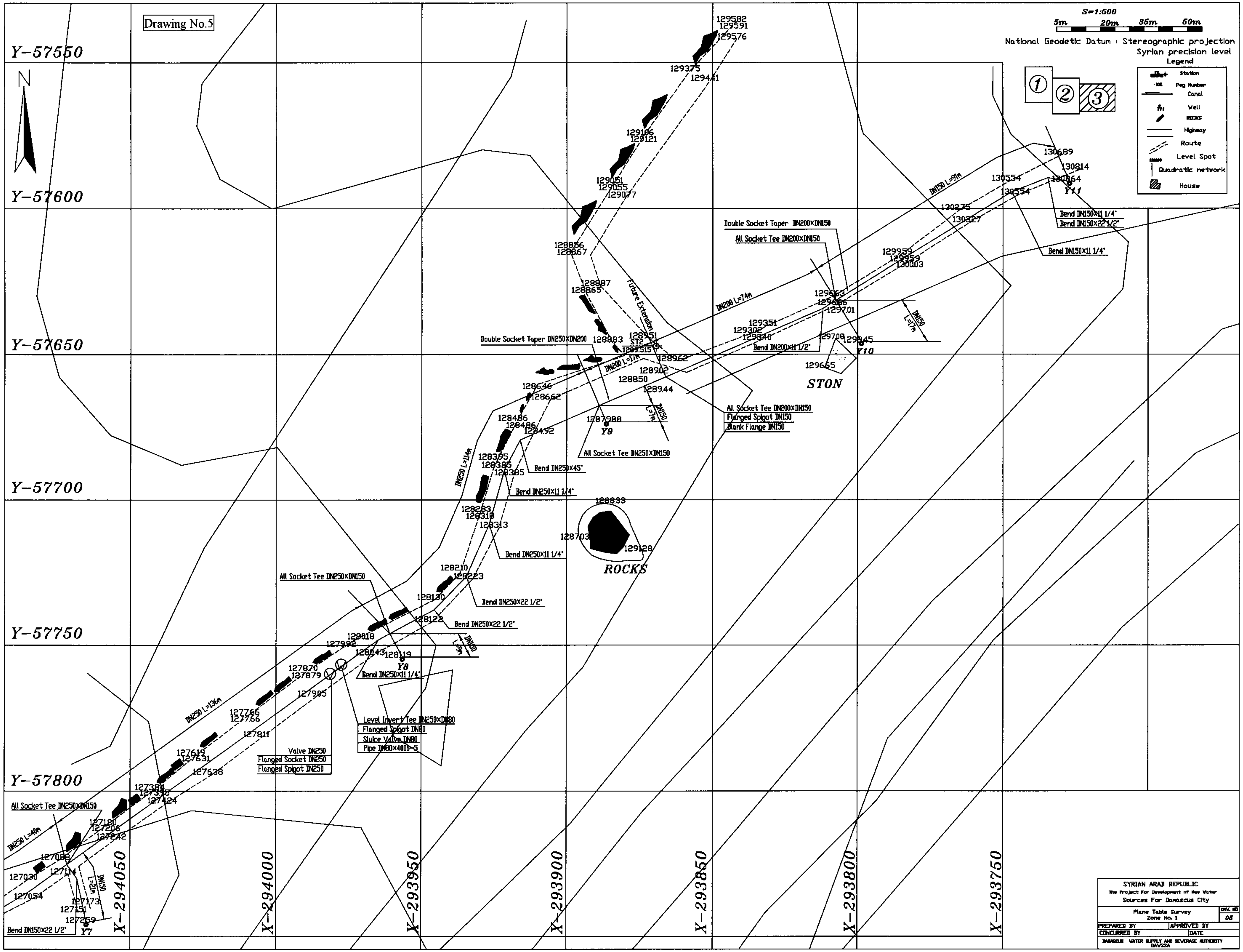

Drawing No.5
S=1:500
National Geodetic Datum : Stereographic projection
Syrian precision level
Legend
Station
Peg Number
Canal
Well
ROCKS
Highway
Route
Level Spot
Quadratic network
House
Y-57550
Y-57600
Y-57650
Y-57700
Y-57750
Y-57800
X-294050
X-294000
X-293950
X-293900
X-293850
X-293800
X-293750
N
STON
ROCKS
Double Socket Taper DN200×DN150
All Socket Tee DN200×DN150
Double Socket Taper DN250×DN200
All Socket Tee DN250×DN150
Bend DN250×45°
Bend DN250×11 1/4°
Bend DN250×22 1/2°
Bend DN200×11 1/2°
Bend DN150×11 1/4°
Bend DN150×22 1/2°
Flanged Spigot DN150
Blank Flange DN150
Level Invert Tee DN250×DN80
Flanged Spigot DN80
Sluice Valve DN80
Pipe DN80×4000-5
Valve DN250
Flanged Socket DN250
Flanged Spigot DN250
Future Extension
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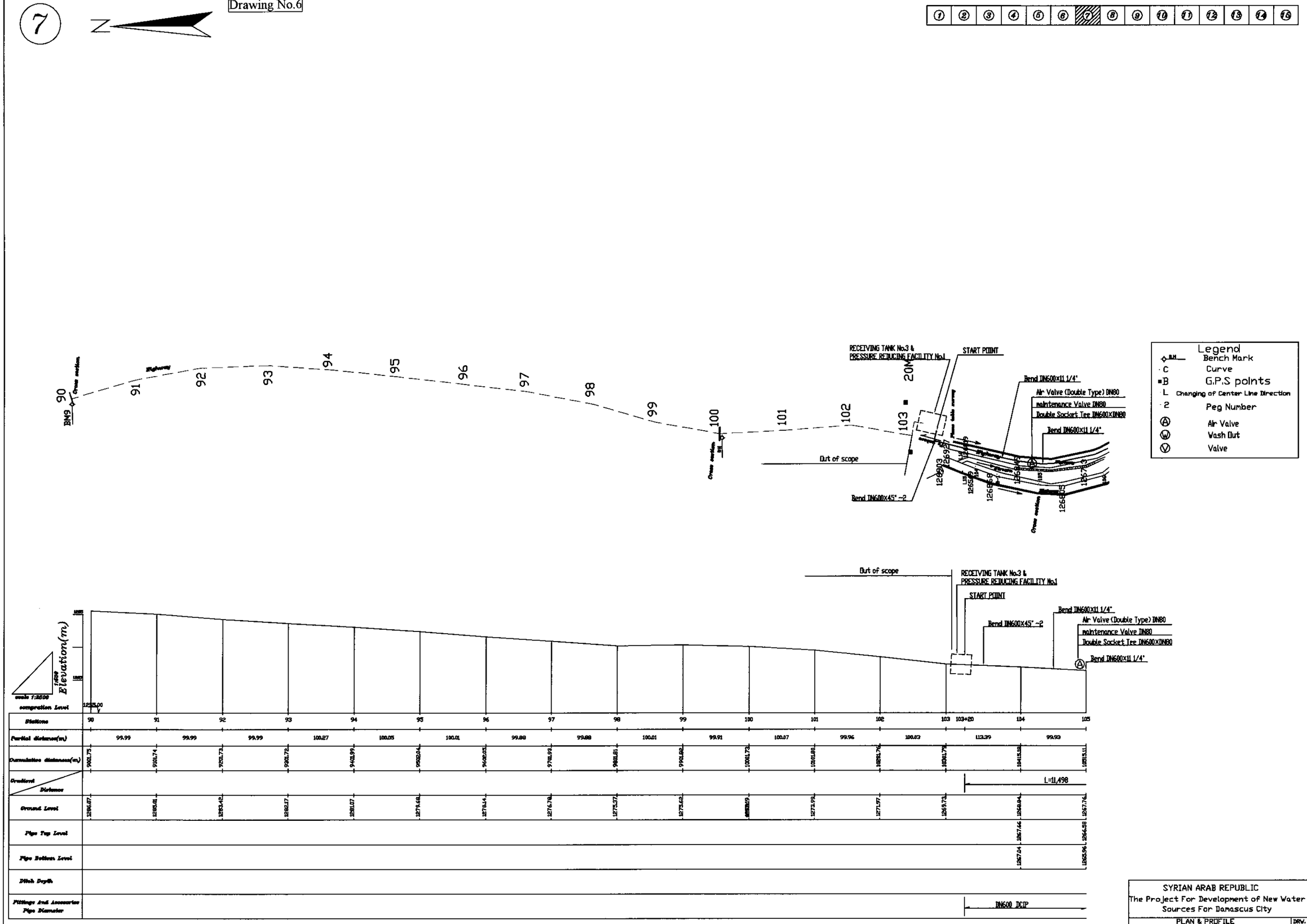
Drawing No.6



Stations	Partial distance(m)	Cumulative distance(m)	Ground Level
90		9001.75	1286.87
91	99.99	9101.74	1285.81
92	99.99	9201.73	1283.42
93	99.99	9301.72	1282.17
94	100.27	9401.99	1281.07
95	100.05	9502.04	1279.68
96	100.01	9602.05	1278.14
97	99.88	9701.93	1276.78
98	99.88	9801.81	1275.37
99	100.01	9901.82	1274.62
100	99.91	10001.73	1273.79
101	100.07	10101.80	1273.99
102	99.96	10201.76	1271.97
103	100.03	10301.79	1269.73
103+20	113.39	10415.18	1268.84
104	99.93	10515.11	1267.76
105			

Pipe Top Level	1267.66, 1266.58
Pipe Bottom Level	1267.04, 1265.96
Ditch Depth	
Fittings And Accessories / Pipe Diameter	DN600 DCIP

