

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 1 of 79

DESIGN OF TREATMENT WETLAND IN SHIRVAN

<i>Project manager</i>	<i>Dr. Giulio Conte</i>	<i>Iridra S.r.l</i>
<i>Design Engineers</i>	<i>Eng. Riccardo Bresciani</i>	<i>Iridra S.r.l</i>
	<i>Eng. Nicola Martinuzzi</i>	<i>Iridra S.r.l</i>
	<i>Eng. Anacleto Rizzo</i>	<i>Iridra S.r.l</i>
	<i>Dr. Fabio Masi</i>	<i>Iridra S.r.l</i>

<i>Num</i>	<i>Description</i>	<i>Date</i>	<i>Approval</i>				
0	<i>Issued for approval</i>	<i>5th May 2019</i>	<i>G.Conte</i>				
Title:				<i>Section</i>	<i>Type</i>	<i>Serial</i>	<i>Rev.</i>
Technical Specification				010	SH	002	1
Technical requirements for RFP for the implementation of the constructed wetland							

TABLE OF CONTENTS

1	INTRODUCTION	7
2	PARTICULAR SPECIFICATIONS	8
2.1	Short description	8
2.2	Pipelines	8
2.2.1	<i>Pre-cast control chamber</i>	8
2.3	Waterproofing of reed bed	10
2.3.1	<i>General</i>	10
2.3.2	<i>Seaming procedure</i>	10
2.3.3	<i>Pervious felt</i>	12
2.3.4	<i>Wetland bed waterproofing testing</i>	13
2.4	Bed media filter	13
2.5	Wetland planting	15
2.5.1	<i>General</i>	15
2.5.2	<i>Seeds</i>	20
2.5.3	<i>Rhizomes</i>	20
2.5.4	<i>Potted Plants</i>	21
2.5.5	<i>Field harvested plants</i>	21
2.5.6	<i>Vegetation Start-Up</i>	21
2.6	Electro-mechanical equipment	22
2.6.1	<i>General requirements and workmanship</i>	22
2.6.2	<i>Submersible pumps</i>	23
2.6.3	<i>Valves</i>	25
2.6.4	<i>Measurement devices</i>	25
3	METHOD OF MEASUREMENT AND PAYMENT	26
3.1	Introduction	26
3.2	Included Works	26
3.3	Payment	27
3.4	Excavation and Earthworks	27
3.5	Concrete Works	29
3.6	Miscellaneous Concrete	31
3.7	Road Works	31
3.8	Pipe Works	32
3.8.1	<i>Piping Works</i>	32
3.8.2	<i>Valves and appurtenances</i>	32
3.9	Metalworks	33

Technical Specifications

3.10	Fences.....	34
3.11	Landscaping.....	34
4	GENERAL SPECIFICATIONS	35
1	GENERAL REQUIREMENTS	35
1.1	GENERAL INFORMATION.....	35
1.1.1	Power, Current and Voltage	35
1.1.2	Offices and Services Provided by the Contractor	35
1.2	INFORMATION AND OBLIGATIONS RELATING TO SITE ARRANGEMENTS	35
1.2.1	Working Conditions	35
1.2.2	Safety Regulations and General Order of the Site	36
1.2.3	Standards, Weights and Measures, Abbreviations, Labelling and Symbols	36
1.3	Setting out	37
1.4	PROTECTION REQUIREMENTS.....	37
1.4.1	General	37
1.4.2	Underground Services.....	37
1.4.3	Temporary Removal of Existing Services	38
1.4.4	Permanent Diversion of Existing Services	38
1.4.5	Permanent Support for Existing Services, Etc	39
1.4.6	Responsible Authority or Owners May Carry Out Work	39
1.4.7	Care of Boundary Walls and Fences	39
1.4.8	Protection of Property	39
1.4.9	Pre-inspection/Approval Requirements.....	40
1.4.10	Open Excavations	40
1.4.11	Fire Protection	40
1.4.12	Explosives and Blasting.....	40
1.4.13	Tree and Green Area Protection	40
1.4.14	Safety Precautions	41
1.5	MATERIALS AND EQUIPMENT, APPROVALS AND SUBSTITUTIONS	42
1.5.1	General	42
1.5.2	Substitutions	42
1.5.3	Storage and Protection of Equipment and Materials	43
1.5.4	Installation and Testing of Equipment and Construction Work.....	43
1.6	CLEANING	44
1.6.1	General	44
1.6.2	Final Cleaning	45
1.6.3	Employer's Right to Clean	45
1.6.4	Final Cleaning Timing Constraints	45
1.7	SITE RECORDS AND PROGRESS PHOTOGRAPHS OF THE WORK.....	45

Technical Specifications

1.8	AS BUILT DRAWINGS	45
1.9	TEMPORARY WATER, POWER AND SANITARY FACILITIES.....	46
1.9.1	<i>General</i>	46
1.9.2	<i>Temporary Water</i>	46
1.9.3	<i>Temporary Wastewater and water Piping</i>	46
1.9.4	<i>Temporary Power</i>	46
1.9.5	<i>Sanitary Services</i>	46
1.10	PROJECT PLANNING	46
1.10.1	<i>Form of Progress Planning Schedule</i>	46
1.11	ENVIRONMENTAL ISSUES	47
2	DEmolition and Site Clearance	48
2.1	SITE CLEARANCE	48
2.2	DEMOLITION of STRUCTURES	48
3	Earthworks – excavation, filling, compaction, disposal and landscaping	49
3.1	Scope of Work	49
3.2	LEVEL OF THE COMMENCING SURFACE	49
3.3	FOUNDATION METHODS.....	49
3.3.1	<i>Excavation for foundations</i>	49
3.3.2	<i>Preparation of Foundation</i>	49
3.4	TESTING FACILITIES	50
3.5	EARTHWORKS.....	50
3.5.1	<i>Working Width or Area</i>	50
3.5.2	<i>Embankments and General Fill Areas</i>	50
3.5.3	<i>Excavation</i>	51
3.5.4	<i>Excess Excavation</i>	51
3.5.5	<i>Keeping Excavations Free of Water</i>	51
3.5.6	<i>Backfilling and Surplus Excavated Material</i>	52
3.5.7	<i>Testing of Backfill Material and Backfilling</i>	52
3.6	EXCAVATION, BACKFILLING AND COMPACTION FOR STRUCTURAL WORKS	52
3.6.1	<i>Buildings and Structures</i>	52
3.6.2	<i>Subdrains to Structures</i>	53
3.6.3	<i>Excavation and Filling for Subgrade</i>	53
3.7	EXCAVATION, BACKFILL AND COMPACTION FOR PIPE LAYING WORKS.....	53
3.7.1	<i>Excavation of Trenches</i>	53
3.7.2	<i>Backfilling of Trenches</i>	54
3.7.3	<i>Backfill Material</i>	54
3.7.4	<i>Manholes and Chambers</i>	55
3.7.5	<i>Underground Cables</i>	55