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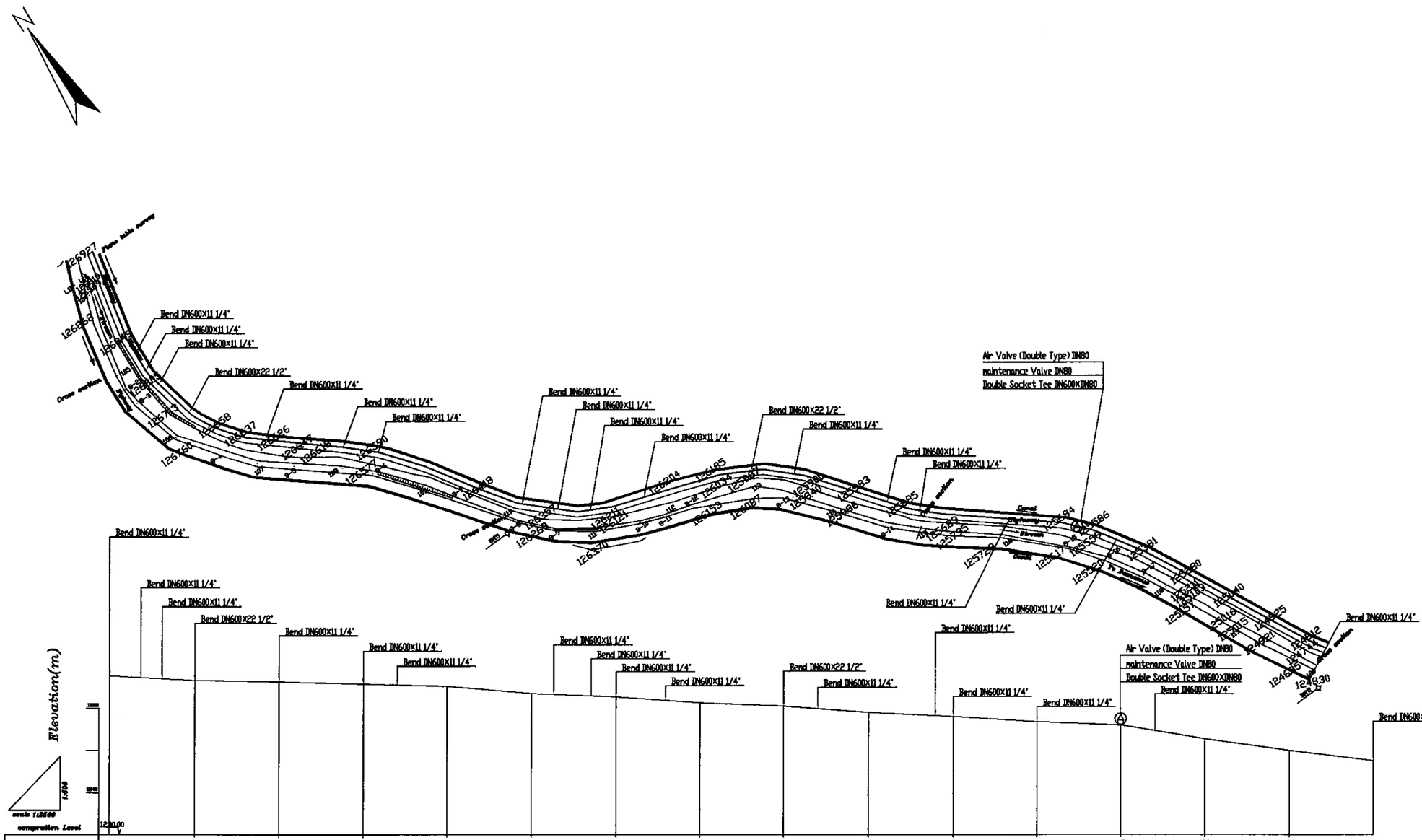
Drawing No.7



Stations	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Partial distance(m)		101.07	100.01	100.00	99.96	100.16	99.96	100.04	99.79	100.34	100.16	99.90	99.90	100.06	100.23	100.18
Cumulative distance(m)	10035.11	10616.18	10716.19	10816.19	10916.15	11016.31	11116.27	11216.31	11316.10	11416.44	11516.60	11616.50	11716.40	11816.46	11916.69	12016.87
Gradient / Distance	L=11.498															
Ground Level	1267.76	1266.71	1266.36	1265.84	1262.82	1262.45	1262.76	1262.26	1262.52	1259.81	1259.01	1256.83	1256.04	1255.72	1249.96	1247.51
Pipe Top Level	1266.36	1265.32	1265.18	1264.66	1264.10	1262.37	1261.58	1260.87	1259.34	1257.63	1256.83	1255.68	1254.86	1251.37	1248.78	1246.38
Pipe Bottom Level	1253.96	1254.90	1254.59	1254.44	1263.48	1261.75	1260.96	1259.55	1258.72	1257.21	1256.21	1255.03	1254.24	1250.53	1248.16	1245.73
Ditch Depth																
Fittings And Accessories / Pipe Diameter	DN600 DCIP															

Legend
- BM Bench Mark
- C Curve
- B G.P.S points
- L Changing of Center Line Direction
- 2 Peg Number
- Ⓐ Air Valve
- Ⓦ Wash Out
- Ⓥ Valve

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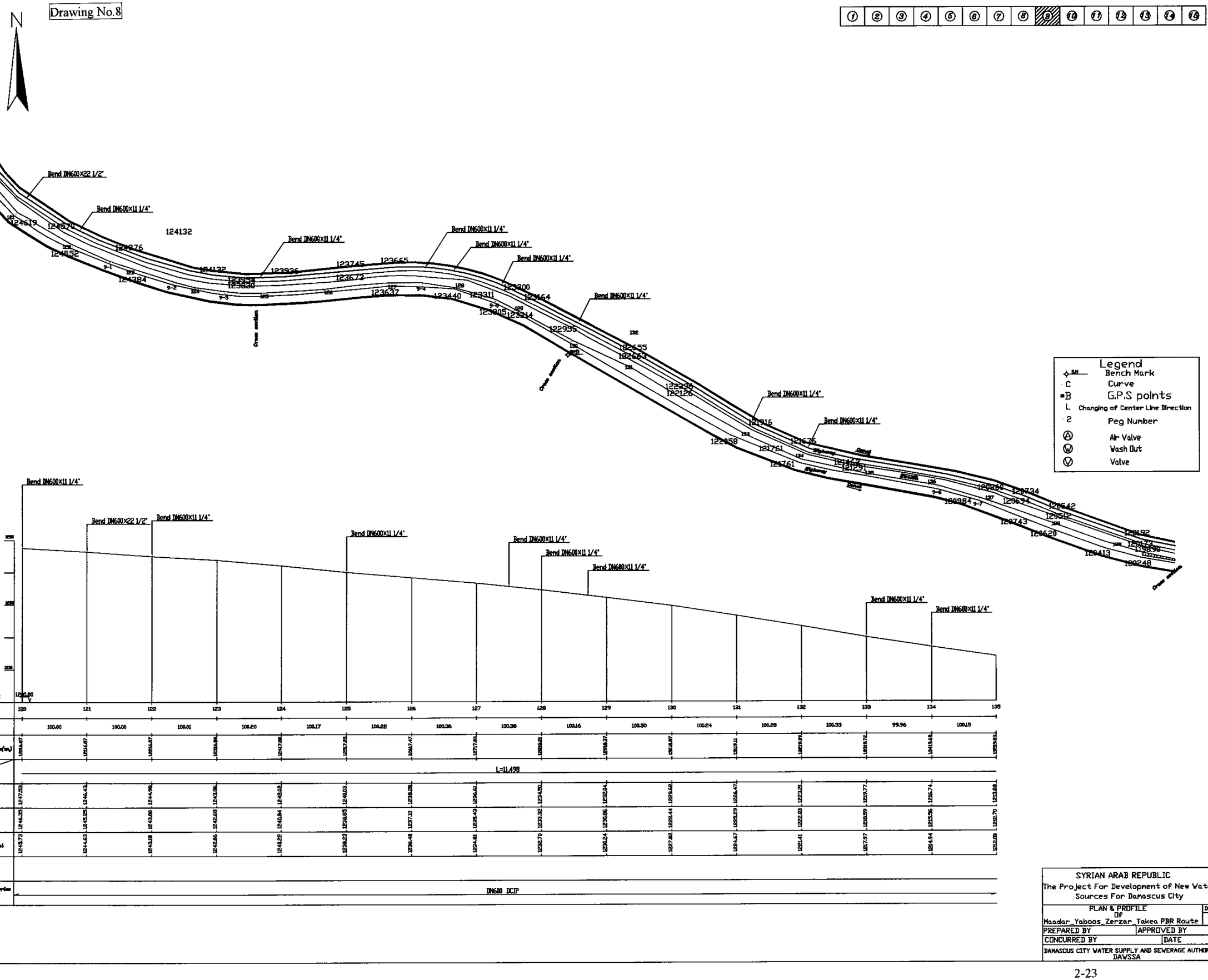
Drawing No.8



Stations	Partial distance(m)	Cumulative distance(m)	Ground Level	Pipe Top Level	Pipe Bottom Level
120	100.00	12016.87	1247.03	1246.35	1245.73
121	100.00	12116.87	1246.43	1245.25	1244.63
122	100.01	12216.88	1245.98	1243.80	1243.18
123	100.20	12317.08	1245.36	1242.68	1242.06
124	100.17	12417.25	1245.02	1241.84	1240.22
125	100.22	12517.47	1240.03	1238.65	1238.23
126	100.36	12617.83	1238.82	1237.10	1236.48
127	100.38	12718.21	1236.61	1235.43	1234.81
128	100.16	12818.37	1234.55	1233.32	1232.70
129	100.50	12918.87	1232.14	1230.96	1230.24
130	100.24	13019.11	1229.62	1228.44	1227.82
131	100.28	13119.39	1226.47	1225.29	1224.67
132	100.33	13219.72	1223.28	1222.03	1221.41
133	99.96	13319.68	1219.77	1218.59	1217.97
134	100.15	13419.83	1216.74	1215.56	1214.94
135		13519.83	1213.68	1212.70	1212.08

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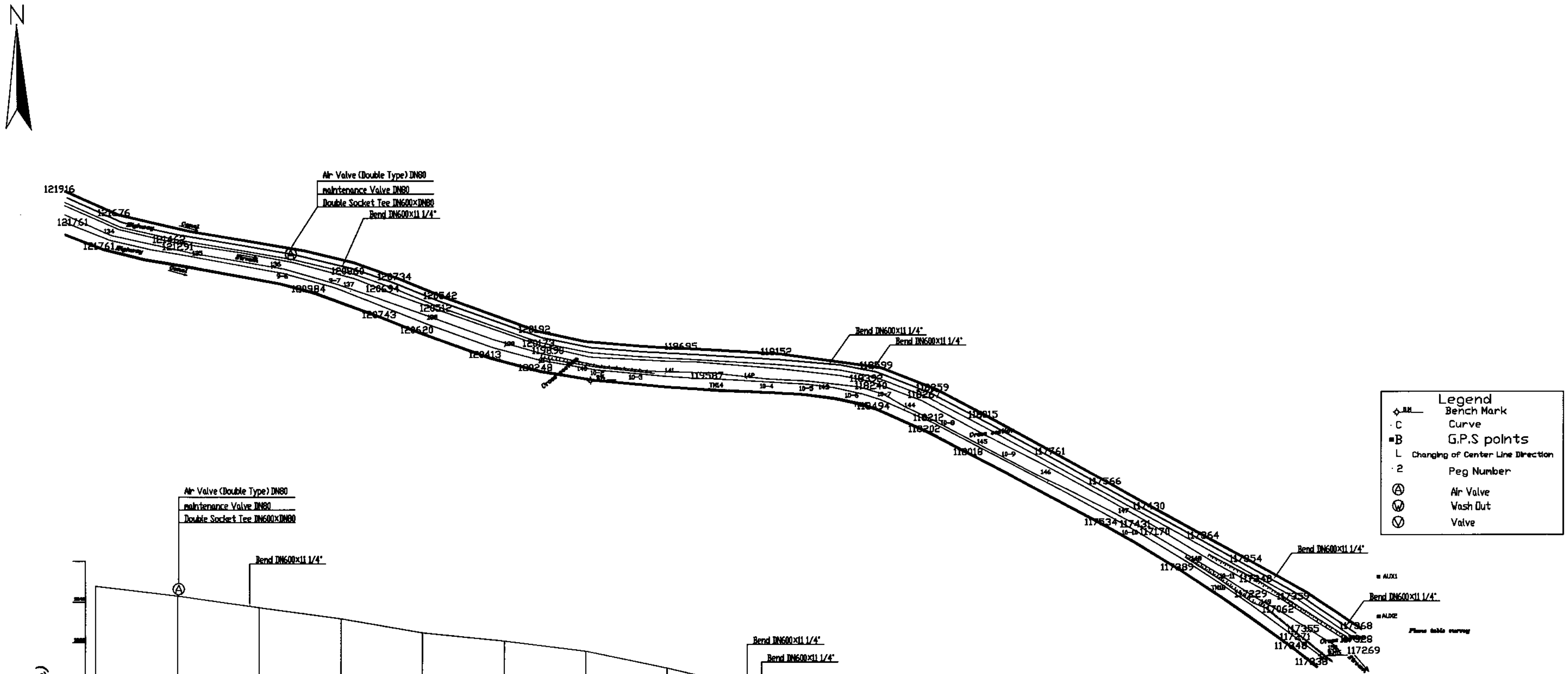
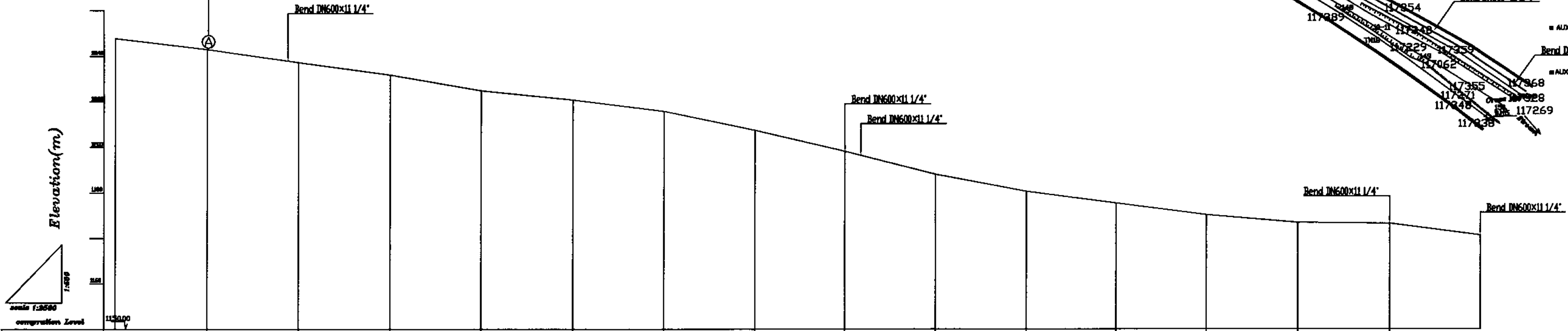
(10)