3.7.6	Compaction.....	55
3.7.7	Grassing.....	55
3.8	DEWATERING	55
3.8.1	Scope of Work.....	55
3.8.2	General Information	56
3.8.3	Submittals.....	56
3.9	ROADS AND YARDS.....	56
3.9.1	General	56
3.9.2	Aggregate Sub-base and Road Base.....	56
3.9.3	Wearing Courses of Roads and Yards	58
3.9.4	Tolerances.....	58
3.10	GROUND IMPROVEMENT MEASURES	59
3.10.1	Geotextiles or Filter Fabric.....	59
3.11	FINISH GRADING AND LANDSCAPING	59
3.11.1	General	59
3.11.2	Grading of Unsurfaced Areas.....	59
3.11.3	Soft Landscaping.....	59
4	CONCRETE WORKS.....	61
4.1	General	61
4.2	Materials	61
4.2.1	Cement.....	61
4.2.2	Aggregates	61
4.3	Execution of Work.....	64
4.3.1	General	64
4.3.2	Formwork.....	65
4.4	Concreting	66
4.4.1	General	66
4.4.2	Pouring	67
4.4.3	Hot Weather Concreting (for Temperature above +20°C)	67
4.4.4	Wet Weather Concreting.....	68
4.4.5	Cold Weather Concreting.....	68
4.4.6	Protection and Curing.....	68
4.4.7	Construction Joints	69
4.4.8	Waterstops and Jointing Materials	69
4.4.9	Internal Epoxy paint for wastewater treatment concrete works.....	69
4.4.10	Concrete Finish without Formwork.....	70
4.4.11	Removal and Replacement of Unsatisfactory Concrete	70
4.4.12	Test of Water-Tightness of Finished Structures	71

Technical Specifications

4.4.13	Concrete protecting coating	71
4.4.14	Tolerances for prefabricated concrete units.....	71
5	SPECIFICATION FOR underground PIPework	72
5.1	GENERAL.....	72
5.1.1	Scope of Work.....	72
5.1.2	Quality Assurance	72
5.1.3	Submittals.....	72
5.2	MATERIALS	73
5.2.1	General	73
5.2.2	Pipes and Pipe Fittings.....	73
5.2.3	Pipe Jointing, Saddles and Repair Clamps	74
5.2.4	Valves	75
5.2.5	Miscellaneous Fittings and Appurtenances	75
5.3	EXCAVATION, BACKFILLING AND RESTORATION.....	75
5.3.1	Excavation	75
5.3.2	Backfilling	76
5.3.3	Surface Reinstatement	76
5.4	INSTALLATION	76
5.4.1	General	76
5.4.2	Thrust Blocks for Pressure Pipelines	76
5.4.3	Welded Joints in Steel Pipes.....	77
5.4.4	Cutting of Pipes.....	77
5.4.5	Chambers.....	77
5.4.6	Step Irons and Miscellaneous Ironwork.....	77
5.5	TESTING	77
5.5.1	General	77
5.5.2	Testing of Non-Pressure Pipelines.....	77
5.5.3	Testing of Pressure Pipelines	78

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 7 of 79

1 INTRODUCTION

In Shirvan a new treatment wetland will be constructed to treat part of the polluted water of a small open ditch that collect untreated water to the lake. The water is significantly diluted by the contribution of groundwater, due to the high level of the groundwater table in the area shown also by the geological survey.

The treatment wetland is aimed at reducing the pollution of the lake by recurring to sustainable and replicable treatment methods capable to treat different type of pollution sources before their discharge into the environment.

According to the present design, the constructed wetland is able to treat a flow of about **3 l/s**, derived from the channel by a pumping station.

The Contract include the furnishing of all labour, plant and equipment, materials required to complete the entire works, pre-commissioning, testing, preparation of working, shop and as-built drawings.

All the works are as determined in detail in the section Particular Specifications of TS and as shown on the drawings, as per list enclosed in Bidding Document.

The General Specification included in this TS are intended to indicate the minimum standard of design, workmanship and materials acceptable for this project. The itemized specific requirements are given in the Particular Specification section.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 8 of 79

2 PARTICULAR SPECIFICATIONS

2.1 Short description

The general lay-out of the proposed CW treatment plant can be summarized as follow:

- **Preliminary treatment:** The headwork consist in a manual screen with 4 cm bar spacing placed on the channel that permits to block coarse solids before the discharge into the lake and to preserve the pumping system; the placement of a small weir about 20 cm high and of a DN125 pipe permits to derive part of the flow (maximum around 10 l/s) and to collect it to a pumping station. The pumping station is provided by 2 submersible pumps and it permits the derivation of a part of the flow, whereas the surplus water can be redirect to the channel after the weir. A flow meter and a gate valve permit to regulate the flow depending by the monitoring results, with the aim to treat as more as possible the inflow. The standard flow individuated on the basis of preliminary surveys is 3 l/s.
- **Constructed Wetland:** the CW is composed by one single stage:
 1. *Free Water Surface System (FWS):* fully vegetated with emergent plants; total surface of the bottom 4350 m², total surface of the water 5480 m².
- **Gravity discharge** into the lake.

2.2 Pipelines

The pipelines must be manufactured in according General Technical Specification requirement, as per clause 5.2.2.

The HDPE pipes shall be supplied with plain ends, and should be coupled by butt welding according UNI 10520, if not otherwise specified elsewhere. All the fittings shall in HDPE if not otherwise specified elsewhere.

The PVC pipes shall be in accordance with standard EN ISO 1401 and joined by rubber ring joint pipe and complete of special fittings.

2.2.1 Pre-cast control chamber

The control chambers should be in pre-cast concrete (concrete class: C32/40), with cast iron manhole covers. The precast concrete manhole should be manufactured in accordance to the harmonized European standard SR EN 1917 "Concrete manholes and inspections chambers, unreinforced, steel fibre and reinforced".

The bottom and the walls of the chambers, have to be coated by a two component epoxy paint.

Indicative dimensions of circular precast concrete manholes:

Concrete manhole - components-	Internal diameter	External diameter	Nominal height	Total height	Weight (kg)
-----------------------------------	----------------------	----------------------	-------------------	-----------------	----------------


Technical Specifications

	(mm)	(mm)	(mm)	(mm)	
Manhole cover:					
Cast iron cover and frame cast into a concrete surround according to SR EN 124-96 -Type_1 class B125 pedestrian areas	587	745	-	120	100
Cast iron cover and frame according to SR EN 124-96 -Type_2 class D400 vehicular areas	670	780	-	120	100
Adjusting manhole unit reinforced concrete	620	865	84	104	65
Straight back taper (reducing unit) unreinforced concrete; 2 steps	1000/650	1200/850	600	670	498
	1200/650	1420/870	600	670	672
Shaft units (manhole rings) tongue and groove; unreinforced concrete; 1÷ 4 steps according to the nominal height	1000	1200	250	316	209
	1000	1200	500	566	425
	1000	1200	750	816	641
	1000	1200	1000	1066	856
	1200	1420	250	316	275
	1200	1420	500	566	557
	1200	1420	750	816	840
	1200	1420	1000	1066	1124
Base unit reinforced at the bottom and above the pre-formed inlet/outlet holes	1000	1490	1000	1125	max. 3200
	1200	1690	1100	1225	max. 4500

The steps (if required) should be made from galvanizes steel.