Drawing No.9





Stations	Partial distance(m)	Cumulative distance(m)	Ground Level	Pipe Top Level	Pipe Bottom Level
135		13519.82	1213.68	1212.70	1213.88
	100.50				
136		13620.32	1211.47	1210.29	1209.67
	100.49				
137		13720.80	1208.66	1207.48	1206.86
	100.55				
138		13821.37	1205.91	1204.73	1204.11
	100.23				
139		13921.60	1202.38	1201.20	1200.58
	100.45				
140		14022.05	1200.35	1199.17	1198.55
	99.82				
141		14121.87	1197.82	1196.64	1196.02
	100.10				
142		14221.97	1193.63	1192.45	1191.83
	98.97				
143		14320.94	1189.01	1187.83	1187.21
	99.06				
144		14420.00	1183.95	1182.77	1182.15
	99.21				
145		14519.21	1180.23	1179.05	1178.43
	98.88				
146		14618.09	1177.62	1176.44	1175.82
	100.04				
147		14718.13	1175.05	1173.87	1173.25
	100.09				
148		14818.22	1173.37	1172.19	1171.57
	100.41				
149		14918.63	1173.18	1172.00	1171.38
	100.20				
150		15018.83	1170.64	1169.46	1168.84

Gradient / Distance: L=11,498

Ditch Depth:

Fittings And Accessories / Pipe Diameter: DN600 DCIP

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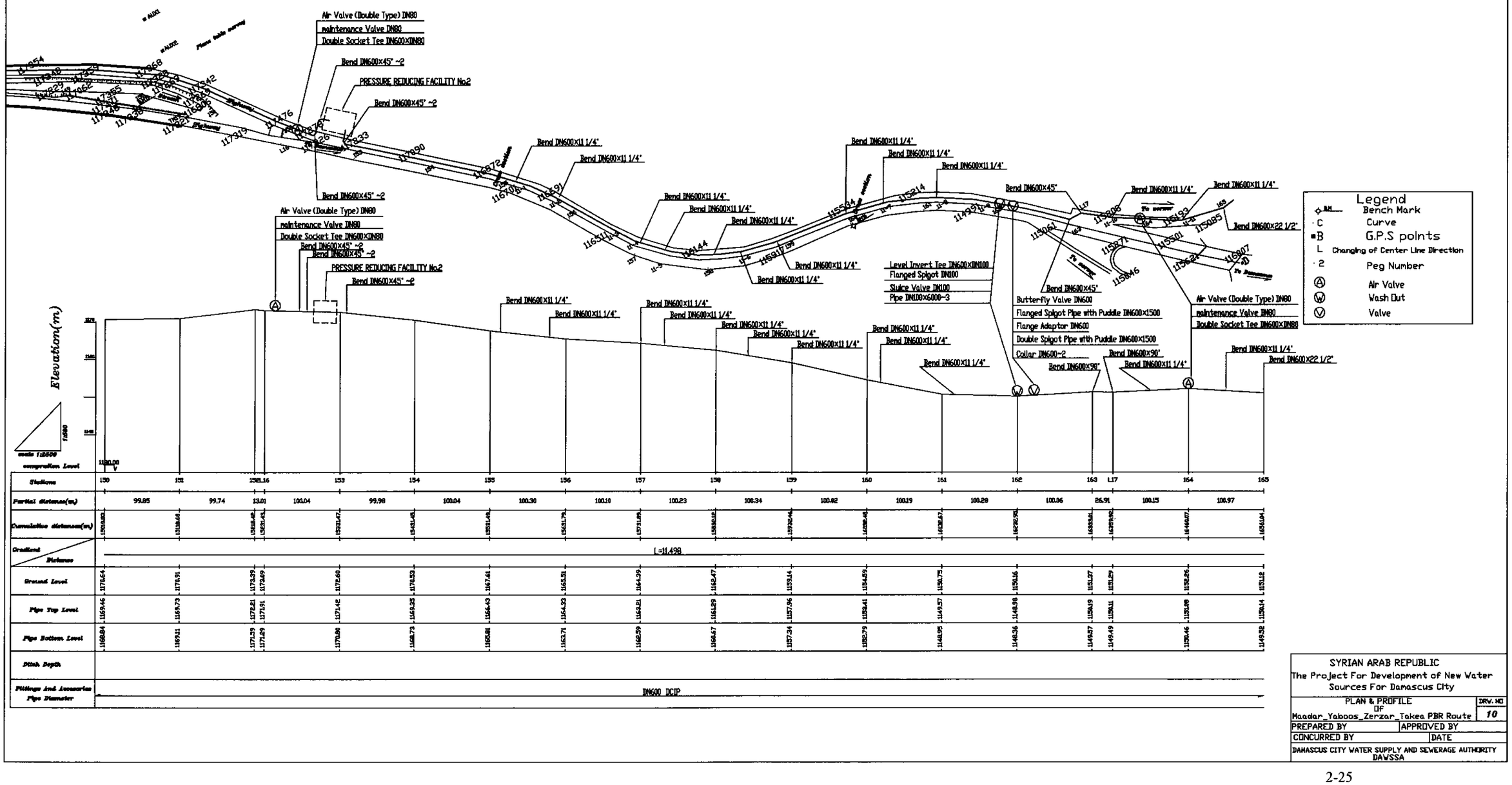
Drawing No.10



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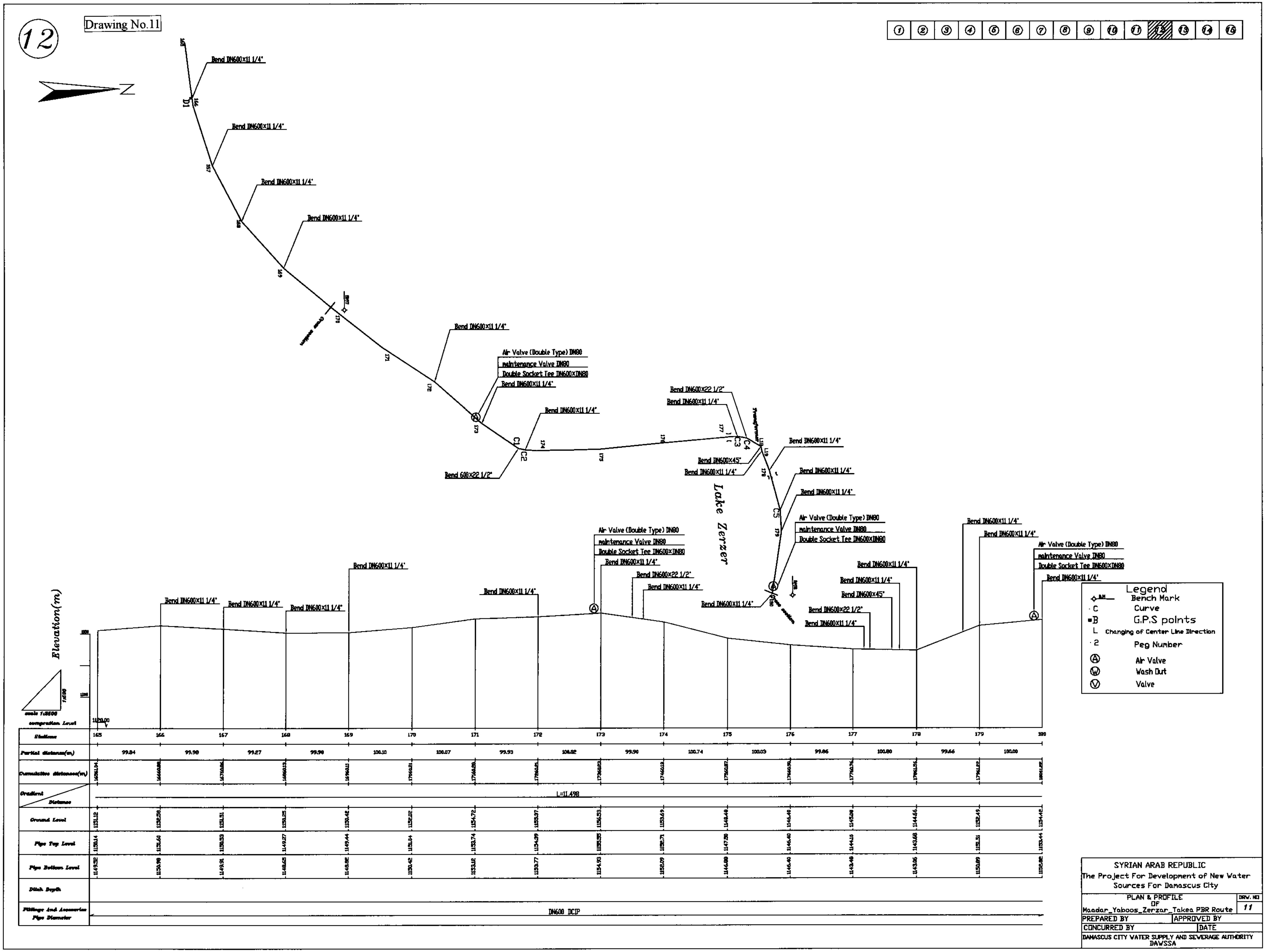
DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY
DAWSSA

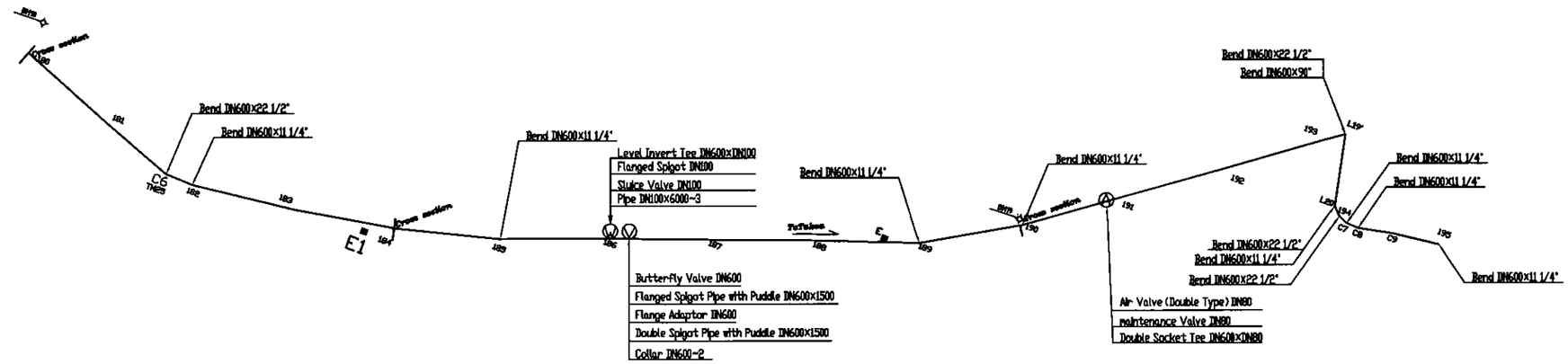


12
Drawing No.11
Bend DN600×11 1/4°
Bend DN600×22 1/2°
Bend DN600×45°
Bend 600×22 1/2°
Air Valve (Double Type) DN80
maintenance Valve DN80
Double Socket Tee DN600×DN80
Lake Zerzer
C1
C2
C3
C4
C5
D1
Elevation(m)
scale 1:2500
comparison Level
1120.00
Stations
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
Partial distance(m)
99.84
99.90
99.27
99.90
100.10
100.07
99.93
100.02
99.90
100.74
100.03
99.86
100.80
99.66
100.00
Cumulative distance(m)
Gradient
Distance
L=11.498
Ground Level
1151.12
1152.58
1151.51
1150.25
1150.42
1152.02
1154.72
1155.37
1156.53
1153.69
1148.40
1146.40
1145.08
1144.66
1152.49
1154.42
Pipe Top Level
1150.14
1151.60
1150.53
1149.27
1149.44
1151.04
1153.74
1154.39
1155.55
1152.71
1147.50
1146.40
1144.10
1143.68
1151.51
1153.44
Pipe Bottom Level
1149.52
1150.98
1149.91
1148.65
1148.82
1150.42
1153.12
1153.77
1154.93
1152.09
1146.88
1146.40
1143.48
1143.06
1150.89
1152.82
Ditch Depth
Fittings And Accessories
Pipe Diameter
DN600 DCIP
Legend
BM Bench Mark
C Curve
B G.P.S points
L Changing of Center Line Direction
2 Peg Number
Air Valve
Wash Out
Valve
SYRIAN ARAB REPUBLIC
The Project For Development of New Water Sources For Damascus City
PLAN & PROFILE OF Maadar_Yaboos_Zerzar_Takea PBR Route
DRW. NO 11
PREPARED BY
APPROVED BY
CONCURRED BY
DATE
DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY DAWSSA

13

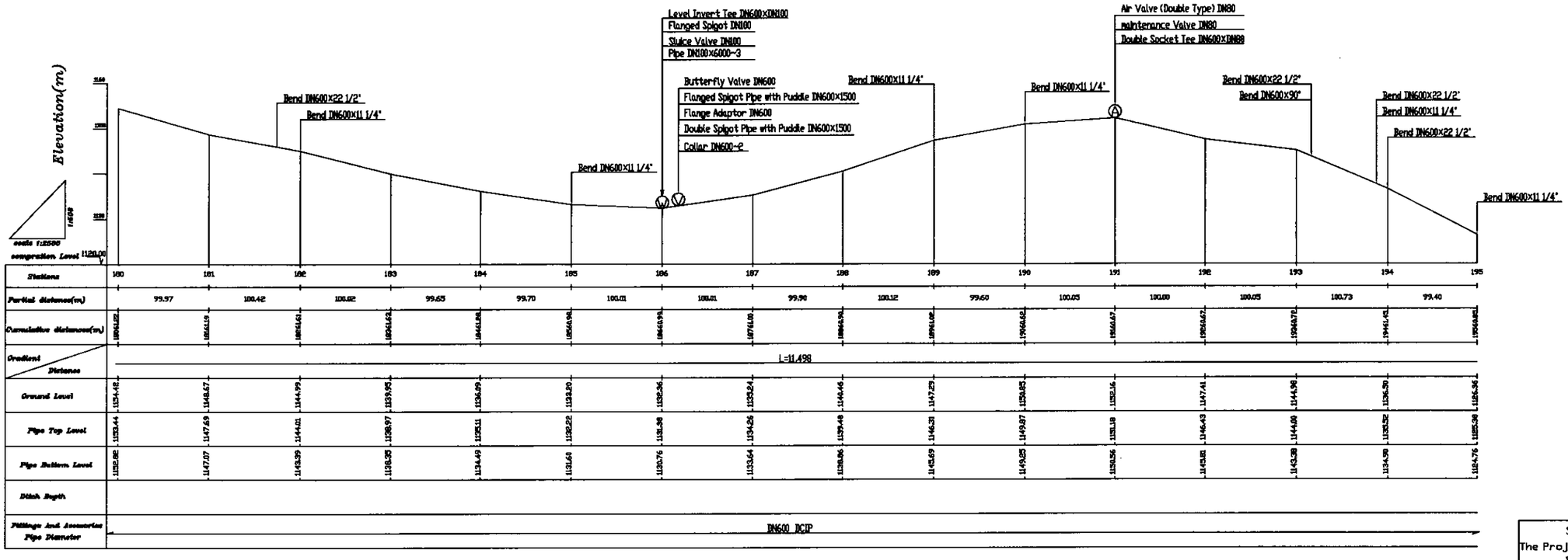
Drawing No.12

N



Legend

- BM — Bench Mark
- C — Curve
- B — G.P.S points
- L — Changing of Center Line Direction
- 2 — Peg Number
- Ⓐ — Air Valve
- Ⓦ — Wash Out
- Ⓥ — Valve

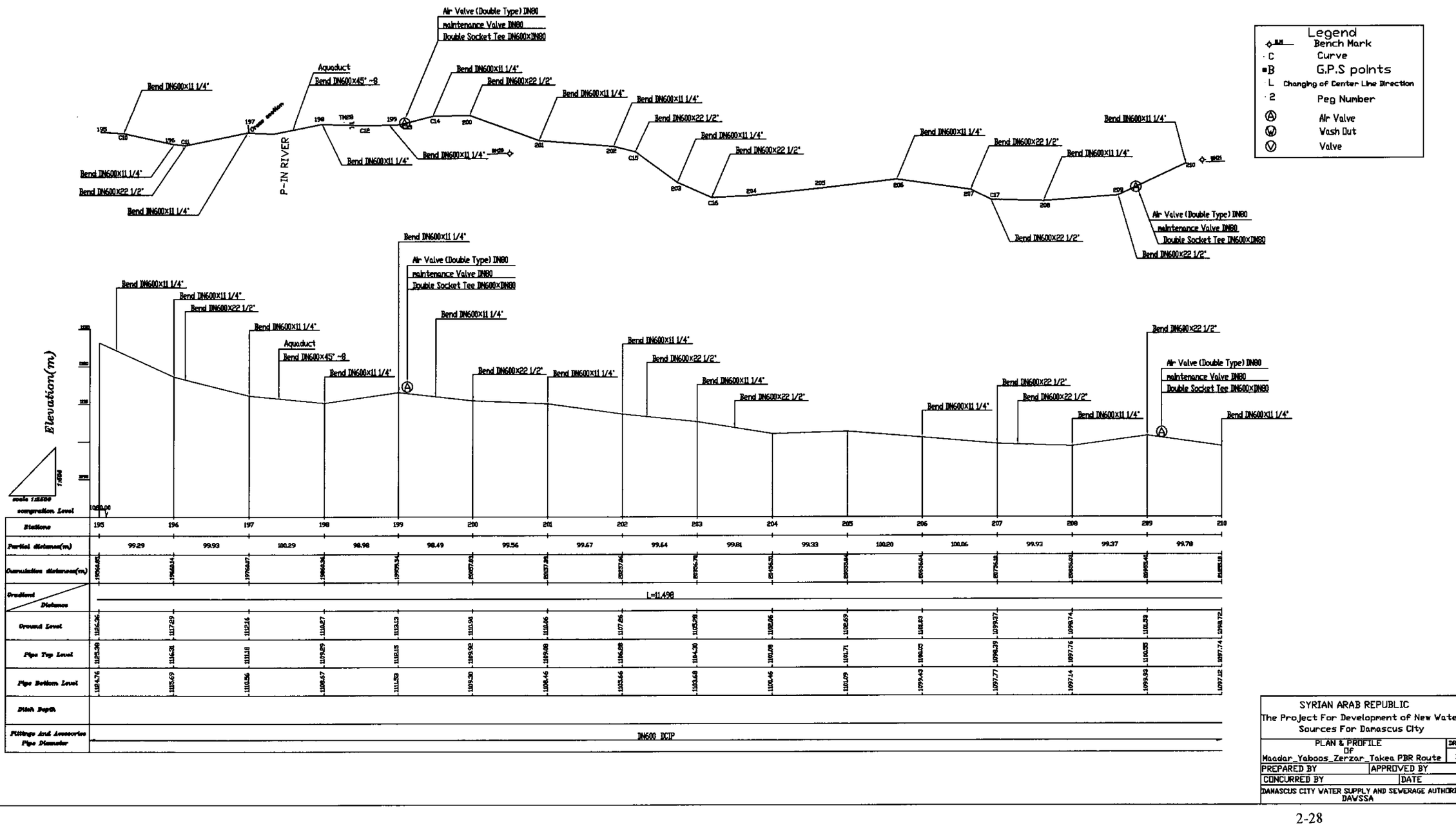


SYRIAN ARAB REPUBLIC	
The Project For Development of New Water Sources For Damascus City	
PLAN & PROFILE OF Maadar_Yaboos_Zerzar_Takea PBR Route	DRV. NO 12
PREPARED BY	APPROVED BY
CONCURRED BY	DATE
DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY DAWSSA	