Physical-Mechanical characteristics:

Characteristic	Manhole element	Standards values
Crushing strength	Shaft units	100 kN/m
Drilled core strength	Shaft units	40 N/mm ²
	Base units	40 N/mm ²
	Straight back tapers	40 N/mm ²
Compressive strength	Adjusting units	40 N/mm ²
Deflection under vertical loading strength (2kN) for installed steps	Base units	max. 5 mm
	Shaft units	
	Straight back tapers	
Horizontal pull-out resistance for installed steps	Base units	min 5 kN
	Shaft units	
	Straight back tapers	
Water absorbtion	All concrete manhole elements	max. 6%
Water/cement ratio	All concrete manhole elements	0.38

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 10 of 79

2.3 Waterproofing of reed bed

2.3.1 General

1. The bed will waterproof by a HDPE geo-membrane.
2. HDPE geomembrane shall contains at least 97,5% of pure polymer, and approximately 2,5% of Carbon Black, antioxidants and thermal stabilizers. The product does not contain plasticizers or fillers that can migrate over time. The selected thickness of geomembrane is 1,5 mm.
3. The surface of the smooth geomembrane shall not have striations, roughness, pinholes, or bubbles. The geomembrane shall be supplied in rolls. Labels on each roll shall identify the thickness of the material, the length and width of the roll, lot and roll numbers, and name of manufacturer.

2.3.2 Seaming procedure

1. The seaming procedure will follow:
 - Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.
 - The Fusion System produces a bonded seam by running a hot metal wedge between the overlapped area of the HDPE liners. As the welding machine advances, these overlapped portions of the liners come together at the tapered end of the wedge, where pressure from two nip/drive rollers causes the heated membranes to bond together. The heat applied to the overlapping surfaces is precisely controllable.
 - An extrusion weld is produced by a 4mm or 5mm diameter welding rod manufactured from the same material used to produce the liner. The welding rod is applied as a "welded bead" at the edge of two overlapped liners, resulting in a welded seam.
 - The HDPE geomembrane can be seamed either according fusion welder and extrusion welder procedures, as per following description.
2. Seaming procedures using fusion welder:
 - Surfaces shall be clean and dry.
 - Test welds shall be performed prior to field seaming each morning and afternoon.
 - The overlap between the HDPE liners shall be at minimum 10 cm. The two sheets shall be straightened to keep the seamed edges smooth and wrinkle-free.
3. Seaming procedures using extrusion welder:
 - Surfaces shall be clean and dry.
 - Test welds shall be performed prior to field seaming each morning and afternoon.
 - The area which is to receive the extrusion bead shall be ground to remove surface contamination and surface tension.
 - The welding rod shall be free from dirt, dust, moisture, and tangles at all times.
 - The machine shall be purged for approximately 30 seconds prior to actual extrudate welding.
 - The bottom portion of the welding die shall stay in intimate contact with the liner and conform to various seam angles and configurations.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 11 of 79
	Technical Specifications	

- The welder die shall be kept "on center" at all times, ensuring that an equal amount of extrudate bead is applied to both portions of liner overlap (top and bottom).
- A consistent forward welding speed shall be maintained, to ensure a smooth and uniform extrudate bead.
- All patches shall have a 1" radius at corners, and be securely tacked to the liner.

4. Field seams non destructive testing:

Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:

- Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.
- The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.
- If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.
- Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

5. Destructive Field Seam Testing

- One destructive test sample per 150 linear m seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner's Representative. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner's Representative as seaming progresses.
- All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.
- The destructive sample size shall be 300 mm wide by 1 m long with the seam centered lengthwise.
- Shear Testing: Consists in apply a tensile stress from the top sheet through the weld and into the bottom sheet, at a speed depending on geomembrane raw type, and register the maximum resistance and location the fail occurs. This property is verified by ASTM D 3083 modified according to NSF54 – Appendix A. In this test to take the adequate resistance, one recommend results upper then 80 to 95 % from geomembrane yield resistance.
- Peel Testing: It peels the top sheet back against the overlapped edge of the bottom sheet in order to observe how separation occurs. This test is verified by ASTM D 413 modified according to NSF54 –

Appendix A. One considers attended the resistance if the result be greater than 70% of the geomembrane yield resistance.

- Pass – Fail Criteria: To be acceptable, 4 of 5 test specimens must pass the stated criteria. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.

	Tested Property	Unit	Test Method	Value		Tested Property	Unit	Test Method	Value
Raw Material Identification	Density of Raw Material	g/cm ³	UNE EN ISO 1183-1	≥ 0,932	Functional Properties	Low Temperature Brittleness (t ⁻ : -40°C)	-	UNE EN 495-5	No cracks
	Density of Geomembrane	g/cm ³	UNE EN ISO 1183-1	0,946 ± 0,004		Water Permeability	m ³ /m ² .d.a	UNE EN 14150	< 1.10 ⁻⁴
	Melt Flow Index	g/ 10 min	UNE EN ISO 1133 D Condition (190°C/2,16 Kg)	≤ 0,40		Coefficient of Linear Thermal Expansion	1/°K	ASTM D 696	2,15.10 ⁻⁴
			UNE EN ISO 1133 T Condition (190°C/5 Kg)	≤ 1,30		Water Absorption	%	UNE EN ISO 62 (24h)	≤ 0,1
	Carbon Black Content	%	ASTM D 4218	2,0 - 2,5				UNE EN ISO 62 (6 days)	≤ 0,5
Durability	Oxidative Induction Time (OIT)	min	UNE EN 728 (200°C)	> 100		Thickness of Coextruded Layer	%	UNE EN 1849-2	-
	Stress Crack Resistance/NCTL	h	ASTM D 5397	> 300		Asperity Height	mm	GRI GM 12	-
	Oxidation	%	UNE EN 14575	≤ 15					


Tested Property		Unit	Test Method	Value				
Strength Characteristics Quality of Final Product	Thickness	mm	UNE EN 1849-2	1.00	1.50	2.00	2.50	3.00
	Confidence level 95%	%	-	Tolerance: ± 6				
	Confidence level 90%	%	-	Tolerance: ± 4				
	Tensile Properties (*)							
	Tensile strength at Yield	N/mm	UNE-EN ISO 527 (Type V)	18 (17)	27 (25)	36 (34)	45 (42)	54 (51)
	Elongation at Yield	%		10 (9)				
	Tensile strength at Break	N/mm		32 (26)	48 (39)	64 (52)	80 (65)	96 (78)
	Elongation at Break	%		800 (700)				
	Tear Resistance	N	ISO 34-1	≥ 140	≥ 210	≥ 280	≥ 350	≥ 420
	Puncture Resistance	KN	UNE-EN ISO 12236	3.0	4.0	5.0	6.0	6.5
Exploding Resistance	%	pr EN 14151	< 15					
Dimensional Stability	%	UNE EN ISO 14632 (100°C, 1h)	± 1,5					

	Parameter	Units	1,00	1,50	2,00	2,50	3,00
80210	PRESENTATION (Standard Sizes)	Roll width	m	6 / 6,30	6 / 6,30	6 / 6,30	6 / 6,30
		Roll Length	m	210	140	105	84
		Surface	m ²	1260 / 1323	840 / 882	630 / 661	504 / 529

(*) Values indicated are MEDIUM. In brackets values with 95% confidence level.

2.3.3 Pervious felt

- The filter fabric shall be of a non-woven melded fabric consisting of a mixture of polypropylene and polythene or other similar materials. The grade of fabric shall weigh not less than as shown on the drawings expressed in gr/mq and have a thickness of 0.5 mm. The fabric shall be resistant to ultra violet rays and sunlight.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 13 of 79

2. Where overlapping of fabric is required, the overlap shall not be less than 500 mm and shall be sewn with a lock type stitch in such a manner that it produces a joint as durable as the fabric.
3. Storage and handling of the fabric shall be in accordance with the manufacturers' recommendations, except that in no case shall the geotextile be exposed to direct sunlight, ultra violet rays, temperatures greater than 60°C (140°), mud, dirt, dust and debris, to the extent that its strength, toughness or permeability characteristics are diminished.
4. The rolls have to be placed in parallel and overlapped at least 10 cm.