14

Drawing No.13

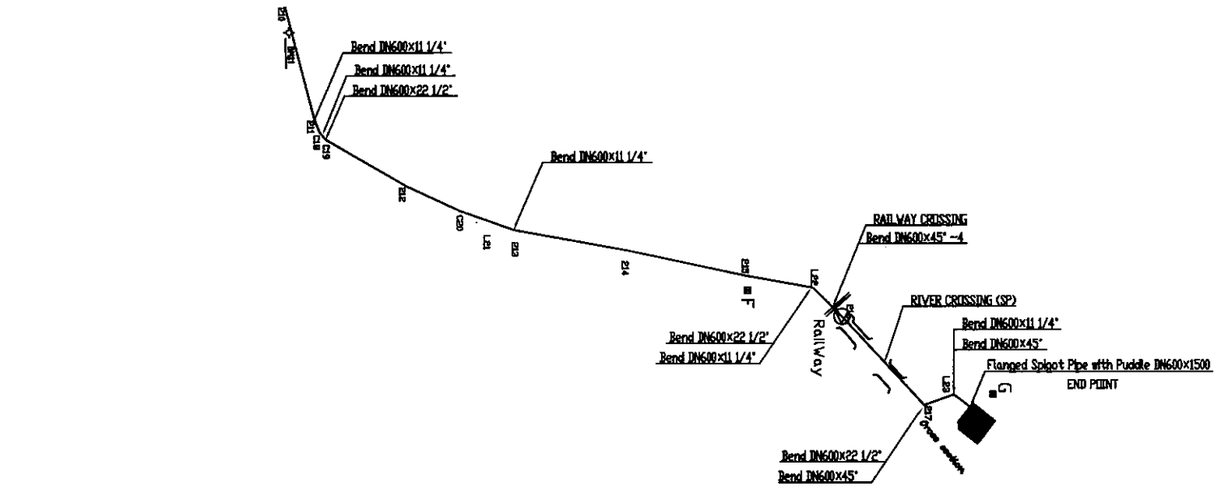
N

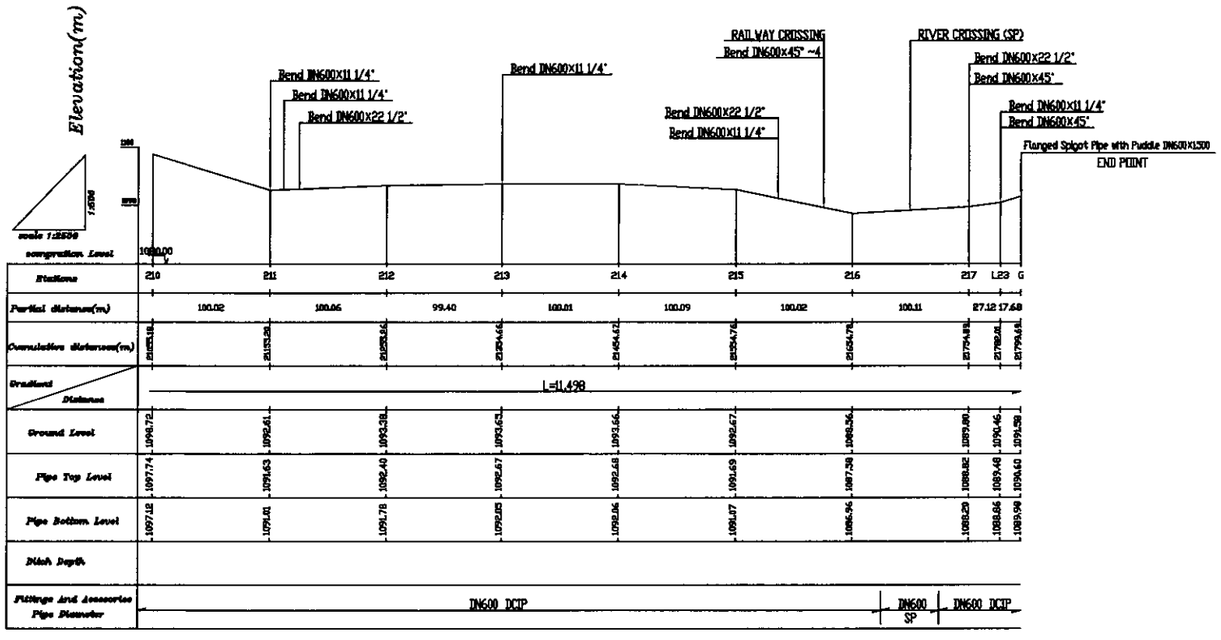


SYRIAN ARAB REPUBLIC
The Project For Development of New Water Sources For Damascus City

PLAN & PROFILE OF Maadar_Yaboos_Zerzar_Takea PBR Route	DRV. NO 13
PREPARED BY	APPROVED BY
CONCURRED BY	DATE

DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY DAWSSA





Legend

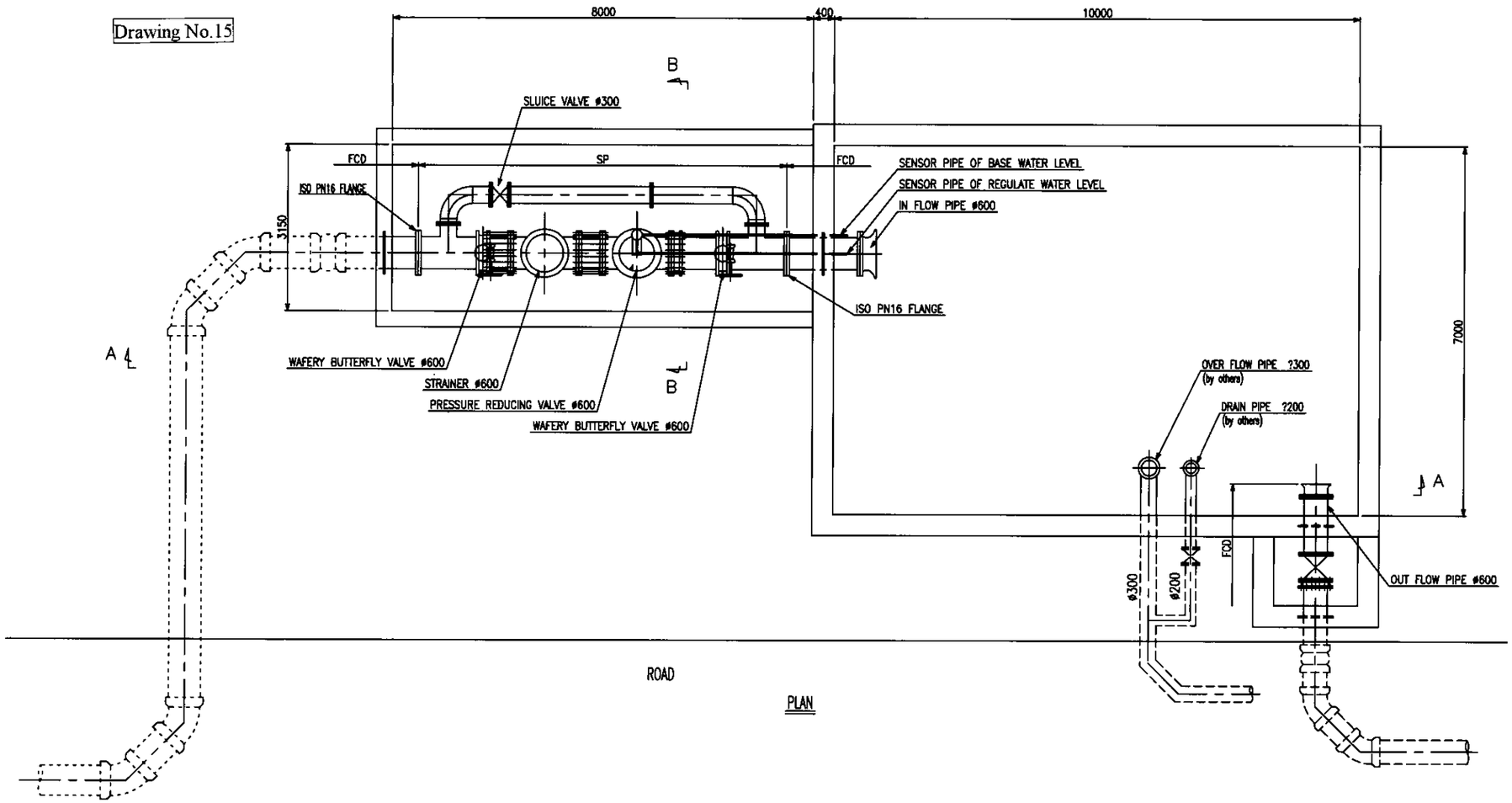
- Bench Mark
- C Curve
- B G.P.S points
- L Changing of Center Line Direction
- 2 Peg Number
- Ⓐ Air Valve
- Ⓦ Wash Out
- Ⓥ Valve

SYRIAN ARAB REPUBLIC
The Project For Development of New Water Sources For Damascus City

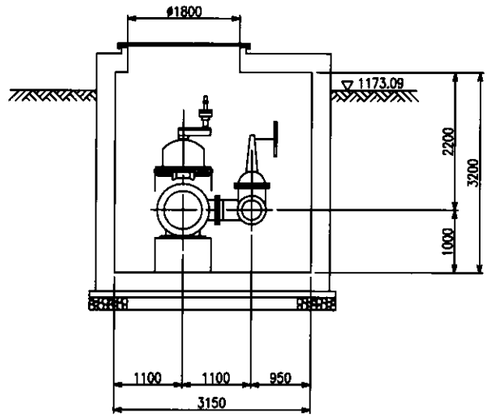
PLAN & PROFILE Of Maadar_Yaboos_Zerzar_Takea PBR Route	DRV. NO 14
PREPARED BY	APPROVED BY
CONCURRED BY	DATE

DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY DAWSSA

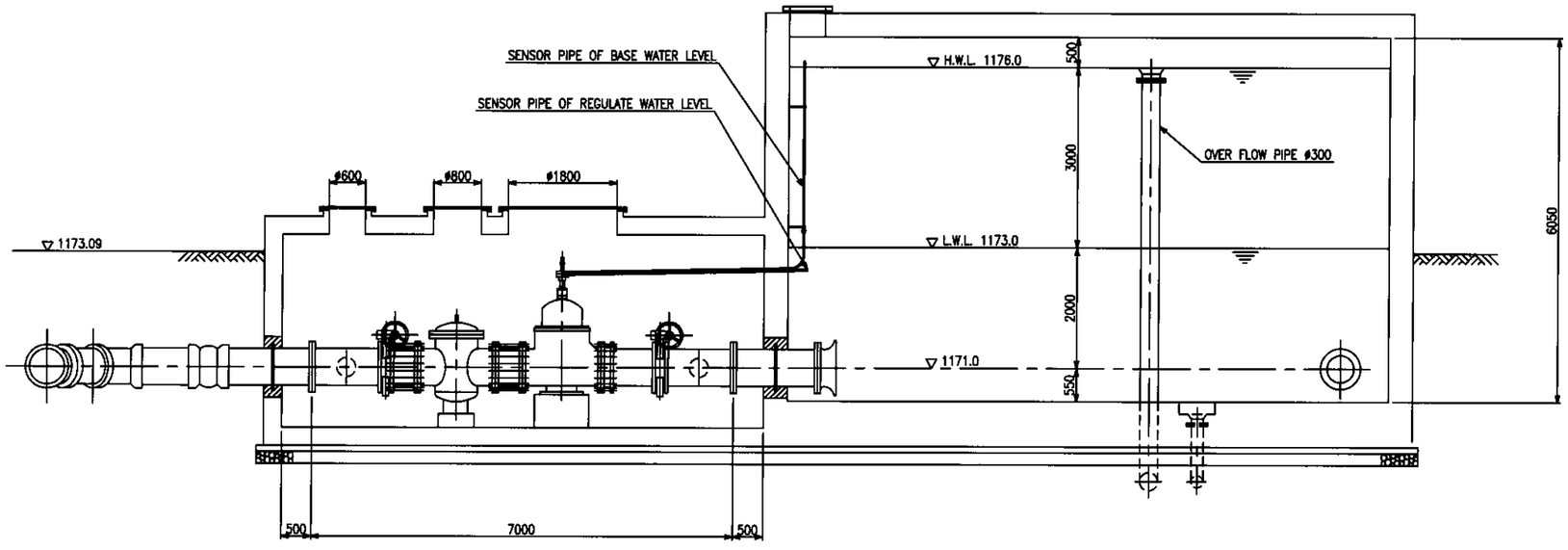
Drawing No.15



PLAN



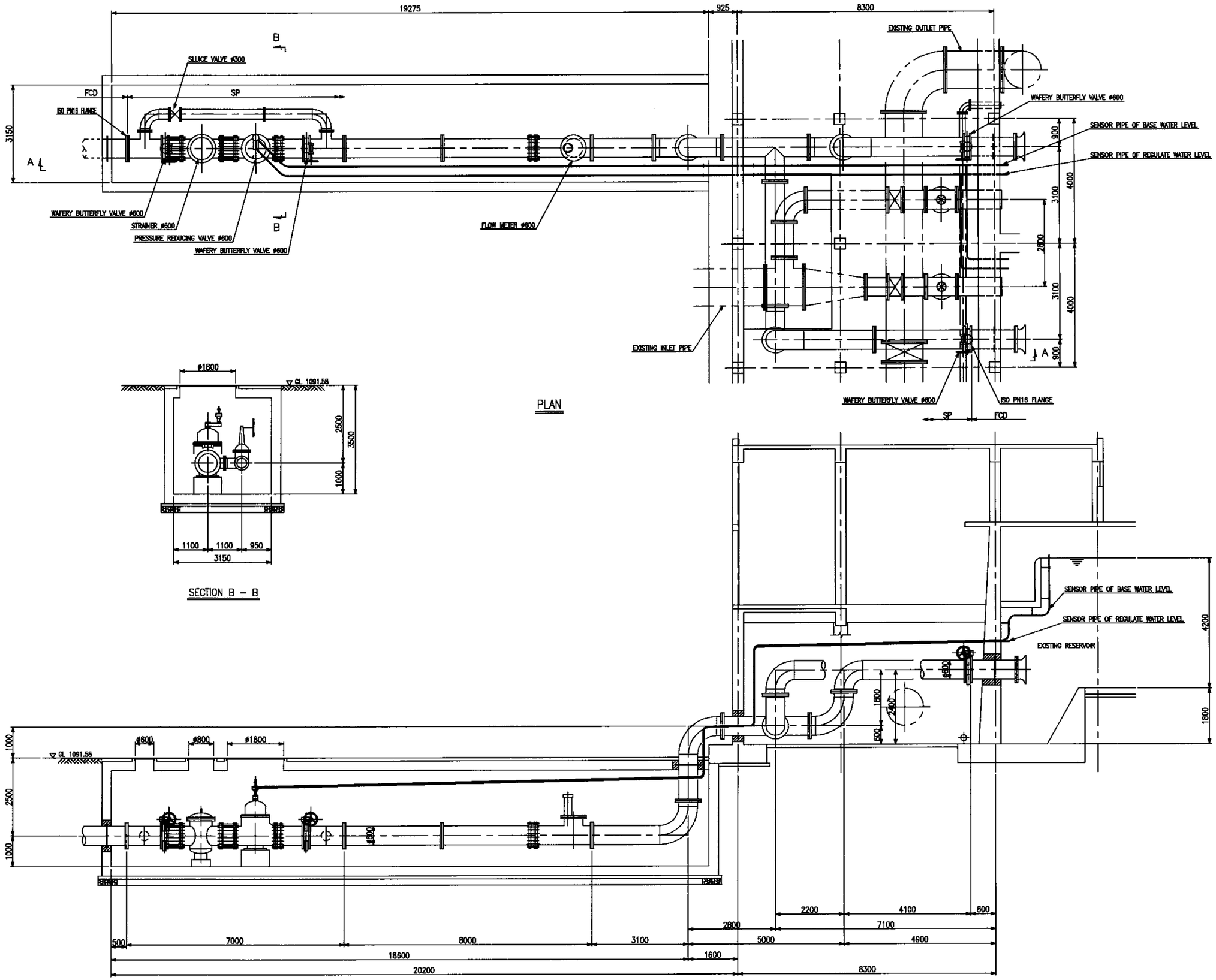
SECTION B – B



SECTION A – A

SYRIAN ARAB REPUBLIC The Project For Development of New Water Sources For Damascus City	
LAYOUT OF PRESSURE REDUCING FACILITY No2	DRW. NO 15
PREPARED BY	APPROVED BY
CONCURRED BY	DATE
DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY DAWSSA	

Drawing No.16



SYRIAN ARAB REPUBLIC
The Project For Development of New Water Sources For Damascus City

LAYOUT OF PRESSURE REDUCING FACILITY No.3 AT YABOOS EXISTING RESERVOIR	DRW. NO 16
PREPARED BY	APPROVED BY
CONCURRED BY	DATE
DAMASCUS CITY WATER SUPPLY AND SEWERAGE AUTHORITY DAWSSA	

2-2-4. Procurement Plan

2-2-4-1 Procurement Policy

The main equipment and materials of the Project are submersible pumps, ductile cast iron pipes (DCIP) and constant water level self-control valve (CWLS-Valve) and will be imported because they are not produced in Syria. Procurement countries of these equipment and materials are compared and selected from Japan and/or third countries, such as European countries, after studying the economical point of view including transportation charges, requirement and quality, procurement achievement of the supplier, delivery period, after-purchase servicing, agent of spare parts, etc.. Number of spare parts shall be determined in consideration of certain consumption for maintaining efficiency of the equipment. Also, additional materials will be included to avoid shortage of the materials considering possible crossing of underground obstacles and avoiding unknown underground facilities.

This Project involves the procurement of equipment and materials for water transmission facilities to be connected from the water source to the existing PBR, which mainly include a various kind of pump equipment. It is recommendable that trading companies who knows customs formalities, actual conditions of the Middle East area and so on are most suitable for procurement of equipment and materials of the Project. These companies shall have liaison office or branch in Syria or the Middle East area. These companies shall be easy contacted by DAWSSA in case of damages in equipment and materials during ocean transportation, defecting them after construction and installation within guarantee period, so they can respond to these troubles promptly.

The major ports of Syria are Latakia port and Tarturs port. Latakia port is slightly larger than Tarturs but the latter is advantageous because of its shorter distance from Damascus City. The equipment and materials to be procured under the Project such as pipes, valves, well pumps, etc., are many in terms of category and number. Therefore, they will have to be unloaded in Tarturs port due to shorter inland transportation and consequently, lower transport cost.

2-2-4-2 Procurement Conditions

Scope of the Japanese Grant-Aid is the procurement of equipment and materials and the ocean transportation of them to Tarturs port in Syria. DAWSSA understands and has much experience of import formalities in the Project for Rehabilitation of Water Distribution Pipelines in Damascus City. There is no problem of import formalities by DAWSSA, but the Japanese side will bear the insurance cost of inland transportation for securing the equipment and materials to arrive DAWSSA's warehouse.

DAWSSA will design in detail and construct civil work structures for the procured equipment and materials in consideration of operation with a good performance and adjusting with mechanical and electrical facilities. Also, manufacturing and installation of electrical facilities including pump panel shall be provided by the Syrian side. It will be important to confirm the circuit design of the pump facility based on design conditions submitted by the Japanese side for the prevention the defect of the pump and motor during the operation.

Therefore, the Japanese side will submit DAWSSA drawings and study documents and then discuss adjustment among civil works, mechanical and electrical facilities with the Syrian side for their easily understanding the system of main facilities and for the operation and maintenance of these equipment and materials.

2-2-4-3 Scope of Works

The demarcation for major facilities is shown below. The Government of Japan will provide the major equipment and materials while the Government of Syria will execute the construction of these civil works and installation works of mechanical and electrical equipment under the Project.

Table 2-16 Demarcated Contents of Major Facilities

Major Facility	Japan	Syria
Procurement of submersible pumps	○	
Installation of submersible pumps and pipe connection works		○
Construction of well pump houses		○
Procurement of transformer, generator, electric panel for pump control		○
Installation of electric facility		○
Procurement of collecting pipes (small diam. up to 200mm)		○
Procurement of collecting pipes (more than 200mm)	○	
Pipe laying works for collection pipes		○
Construction of receiving tanks		○
Procurement of transmission pipes	○	
Pipe laying works for transmission pipes		○
Procurement of pressure reducing valve with strainer	○	
Construction of pressure breaker reservoir including installation of valves		○

Demarcations of both Governments are indicated also for the following items.

Japanese side

- Preparation of tender documents, tendering and support of contract with the Supplier,
- Inspection of procured equipment and materials and marine transportation to Tarturs, and
- All insurances of transportation including inland transportation.

Syrian side

- Construction of deep wells and pumping tests,
- Detail design of civil work structures,
- To secure lands for receiving tanks and pressure breaker reservoirs,
- Inland transportation from Tarturs to Adra warehouse, and
- To obtain permissions for the construction of collection pipes and transmission pipes.

2-2-4-4 Consultant Supervision

(1) Principle of Consultant Supervision

After Japanese Consultant for supervision of the Project to be recommended by the Government of Japan, the Consultant shall sign contract with DAWSSA, the implementation agency, then the Consultant will investigate sites for reconfirmation of the well locations and necessity of any changes on its basic design. Also, the Consultant will discuss details on civil work structures and electrical device with DAWSSA and then re-study or modify the specification, quantity and location of wells, if necessary.

As for the selection of the Supplier, the Consultant will publish on the major daily construction/economic newspapers in Japan on behalf of DAWSSA. Also, it will be published in JICA home pages.

The Consultant will take procedure in tender bids for the Project on behalf of DAWSSA with its representatives for completion of smooth contract procedure with the Supplier.

The Consultant will inspect specification and drawings submitted by the Supplier before manufacturing the equipment and materials and check the specification and quantity with the basic design plan. The Consultant will supervise the supplier's schedule and carry out the shop inspection during and at the manufacturing for smooth procurement.

(2) Organization of Consultant Supervision

Organization of the Consultant supervision consists of Chief Consultant, Mechanical/electrical engineer, Pipeline/civil engineer and Spec-writer/cost-estimator. The Chief Consultant will carry out whole consultant services, such as consulting agreement with DAWSSA, preparation of tender documents, support of the contract between DAWSSA and the Supplier, inspection of shipping in Japan and receiving in Syria for the equipment and materials, and prepare

reports.

Each engineer will discuss with DAWSSA and confirm specifications and quantity based on the basic design, prepare the tender document, approve the specification and drawings submitted by the Supplier and inspect the equipment and materials in the manufacturer's factory.

In the inspection before shipping, required appearance, function, number and parts shall be inspected thoroughly to verify and confirm the conformity with the bidding documents and contracts. These procedures will be executed by the third-party inspection firm.

2-2-4-5 Procurement Plan

The procurement of major equipment and materials is programmed as follows.