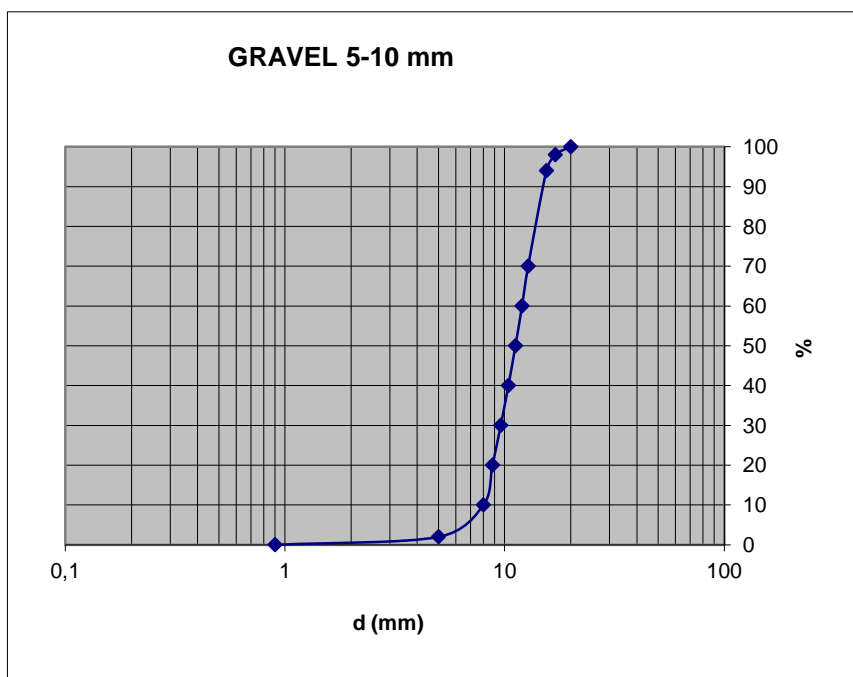
2.3.4 Wetland bed waterproofing testing

1. The constructed wetland basin will be tested for water-tightness in the following phases:
 - at HDPE liner completion;
 - at the end of filling phase.
2. Water for testing shall be provided by the Contractor. The basin should be filled as direct by the Engineer. After filling to top water level, the water shall stand for 3 days. The liquid level shall be recorded every 24 h for the next 3 days. The wetland basin may be deemed to be watertight if the total drop in surface level is equal zero after three days, considering the evaporation losses related to the climatic conditions (in a dry period a loss of 1 cm/day is normally accepted).
3. Any leaks and other defects that appear shall be repaired to the satisfaction of the Engineer. Leakage shall be defined as cumulative flow of water through the structure and its joints or a drop in liquid level of the structure in excess of that determined as being due to evaporation loss

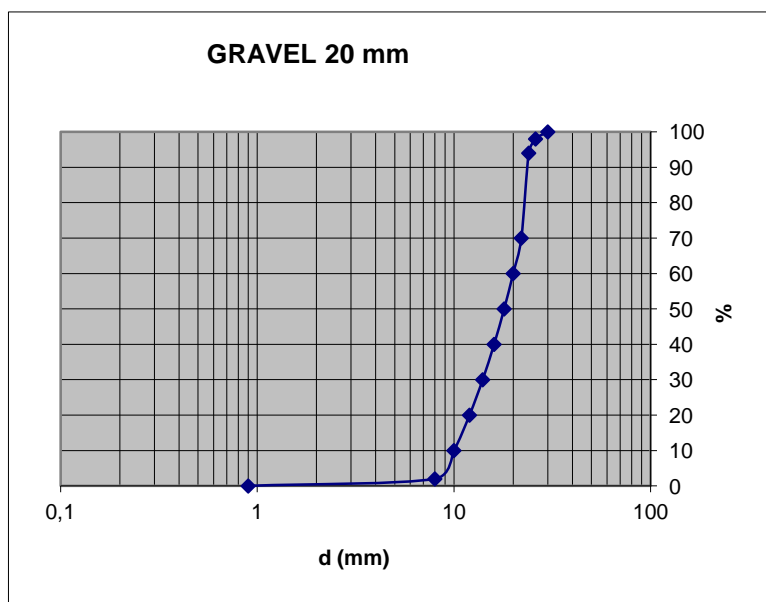
2.4 Bed media filter

1. The filter media consists in combinations of various size gravel. The Contractor shall execute the filter by using specialized personnel and with the most suitable equipments. The activity should be strictly in accordance at the Technical Specification and the following main indication:
 - The execution of the filter layers shall be in accordance with the following main indication:
 - the HDPE liner have not to be damaged during filter placing procedure;
 - the upper surface of each gravel layers have to be perfectly horizontal and uniform;
 - The depth of different gravel layers should be according technical drawings.
 - The filling material shall be obtained from approved borrow areas after the completion of any tests to confirm the suitability of the material.
 - The gravel shall be well washed, preferable rounded, but also crushed gravel can be accepted
 - Maximum calcium carbonate content 20%
 - Acid solubility: <2% 1:1 HCl Solution
 - The supply of the material shall be authorized only after receiving the chemical characteristics, the sieve analysis, pictures and sample of the material, certificate of origin
2. The gravel indicated in the drawings should be in accordance with the following specification:
 - The granulometric distribution of the fine gravel 5-10 mm should follow as closely as possible the following curve ($d_{10} > 5 \text{ mm}$ $d_{60}/d_{10} < 2$).

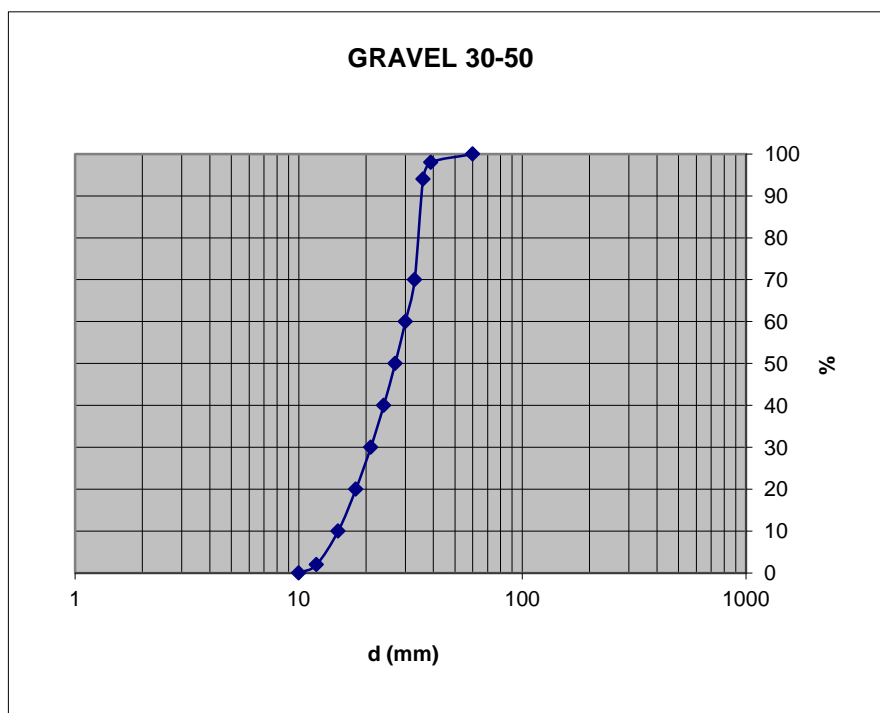
Technical Specifications



- The granulometric distribution of the fine gravel 20 mm should follow as closely as possible the following curve ($d_{10} > 12 \text{ mm}$ $d_{60}/d_{10} < 2$).