(1) Submersible Pump

The submersible pumps being used by DAWSSA were produced in Denmark, Germany, Italy, etc. and purchased based on each bid specifications.

The pumps under this Project require specific design and manufacturing to meet the specification of the wells, therefore ordinary product which is widely used may not be suitable. Considering economical points of view not only unit price but also total costs including transportation charge, pumps produced in Japan is cheaper than that of the third countries. Therefore, the pumps produced in Japan will be selected.

(2) Pipe

There are many pipe materials, valves and generators in Adra warehouse of DAWSSA. Ductile Cast Iron Pipes (DCIP) presently kept and used by DAWSSA are imported from France and Japan and normal cast iron pipes, not exceeded 150mm in diameter, kept in the warehouse are those made in Syria and imported from China.

The pipe material of the Project is DCIP above 250mm in diameter. DCIP are recently being produced in the Middle East, however DAWSSA has limited achievements of the Middle East product. Pipe materials procured in France and Japan are kept in DAWSSA's warehouse and these will be useful for repairing the pipelines in future. The procurement, therefore, is examined not only in economical point of view including transportation costs, but also the delivery period of prospective suppliers in Japan and third countries as same as the submersible pumps.

Materials produced in Japan are 5% cheaper than those in France. Pipe materials produced in Japan were imported for distribution pipelines in Damascus City recently and were still strongly favored by DAWSSA. Japanese suppliers can produce many pipes similar to those to be used in this Project. Therefore, Japanese products will be more advantageous.

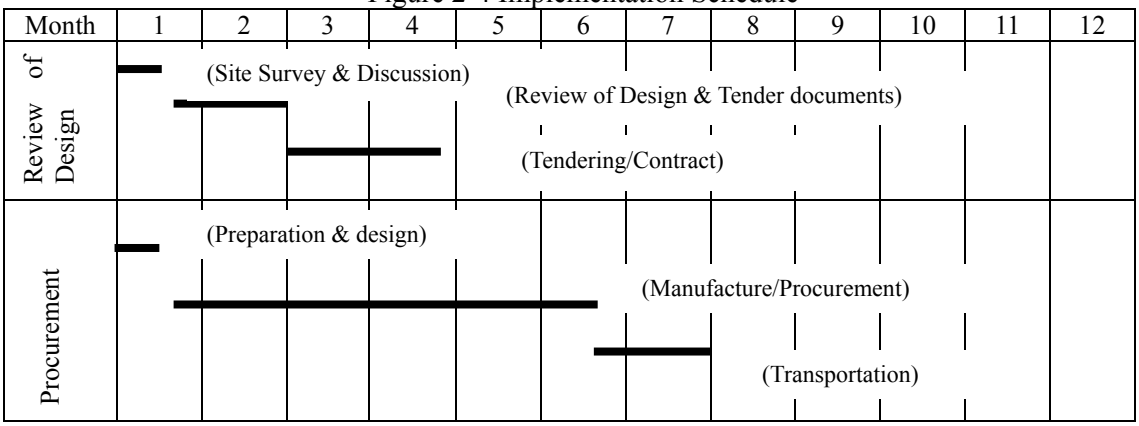
(3) Constant Water Level Self-control Valve (CWLS-Valve)

The pressure reducing valves used in the existing pressure control facilities are made in Germany and France. The type of these pressure control valves is Self Control Reducing Valve. As mentioned in Table 2-12 in "2-2-2-3 ", CWLS-Valve is the most suitable for the Project, middle class diameter of 600mm with a large capacity, and high technology as compared to the Self Control Reducing ones. High technology is required for protection against corrosion by cavitations and damage by water hammer and prolonged durability to withstand continuous and long-term use. By taking account of past performances under similar conditions as well as functionality and durability, Japanese products will be selected.

2-2-4-6 Implementation Schedule

The implementation schedule is shown in Fig 2-4.

Figure 2-4 Implementation Schedule



2-3. Obligations of Recipient Country

The Government of Syria is obliged to carry out the following at each stage to complete the Project under Japan's Grant Aid Scheme;

(1) Study and Planning Stage

- To build the consensus on the implementation of the Project among stakeholders including residents living around the new water sources,
- To complete the EIA procedures following the related laws and regulation in Syria,
- To complete the well construction work for the Project,
- To establish the monitoring system, and
- To carry out the detailed design for civil works and electrical works necessary for the Project.

(2) Procurement Stage (Cooperation by the Japanese Grant Aid)

- To ensure prompt unloading, customs clearance and inland transportation of the products purchased under the Japan's Grant-Aid at ports of disembarkation in Syria,
- To accord Japanese nationals whose services may be required in connection with the supply of the products and services under the verified contracts assistance as may be necessary for their entry into Syria and stay therein for the performance of their work,
- To bear commissions, namely advising commissions of an Authorization to Pay (A/P) and payment commissions, to the Japanese foreign exchange bank for the banking services based upon the Banking Arrangement (B/A),
- To exempt Japanese nationals from customs duties, internal taxes and fiscal levies which may be imposed in Syria with respect to the supply of the products and services under the verified contracts, and
- To bear all the expenses, other than those covered by the Japan's Grant Aid, necessary for the Project.

(3) Construction Stage

- To obtain necessary permissions, licenses, and other authorization for implementing the Project, if necessary,
- To secure a land necessary for the Project,
- To take measures for traffic regulation, security for passerby and vehicle, environmental impact, protection of other obstacles, such as electric cables, telephone cables, etc., during the construction and to contact and coordinate relevant authorities and organizations,
- To provide facilities for distribution of electricity and other incidental facilities in and around the site,
- To undertake installation and construction work using equipment and materials provided by the Japanese Grant Aid, and
- To notify the pubic that the Project is under the Japanese Grant Aid scheme.

(4) Operation and Monitoring Stage

- To ensure that the equipment and materials purchased under the Japan's Grant Aid be maintained and used properly and effectively for the Project,
- To monitor the environmental impact appropriately,

- To operate the new water sources based on the result of the monitoring (bare essential production within the designed permissible amount, appropriate measures in case of unexpected negative influence), and,
- To enhance comprehensive water resources management including improvement of the existing water distribution systems and the study of inter-basin water transmission.

The Project cost to be borne by Syrian side is shown in the following section (2-5. Project Cost Estimation, 2-5-1, (2) Project Cost to be borne by the Syrian Side).

2-4. Project Operation Plan

The facilities to be constructed under the Project are the production wells (11 wells), the collection pipeline (2.2 km), the transmission pipeline (11.5 km), and the pressure reducing facilities (2 units), and the water taken from Yaboos well field shall be transported to the existing Takea PBR through these facilities.

Operation and maintenance of the facilities are to be done by the Production Division of DAWSSA. Total 239 staffs including temporary workers are on the register of the Division (as of March, 2004). Under the Division, the Barada and Figeh Branch-office is operating and maintaining the Barada-Figeh transmission pipeline (ϕ 1,200 mm) with 55 staffs including a general manager, and the scale and functions of the pipeline are similar to the one planed under the Project. For a repairing of the pumps, the Division has 40 stuffs in charge of mechanical and electrical works, who have enough capacity for checking pumps, replacing parts, and so on required for operation and maintenance.

Thus, DAWSSA is deemed to have enough capacity to operate and maintain the facilities to be constructed under the Project from technical and work force point of view, except for the installation of deep well more than 100m and the pressure reducing facility. They have no similar facilities. In considering to the issue, a proper guidance or training on the installation shall be planed. And before the actual operation, training on maintenance of these facilities shall be carried out for sustainable operation and maintenance in the future. These guidance or training on the installation and/or maintenance shall be scheduled in the next phase of the Project. They must be performed after the equipment has arrived and civil works concerned have been completed.

While, ductile cast iron pipes to be provided under the Project have around 50 years of durable life and joints are also enough durable for long time. When any repairing on them is required by water leaking, stop valves of receiving tank or pipelines shall be closed and then repairing work will be done by cut-and-connect pipes. The Production Division of DAWSSA has, however, enough technique and experiences on such treatment.

However, in the cases to resume supplying water after long vacant condition of the pipeline, which shall be happened frequently through the actual operations, the water flows out during a certain beginning period must be checked its quality carefully and utilized after it becomes enough clean for water supply.

In the process of EIA survey conducted since April 2004, likely impacts have been evaluated for every possible element of environment, and the following adverse impacts have been identified in every project stage of planning, construction and operation in Yaboos site (referred to Table 2-17). In the operation and maintenance stage, several impacts for groundwater system such as hindering to existing wells, deterioration of water quality or contamination, and damaging to vegetation mainly caused by decreasing groundwater level, shall be forecasted. Out of the impacts prospected, as shown in the table, groundwater extraction was supposed to cause the most adverse impacts on quantity/quality of water resources.

Among those possible impacts, the items to be monitored urgently and successively are concerning to water levels and quality. For the purpose, two monitoring wells on water levels and quality, and a monitoring well for groundwater intake, both in the upstream of the well field are planed to be installed. These monitoring wells are settled within the influence circle by the group pumping to monitor environmental impacts near and around the well field.

Table 2-17 Negative Impact and Environmental Element (Devised Plan: Phase I)

Project Stage	Activity	Likely Adverse Impacts	Environment Element									
			Physical				Biological & Ecological			Socio-economic & Human		
			Ground Water (Qnty)	Ground Water (Qlty)	Spring Discharge	Land / River / Lake	Forest & Vege-tation	Cultural Heritage	Public Facility etc..	Health	Economic	Social Culture
Planning Stage	B/D & D/D (pumping test etc.)	to damage farms/vegetation mobilization	-	-	N/A	-	△	-	-	-	△	-
		to decrease groundwater level	△	-	N/A	-	-	-	-	-	-	-
		to flow out water to farms & vegetation	-	-	N/A	△	△	-	-	-	△	-
Construction Stage	Pumping well/Pipeline/Pressure breaking tank Construction'	to damage farms by mobilization	-	-	N/A	△	△	-	△	-	-	-
		to damage forest and vegetation	-	-	N/A	△	N/A	-	-	-	-	-
		to occupy road / obstruct traffic	-	-	N/A	-	-	-	△	-	△	-
		to cut slope	-	-	N/A	△	△	-	△	-	△	-
		to remove / disturb soils	-	-	N/A	△	△	-	△	-	-	-
		to make noise / dust	-	-	N/A	-	△	-	△	△	-	-
		to flow out wasted water.	-	-	N/A	△	△	-	△	-	-	-
Operation Stage	Groundwater Pumping/Water Conveyance	to decrease groundwater level	○	-	N/A	-	-	-	△	-	△	-
		to be less water resources	○	△	N/A	-	-	-	-	-	△	-
		to deteriorate water contamination	-	△	N/A	-	-	-	-	△	△	-
		to reduce spring water discharge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		to damage forest and vegetation	-	-	N/A	△	-	-	-	-	-	-

Note: - :No Impact Caused by the Project Activity △:Slight or Very Small/Low ○:Small/Low or Medium
●:Medium or Large/high N/A: Not applicable due to no spring/ permanent surface water be affected by Project facilities.

Besides, an evaluation of impact to the water resources potential in sub-basin basis is also planed to be carried out. Ministry of Irrigation of Syria is reconstructing the monitoring system covering whole Barada/Awaj Basin since 2004, and 21 observation points (14 monitoring wells and 4 meteorological stations) in Maadar/Yaboos sub-basin which include the Project site shall be activated fully from 2005. Through the monitoring, a water balance of each sub-basin shall be laid open every year, and an influence to water balance around the site shall be checked based on the monitoring data. Further, an impact to vegetation near the site by a decreased water volume and reduced water level shall be observed.

Pumping rate in the operation period shall be controlled through setting a managing water level (limit elevation). However, continuous observation data for several years through monitoring facilities and meteorological stations near and around the site are required to set the managing water level. Therefore, before the determination of the level, the operation of well field shall be limited during the dry season from August to December and stopped pumping during the wet season to recover the water level. The lowest water level during normal operation shall be decided referring to the lowest level ever observed (the water level observed in 2001/02 hydrological year).

In the actual operation stage, such systematic monitoring work shall be carried out by the Barada and Figeh Branch-office under tight cooperation with the Environmental Section, the Survey and Design Division of DAWSSA.

Details of the monitoring work are severely studied and planned out through an EIA procedure by DAWSSA. The EIA Report was prepared and submitted to General Commission for Environmental Affair (GCEA) for their approval, and it was approved on March 26. The report contains not only for the monitoring work but almost all of socio-environmental impacts and their counter-measures or mitigation means through every stage of the project. Therefore, it is strongly recommendable that all of the sections of DAWSSA, in particular the sections concerning to the daily operation, shall study the report carefully to understand the environmental issues concerning to their jobs and to continue the daily operation together with monitoring work under the clear concept of their importance.

2-5. Project Cost Estimation

2-5-1. Estimation of the Project Cost

The general project cost, when it is implemented under the Japan's Grant Aid, shall be estimated as 946 million Yen in total, and the share of the cost for Japan and Syrian sides is also estimated as follows.

This cost estimation is, however, provisional and would be further examined by the Government of Japan for the approval of E/N amount.

(1) Project Cost to be borne by the Japanese Side

Table 2-18 Approximate Project Cost (the Japanese Side)

Item		Estimated Cost (Million J.Yen)	
Facility	—	0	709
Equipment and Materials	Submersible pumps, pipe materials for collection and transmission pipelines, Pressure reducing facilities, valves, etc.	709	
Consultant Fee			28
Total			737

(2) Project Cost to be borne by the Syrian Side

Table 2-19 Approximate Project Cost (the Syrian Side)

Item	US$ (x 1,000)	SP (x 1,000)	Yen conversion (Million J.Yen)
1. Design/Construction	0	44,495	96
2. Monitoring Cost	0	20,970	45
3. Local Port Charge	0	1,920	4
4. Storage Cost	182	0	20
5. Inland Transportation Cost	400	0	44
Total	582	67,385	209

Break-down of the Project Cost to be borne by Syrian side is shown in Appendix-6, "Other Relevant Data."

(3) Conditions for Cost Estimation

(a) As of November 2004.

(b) Exchange Rate: 1 US$ = 111.09 J.yen
1 Euro = 135.99 J.yen
1 US$ = 51.72 SP
1 SP = 2.15 J.yen

(c) Implementation period:

- Preparation of Tender Document, Tendering	4.0 months
- Manufacturing/Procurement	5.5 months
- Transportation/Inspection	2.0 months
- Technical Assistance	0.0 month
Total	11.5 months

2-5-2. Operation and Maintenance Cost

Cost for the operation and maintenance newly burdened to DAWSSA is roughly estimated as follows:

(1) Remunerations:

Remuneration cost shall not be allocated because the number of staff is not changed.

(2) O&M cost:

(a) Electricity/Fuels cost

Pumps; 37kw x 6 sets+ 45kw x 3sets + 55kw x 2sets = 467.0kW

OM1=467.0kW x 24 hr x 365 days x 37.5%[*1] x 2.7 SP/kWh x 1.05 = 4,349,159 SP

[*1]: Mean operation period (2 months x 100% + 5 months x 50%)/12 months.

(b) Repairing cost for mechanical/electrical facilities;

(1 % of mechanical/electrical equipment cost)

OM2=170,530,000 J.yen x 0.01/2.15 SP/ J.yen = 739,163 SP

(c) Repairing cost for mechanical/electrical facilities;

(0.5 % of pipe materials and /civil works construction cost)

OM3=337,985,000 J.yen x 0.005/2.15 SP/ J.yen = 786,012 SP

Thus, the total of O&M cost shall be increased as 5,928,334 SP/year (= OM1 + OM2 + OM3)

(3) Replacement cost:

The replacement cost setting the depreciation periods as 12 and 50 years for pump equipment and pipe/civil facilities respectively is estimated below.

$M = A \times i \times (1+i)^n / \{(1+i)^n - 1\}$

Where M: Replacement cost,
A: Facility cost,
i : Interests rate (set it as 6%), and
n: Depreciation period.

(a) Pump equipment;

$M1 = 170,530,000 \text{ J.yen} \times 0.06 \times 1.06^{12} / (1.06^{12} - 1)/2.15 \text{ SP/ J.yen} = 9,460,610 \text{ SP}$

(b) Pipe/Civil facility;

$M2 = 337,985,000 \text{ J.yen} \times 0.06 \times 1.06^{50} / (1.06^{50} - 1)/2.15 \text{ SP/ J.yen} = 9,973,589 \text{ SP}$

Thus, the total replacement cost shall be of 19,434,199 SP (= M1 + M2).

On the other hand, the tariff shall be increased around 4.0 million SP/year because of the increased water supply.

50 m3/hr x 24 hr x 365 days x 11 units x 37.5% x 75% (1-leakance) x 3 SP = 4,065,188 SP.

However, the water supply cost by the new water sources is rather high because of the pumping system and it cannot cover the increased operation/maintenance cost of the new facility under the Project. Due to the original purpose of the development of new water source to mitigate the water supply suspension, it cannot help increasing the operation cost. Even if the operation and maintenance cost exceeds the water tariff, the deficit can be covered by a subsidy, so there shall be no problem for financial situation of DAWSSA. However, the financial condition of DAWSSA should be re-considered basically in near future, including such low tariff system.

2-6. Attentions on the Implementation of the Project

In the Project, major equipment and materials are to be provided by the Japanese side, and their installation and construction of these facilities is to be done by the Syrian side. For smooth and prompt implementation of the Project, tasks by the Syrian side must be progressed as much as possible during the terms of procurement work by the Japanese side, so that the equipment and materials can be installed immediately.

The project implementation schedule by the Japanese side is shown as Figure 2-4, and the

main items and the draft of these work schedule to be carried out by the Syrian side are as follows and shown in Figure 2-5.

(a) Detail Design: Civil work structures (pump houses, receiving tanks, pressure breaker reservoirs, pressure reducing valve chambers, connection work with existing facilities, valve chambers for pipelines, etc), and electric facilities (generators, transformers, control panel, switchgear, instrumentation board, etc),
(b) Tendering: Civil works, collection pipe laying works, transmission pipe laying works, procurement of electrical equipment and materials, installation works for machinery/electricity,
(c) Construction work: Civil works, collection pipe laying works, transmission pipe laying works, procurement of electrical equipment and materials, installation works for machinery/electricity, and
(d) Others: Test and inspections.

Fig. 2-5 Work Schedule of the Syrian Side

Item	Construction Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
First Phase																																		
Ⅰ Japanese Side																																		
Detail Design & Tendering	4.0																																	
Procurements	5.5																																	
Transportation & Inspection	2.0																																	
Ⅱ Syrian Side																																		
a) Detail Design	3.0																																	
b) Construction																																		
Tendering	2.0																																	
Mobilization	1.0																																	
Well Houses	2.5×11 Pls																																	
No.3 Receiving Tank	10.9																																	
No.2 PBR	9.0																																	
No.3 PBR	5.2																																	
c) Installation																																		
Procurements	5.0																																	
Well Pumps	1.0 × 11 Pls																																	
Pressure Reducing Facility	2.0 × 2 Pls																																	
Electric Facility	3.0																																	
d) Pipelaying Works																																		
Tendering	2.0																																	
Mobilization	1.0																																	
Collection Pipelines	2.8																																	
Transmission Pipelines	9.2 × 5 pts																																	
Pressure reducing Facility	2.0																																	
e) Test & Inspection	1.0																																	

Chapter 3. Project Evaluation and Recommendations

3-1. Project Effect

(1) Direct effect

Current situation and problems on the water supply issue, countermeasures by the Project, and direct effect expected through the implementation of the Project are simply summarized as Table 3-1 shown below.

Table 3-1 Problems, Measures and Effects

Situation/problems	Countermeasures	Direct effect
Beneficiaries by the Project are 2.82 million people in/around Damascus city. Population in the area is increasing rapidly, and the spring yields of major water sources depend heavily on rain or snowfall. Under such situation, severe suspension of water supply happened in the late 90s due to 3 years drought.	The new well field with 11 production wells, 2.2 km of collection pipeline, and 11.5 km of transmission pipeline are provided and connected to Takea existing PBR.	As emergency water sources in dry season, 13,200 m^3/day of water supply is increased, and therefore, the degree of water shortage in Damascus metropolitan area is relieved, resulting reduction of average water supply suspension time in dry season around 30 minutes a day.

(2) Indirect effect

Besides the direct effect as mentioned above, several indirect effects listed below are to be expected.

(a) Severe inconveniences for economic, hygienic, and/or social aspects caused by quite often and for long time water supply suspension to the people living in Damascus metropolitan area, in particular to the poverty zone, are relieved and dissolution of social unrest shall be accelerated,
(b) Flexibility on selecting water sources in dry season or for emergency is to be expanded because of newly provided well field, and it shall avoid withdrawing groundwater heavily from one site,
(c) Through the EIA process, in particular by stakeholder meetings involving the rural inhabitants or implementation of a group pumping test, the rural people raised up their concern to the environmental and social influences or healthy drinking water, as well as for saving irrigation water, and
(d) DAWSSA could have an expert group of environment through the implementation of the EIA on the Project, and it made DAWSSA easily perform EIA procedures for any other programs.

3-2. Recommendations

In accordance with JICA's development study, "The Study on Water Resources Development in the Northwestern and Central Basins in the Syrian Arab Republic (1998 to 2000)," the water balance of Barada/Awaj Basin including the Project areas has fallen into minus and groundwater was over withdrawn. Under such serious situation, it is quite important to conduct a systematic groundwater monitoring and to operate the well field in response to the monitoring results. The implementation of the Project may cause further deterioration of the water balance basin wide. On the other hand, in considering the severe current water supply condition of Damascus metropolitan area, to promote the measures to improve the water supply condition, including a water diversion plan from the other basin, further improvement of water leakage, promoting of drip irrigation, reuse of sewerage water, and so on, is also quite important and urgent. Furthermore, the following technical issues is recommended for smooth and effective implementation of the project:

(a) The Production Division of DAWSSA shall be trained to operate and maintain the newly introduced pressure reducing facility,
(b) The production wells newly constructed under the Project were rather deeper than the wells ever constructed. The depths of pump installation are also rather deep as more than 100m and DAWSSA has less experience of such deep pump installation. A technical support on pump installation into such large depth shall be provided, and
(c) DAWSSA has enough quality and quantity engineers on construction, operation and maintenance of facilities but the number of hydrogeologist in charge of planning, investigating, and analyzing on water resources development is insufficient. It shall be required the transfer of technology on hydrogeological investigation and analysis.