- The granulometric distribution of the gravel 30-50 mm should follow as closely as possible the following curve ($d_{10} > 20 \text{ mm}$ $d_{60}/d_{10} < 2,5$).

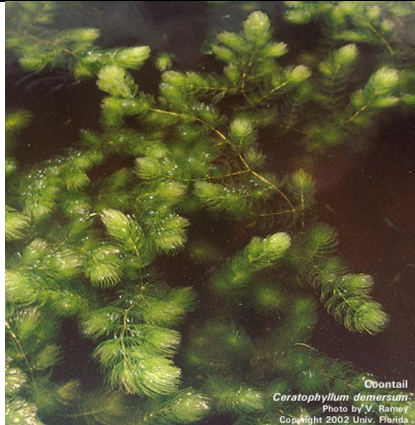





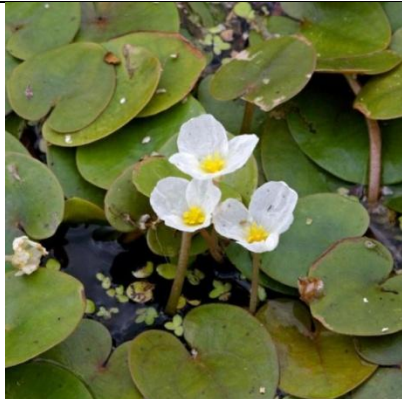



2.5 Wetland planting

2.5.1 General





The species proposed for plantation could be chosen among those listed in the following table.

<p><i>Ranunculus trichophyllus</i></p> <p>It occurs throughout much of the Northern Hemisphere, from the Mediterranean east through Siberia, the Caucasus, the Middle East, the Himalayas, Kazakhstan and Mongolia to Kamchatka in the Russian Far East, Japan, China and the Korean Peninsula, it also occurs across central North America.</p>	<p><i>R. trichophyllus</i> will occur in most types of mesotrophic to eutrophic water body, from dune slacks and drainage ditches to ponds, lakes, streams and slow-flowing rivers.</p>	
---	---	---



<p><i>Ceratophyllum demersum</i> This species has a more or less cosmopolitan distribution. It occurs from the Azores and Europe east through the Middle East and the Indian subcontinent to east and southeast Asia, and is widespread throughout China. It occurs in Africa north and south of the Sahara including Madagascar, as well as Australasia and North, Central and South America.</p>	<p><i>C. demersum</i> grows in static and slow-moving shallow or deep water in lakes, ponds, rivers and streams, and also in reed swamps. It can tolerate brackish conditions in estuaries and forms thick mats just below the surface.</p>	 <p><small>Coontail <i>Ceratophyllum demersum</i> Photo by V. Ramey Copyright 2002 Univ. Florida</small></p>
<p><i>Myriophyllum spicatum</i> This species occurs more or less throughout the Old World and as a non-native in North America. It ranges from Europe into and throughout Africa, and east to China, Japan and the Korean peninsula and south into Indonesia, but is absent from Australasia.</p>	<p><i>Myriophyllum spicatum</i> occurs in lakes, rivers, streams, canals and ditches. It prefers base-rich water systems with high dissolved inorganic carbon, nitrate, nitrite and pH, and in hydrosol with high phosphate and organic matter contents.</p>	
<p><i>Nymphaoides peltata</i> <i>N. peltata</i> is native to Europe and northern Asia, from the Baltic States south to the Iberian Peninsula and east through the Middle East, the Caucasus, Jammu and Kashmir in India, Siberia and Mongolia to the Russian Far East, China, Japan and Korean Peninsula. It is naturalised in North America.</p>	<p><i>N. peltata</i> typically occurs in naturally eutrophic, calcareous, slow-flowing rivers and large ditches.</p>	
<p><i>Nuphar luteum</i> This species occurs from Europe south to North Africa and east through the Middle East, the Caucasus, Siberia and Kazakhstan to China. It occurs more or less throughout Europe, except for the Balearic Islands, Corsica, and Crete. In Middle East it is known from Iran, Turkey, Syria, Palestine.</p>	<p><i>N. lutea</i> typically occurs in slow-flowing or standing, mesotrophic or eutrophic water bodies such as ponds, lakes, rivers and canals. It will also occur in oligotrophic conditions.</p>	

<p><i>Hydrocharis morsus-ranae</i> <i>H. morsus-ranae</i> occurs from Algeria, through Europe north to Scandinavia and east through the Altai, the Caucasus and the Middle East to Siberia and Kazakhstan.</p>	<p><i>H. morsus-ranae</i> typically occurs in shallow, calcareous, mesotrophic or meso-eutrophic water in the sheltered bays of lakes or in ponds, canals and ditches.</p>	
<p><i>Tipha latifolia</i> The species has a subcosmopolitan distribution, ranging east from Europe to the Russian Far East, and from Kamchatka to Sakhalin Island, China, Japan and the Korean Peninsula. The species is also present in North America, Mexico and parts of South America; in Africa it occurs in few countries. It has been introduced to Australia and Hawaii.</p>	<p>The species typically grows in the margins and shallow waters of eutrophic lakes, marshes, rivers, ponds and ditches.</p>	
<p><i>Typha angustifolia</i> Widespread in most parts of temperate Northern Hemisphere. Also recorded from China, Thailand and Viet Nam.</p>	<p>It grows in shallow water of lakes, rivers, ponds, marshes, and ditches.</p>	
<p><i>Iris pseudacorus</i> The species occurs from Madeira to North Africa and Europe east through Western Siberia, the Caucasus, the Middle East and Kazakhstan to the Primorskye region of far eastern Russia, Sakhalin Island and China. It has apparently been introduced to the Korean Peninsula, India, Canada, the United States and Argentina.</p>	<p><i>I. pseudoacorus</i> occurs in shallow water or saturated soils in marshes, along the shores of lakes or ponds with stagnant or slow flowing waters, and ditches.</p>	

Technical Specifications

<p><i>Lythrum salicaria</i></p> <p>This species is native throughout Europe and North Africa east through Turkey, Palestine and Lebanon to China, Japan and Korea. It has been introduced to North America and Australia where it can be extremely invasive.</p>	<p><i>L. salicaria</i> will occur in most wetland types from river margins and banks, to low-lying seasonally inundated areas in rough pasture, the margins of wet woodland and even seasonally pools.</p>	
<p><i>Phragmites australis</i></p> <p>This species has a sub-cosmopolitan distribution; it occurs from north-west Europe south through central and southern Europe to North Africa and south through Southern Africa to the Cape; it also occurs east through Russia and the Middle East to the Far East and south through South-east Asia to Australia, as well as throughout much of Canada south throughout the United States and Mexico as far south as Chile and Argentina.</p>	<p>This species will occur in most wetland habitats, from the margins of small ditches through river margins, ponds, lakes and reservoirs to vast expanses of reedmarsh, often in shallow water or growing out over deeper water. It can tolerate brackish conditions and variation in nutrient status from oligotrophic to highly eutrophic.</p>	
<p><i>Carex riparia</i></p> <p>The species occurs throughout most of Europe, south to North Africa (Algeria, Morocco) and east through Siberia, the Caucasus and the Middle East to Xinjiang Province in China</p>	<p><i>C. riparia</i> typically grows on the margins of base-rich, mesotrophic to eutrophic rivers, streams, lakes and canals, in marshes and in fens.</p>	
<p><i>Juncus effusus</i></p> <p>It is a cosmopolitan species which occurs throughout most of Europe, Asia south to Indonesia, North America, the Atlantic islands and Madagascar.</p>	<p><i>Juncus effusus</i> occurs in most wetland habitats but is most typical of wet pasture and moorland. It is common on the margins of rivers, ponds, lakes and ditches and will occur as scattered stands in open, wet woodland.</p>	

Technical Specifications

<p><i>Alisma plantago aquatica</i></p> <p>This is a widespread species. It is found in locations from northern Europe to Africa and southeast Asia. It ranges from E Europe through the Caucasus, to the Middle East, Siberia, Kazakhstan, the Himalayas and Mongolia to the Russian Far East, China, Japan, the Korean Peninsula, as well as Myanmar, Thailand and Vietnam.</p>	<p><i>A. plantago-aquatica</i> is an amphibious and herbaceous perennial Helophyte. It occurs mainly in lowlands (though in Ethiopia it grows to altitudes of 2500 m) and will grow in most mesotrophic to eutrophic wetland types, from the margins of streams and rivers, to lakes, ponds and marshy pools</p>	
<p><i>Schoenoplectus lacustris</i></p> <p>This species occurs in northern and southern Africa and from Europe east through Siberia, the Caucasus, the Middle East, Kazakhstan and the Himalayas in India to Mongolia and the Russian Far East.</p>	<p>This species typically grows in soft silt in water in the margins of lakes, canals, ponds, rivers and streams.</p>	

For FWS CW, we recommend the planting density for each species depending by the kind of plantation, to be placed in the areas indicated in the drawings :

Species	N° of pots per m2	N° of harvested plants per m2	N° of rhizomes per m2
Phragmites australis	4	6	8
Typha latifolia	4	6	8
Schoenoplectus lacustris	5	7	10
Iris Pseudacorus	4	6	8
Juncus effusus	4	6	8
Alisma plantago aquatica	4	6	8
Carex riparia	4	6	8
Lythrum salicaria	4	6	8
Hydrocharis morsus-ranae	2		
Nuphar luteum	2		
Ranunculus trichophyllus	2		
Nymphoides peltata	2		
Ceratophyllum demersum	2		

Myriophyllum spicatum	2		
-----------------------	---	--	--

The contractor can provide an alternative proposal on the basis of the availability of the plants in the region; in case the proposal has to be approved by the designers before the supply and the placement.

Plant stock that are frequently used to establish constructed wetland for wastewater treatment include seeds, rhizomes, green-house potted plants, and field harvested plants. These techniques are ideally suited for the common reed that is the most commune used plant in CWs.

Planting of seeds or rhizomes can occur in the spring after the last frost; rhizome material can also be planted in the fall.

2.5.2 Seeds

Wetland plants can be established directly from seeds, given suitable seed stock, soil moisture, light and temperature conditions. Seed germination is highly dependent on the soil/seed contact and the moisture regime of the soil.

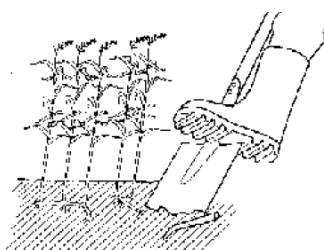
The sowing involves longer times for plant growth and a longer period for a complete and uniform coverage of the system.

The sowing is done using 7-10 seeds/m² (about 0,5 kg/ha), on a bare and wet soil. The best period to planting is between April and May with temperatures in the range 10 and 25 ° C. Germination can occur within 3-4 days under good environmental conditions. You can raise the water level up to about 2 cm above the gravel bed after 40-50 days. You can completely flood the bed when the plants grow.

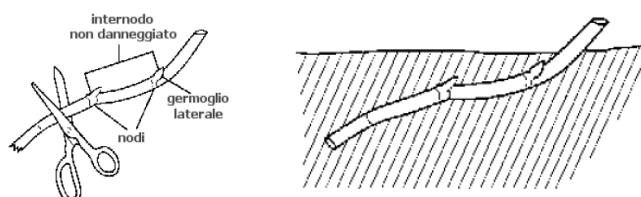
This method is rarely adopted in constructed wetland construction, whereas it is adopted to establish nurseries or temporary plantations near the construction site, with the aim to use produce rhizomes or young plants for the future reed beds

2.5.3 Rhizomes

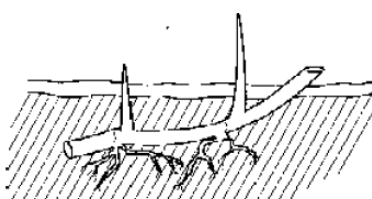
The rhizomes are generally taken from spontaneous growth areas or other wetland plants. We must be careful not to damage both the mother plant that the rhizome.



We must cut sections of rhizome containing an internode between two nodes with lateral shoots. Damaged parts must be removed. The rhizome is buried with an inclination of about 45 ° to the soil profile, leaving one end in contact with the atmosphere.



After planting, the water level is immediately raised so that the rhizomes do not dry out.



2.5.4 Potted Plants

To establish planting materials with a developed root structure, seedlings can be planted and grown in containers filled with potting soil. If you operate in a protected environment (with temperatures between 25-30 ° C for 16 hours a day which followed by 8 hours at 10 ° C), the seedling can be transplanted after about six weeks.

Before planting, it is important to verify that rhizomes and roots are well developed. With this technique you can transplant at any time of year; nevertheless cold periods should be avoided.

Presently, the use of potted seedlings is the most commonly used technique in northern Europe. Also, it has been found that planting of bare-root seedlings is possible and advantageous as compared to potted seedlings. The major advantage is that large number of bare-root seedlings could be easily transported. Also, the soil from pots may be washed out and contribute to bed clogging.

We must always select vegetal materials from a similar environment or more restrictive environmental conditions.

2.5.5 Field harvested plants

In some cases, herbaceous wetland plant stock can be field harvested and used to plant a new constructed wetland. This planting technique is used in areas with abundant natural wetlands.

After delivery to the job site, plant material should be stored in the shade and kept cool and moist. Plant stock left out in the sun can dry out and be useless within a few hours. The maximum storage period is 48 h.

2.5.6 Vegetation Start-Up

To favour the start-up of the vegetation in the FWS reed bed, the slightly polluted water in the channel can be used.

Generally, there are three phases to water level adjustment during vegetation start-up:

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 22 of 79
	Technical Specifications	

Phase 1: maintaining the water level minimum 10 cm below the gravel surface in filtration zones to permit the initial planting;

Phase 2: increase the water depth until approximately 5 cm above the gravel surface for about 1 month: the emergent shoots should be above the water surface at all times to give the plants access to sunlight and oxygen.

Phase 3: Setting the water level at the design standard depth after plants are established and start the loading with wastewater.

Sixty days after the completion of the planting, a satisfactory stand is defined as one in which: (1) spacing between plants averages 2 m or less; (2) the plant survival averages at least 70 percent; and (3) no areas of greater than 20 contiguous m² with a plant survival rate of less than 50 percent.

If there is significant failure during the initial planting, these steps may need to be repeated.

Once emergent plants are well established, replanting is usually not necessary unless the plants are damaged by wild animals or the system is stopped for more than 2-3 months in the dry season. Planting and replanting operations have to be performed in the appropriate season (April-June or September-October); July and August are not recommended if the temperature are too high, whereas a plantation during October-November could be risky because the plants could not have the necessary time to well establishment and they could be damaged during the winter season.

During the first 1-2 years, it is very important to control the diffusion of weeds inside the beds that can make difficult the propagation of reeds. Weeds shall be removed manually, checking the surface of the beds one time per month during spring and summer.

2.6 Electro-mechanical equipment

This Specification is intended to indicate the minimum standard of design, workmanship and materials acceptable in this project. The itemized specific requirements are given in the Particular Electro-Mechanical Specifications.

2.6.1 General requirements and workmanship

All supplied parts shall be designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials shall be new and both workmanship and materials suitable for the service the units are to be subjected and shall conform to all sections of the Specifications.

The general mechanical and electrical design of the Works and particularly that of the bearings, contacts, and other such wearing parts shall be governed by the need for a long period of service without frequent maintenance and attention.

Unless otherwise specified, all items of the Works shall be rated for continuous service at the specified duties under the prevailing atmospheric and operational conditions of the Site.

All parts subject to wear shall be readily accessible. Provision shall be made for taking up wear in all bearings and other wearing parts or for easy replacement if adjustment is not practicable.

Wherever practical the MINAVRA shall ensure the maximum interchangeability of similar items from alternative suppliers.

Suitable packers, shims, adjustment and the like shall be fitted for ease of adjustment and realignment of all machinery units with particular attention given to combined sets.

All pipes shall be checked for alignment and mating of connections before being secured and pipes shall be in straight line and grade.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 23 of 79

Pumps shall be designed to meet the operational duties under the Site conditions as specified. Pumps shall be designed to keep constant performance. Waterways through the pump and impeller shall be smooth and free from recess and projections.

2.6.2 Submersible pumps

2.6.2.1 Pumping station

The pumping station loads the bed in a continuous mode, controlled by emergency switch level regulators. A timer allows to set up the pumping time during the day, in case there is the necessity to exclude some periods.

The pumps are 2 and they are centrifugal submersible, type Lowara DL80 or similar.

Only one pump has to be in function in standard mode: an electric device permits to switch the pump every 2 hours of functioning.

Each selected pump has the following characteristics:

PUMP BODY: cast iron.

MOTOR FRAME: stainless steel AISI 304.

CHASSIS: cast iron

IMPELLER: single channel type, stainless steel.

MOTOR SHAFT: stainless steel AISI 304.

MOTOR: submersible asynchronous for continuous duty.

V: 3-phase 380 V - 50 Hz with capacitor and thermal overload protector.

INSULATION: class B

PROTECTION: IP 68

Nominal flow: 3.5 l/s; Nominal Head: 3.5 m;

Power nominal capacity: 0,6 KW; nominal speed 2900 rpm; rated current 2.09 A

Head $H(Q=0)=7.6$ m

Weight 19.5 Kg

Coupling and cable:

Support foot in stainless steel.

Electric submarine cable neoprene H07RN-F

Limits of use

Immersion depth up to 5 m

Liquid temperature up to +40

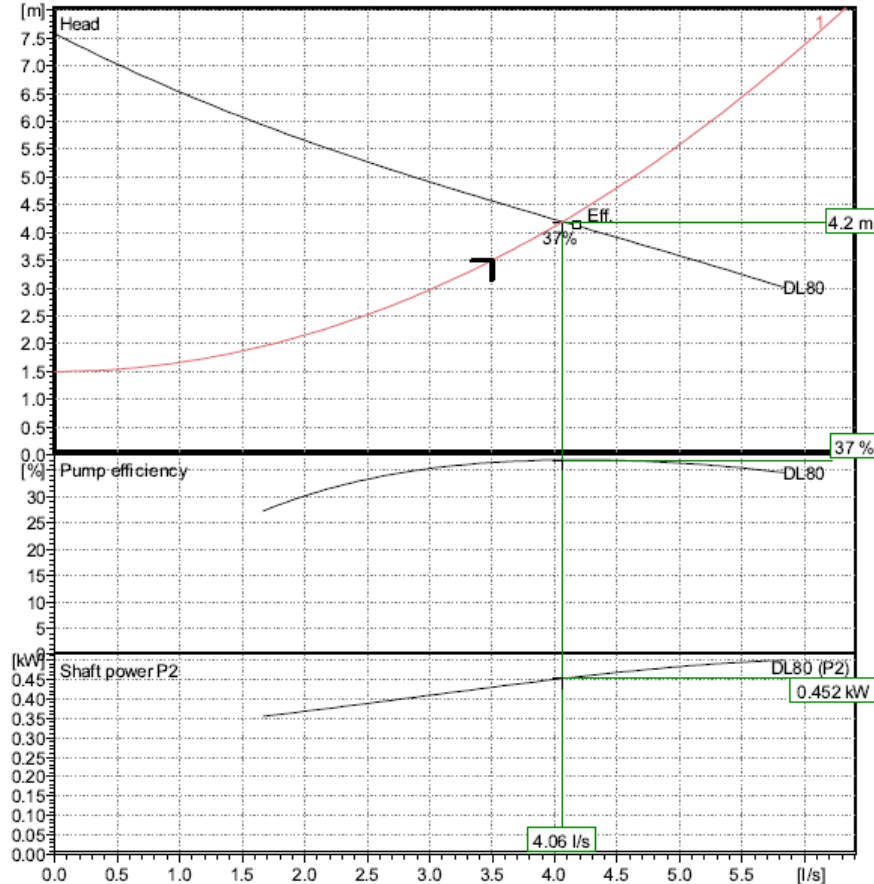
Passage of suspended solid bodies up to 30 mm

For continuous duty: minimum immersion 290 mm from pump base

Performance according to ISO 9906:2012 – Grade 3B

Power datas referred to:

Water, pure [100%] ; 4°C; 1000kg/m³; 1.57mm²/s



The pump is controlled by a control panel, contained in a Box in protected execution IP55 with hinge door, for external installation, including:

1. Electrical protection and automatic or manual command of no. 1 pump

Type of custody: Cabinet in SMC (fibreglass-reinforced plastic) in protected execution IP44 with hinge door.

Type of custody: For external installation.

Motoring start-up: Star/Triangle

The Local switchboards shall meet the requirements of degree of protection index IP55.

Power supply: 400 V - 50 Hz.

2. The panel will contain mounted and connected the following materials:

n°1 Rotary knife, lockable door blocking maneuver

n°1 Fuse 3 pole with fuse to feature delayed

n°1 Complete thermal relay contactors

n°1 Selectors man-o-aut (manual position not stable)

n° 2 Beamers with lamps for each pump

1 lights (pump marching)

1 lights (pump stopped)

n° 1 single-phase transformer for auxiliary circuits adequate power - q.s. relay shutter operation (alternation)

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 25 of 79

n°1 digital timer that control the duration of cyclical pause-work phases. The timer has to permit to put data in minutes.

One floating valve is set only for emergency stop (0.3 m from bottom), pump can start only if this floating will return vertical (0.4 m).

The pumps shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastenings to be disconnected.

The pump will be equipped with a PVC ball valve 2" and electromagnetic flowmeter 2".

2.6.3 Valves

2.6.3.1 General

All valves shall be designed to the minimum working pressure as shown on drawings and/or detailed in Particular Specification. Flanges for valves shall comply with EN 1092-2:1997 for cast iron flanges, or equivalent.

Unless otherwise specified, all valves shall be anti - clockwise opening and operated by hand wheel.

Unless detailed otherwise all hand wheels shall have the words "open" and "close" in English with arrows indicating the direction of rotation cast on. All hand wheels shall be of a solid cast type.

Valves of all types shall be capable of withstanding corrosion in the ambient conditions and any parts manufactured from a material which is not itself corrosion-resistant must be protected.

Works tests will not normally be witnessed except where so specified or required by the Engineer. A certificate from manufacturer's for shop testing shall be provided for the approval of the Engineer.

2.6.3.2 Gate valves

Gate Valves shall be resilient seated with smooth straight through bore. Body and bonnet shall be of cast iron with non-rising stem of stainless steel spindle. The wedge shall be of ductile iron, inside and outside fully rubberised with vulcanised elastomer, the wedge guide of wear resistant plastic with high gliding features both suitable for potable water.

2.6.4 Measurement devices

The meter flow has the following characteristics:

- Electromagnetic Flow Meter DN65 for sewage
- 1,2-119 m³/h
- Suitable for potable water and wastewater
- Electrodes: Stainless steel 316
- Flanges: Carbon steel
- Pressure limitations 6 bar
- Environmental protection IP68
- Buriable to 5m (16 ft) depth
- Conductivity ≥5μS/cm
- Electronic Display Unit: integral with sensor, OR, Remote up to 100m (325 ft), IP65, Glass-loaded polypropylene, polycarbonate window ULVO rated;
- Electrical connections: 20mm glands, or accepts 1/2 in. NPT connections
- Sensor cable: ABB cable

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 26 of 79
	Technical Specifications	

3 METHOD OF MEASUREMENT AND PAYMENT

3.1 Introduction

1. The rates and prices inserted in the Bills of Quantities by the Tenderer shall be deemed to cover all costs, expenses, risks, liabilities and obligations set forth or implied in the Contract Documents.
2. The prices shall include all matters and things necessary for the proper construction, pre-commissioning, completion, operation and maintenance of the Works (if any) including, but not by way of limitation:
 - costs related with General and Specific obligations clauses as stated in the Technical Specifications, not covered by a separate item in the BOQ, but otherwise specified or required.
 - all labor and material including samples, sampling and testing;
 - all temporary work of every description required (including any that may be required by sub-contractors); for the provision and use of all plant of every kind, whether mechanical or non-mechanical, required for the expeditious carrying out of the Works in their proper sequence.
3. The prices shall also include any shifting, altering and adapting temporary works and plant as may be required during the progress of the Works and removing at completion and making good any surfaces disturbed; for full customs and other import duties; taxes and duties (including VAT) of any nature (as applicable, in compliance with the Tender Documents); for cooperation and coordination of his work, for the guarantees and bonds required, for all necessary temporary services for the Works, for the costs of preparing a tender, for the work in connection with measurements and the final account, for profit, and for all other establishment charges and all costs of whatever nature.
4. The method of measurement used and which shall be used for remeasurement and for measurement of any variations ordered in the Works are as stated in the present Method of "Measurement and Payment".
5. These methods of measurement shall be strictly adhered to, non with standing any trade, local or general custom. In the event of any item not being stated in the said Measurement and Payment section, then such item shall not be considered to be additional to the work and shall not be measured or paid for.
6. Unless otherwise stated, all measurements shall be applicable to finished work only as completed and no allowance shall be made for wastage, working space, bulking, shrinkage, overlaps and the like.
7. The units of measurement for each item shall be as shown in the Bills of Quantities. Unless otherwise specifically mentioned, measurement shall be rounded up or down to the nearest whole unit and exact half units shall be rounded up. Any thickness stated in this Document shall be deemed to the finished thickness.

3.2 Included Works

The following are works, which shall be deemed to be included in the unit rates of the relevant items. However, other works and materials which have not been specifically mentioned but could be reasonably implied or inferred from the drawings or the specifications, or are required for the proper execution and completion of the Works, shall be deemed included in the unit rates for the work item to which they relate:

1. Labor;
2. Materials;
3. General and Specific obligations clauses as stated in the Technical Specifications, not covered by a separate item in the BOQ, but otherwise specified or required
4. All shop treatment of materials (e.g. preservation of timbers, galvanizing, priming, chrome plating, stove enameling, anodizing and the like; pipe wrapping, coatings, etc.)
5. Fitting and fixing materials in position
6. Connecting the work of the item to other works, including cutting and shaping, fitting and jointing, and corporation valves, etc.
7. All fittings, connections, branches, couplings and joints, sleeves, plugs, caps, stoppers, ties, fasteners and tappings as necessary, push-on or mechanical screws, nuts, bolts, gaskets, seals, etc as required, shall be deemed included with the item to which they are installed
8. Square raking or curved cutting. Junctions between straight, raking and curved work are in all cases included with the work in which they occur
9. Work in volumes, in areas and lengths of any size and at any location or height; no separate items

Technical Specifications

- being measured for isolated work or work in small quantities, short lengths, narrow widths, etc.
10. All incidental and temporary works and materials
 11. Waste of material
 12. Provision of samples
 13. Earthworks, where required but not specifically mentioned or allowed for under any work item in the BOQ shall be deemed included. Earthmoving Excavation, wherever needed, shall be deemed inclusive of:
 - a) Cutting original surface and excavation in any soil, including concrete of any type, rock and boulders, to any depth and at any location;
 - b) Protection of existing structures and facilities including repair and/or removal and replacement of damaged structures and facilities as directed and to the satisfaction of the Engineer;
 - c) Shoring, sheeting and bracing, and driving and removal thereof, including what is left in place when directed;
 - d) Dewatering and drainage where needed;
 - e) Leveling and/or grading and compacting bottoms of excavations;
 - f) Removal or relocation of underground structures, pipes and facilities as directed.
 14. Replacement and restoration of any works removed or disturbed.
 15. Concrete work, where needed or required but not specifically mentioned or allowed for under any work item in the BOQ, shall be deemed included. Concrete works, wherever needed, shall be deemed inclusive of any formwork needed.
 16. Cleaning up, flushing and disinfecting the works during installation/construction and final cleanup upon completion.
 17. Testing of works and materials in factory and/or in-place, as specified, and commissioning.
 18. Spare parts and special tools not covered by a separate item in the BOQ, but otherwise specified or required.
 19. Start-up, Pre-commissioning, Commissioning, Testing, Operating and Maintenance of the facilities.
 20. Traffic Control, Barricading and Street Closure Permitting.
 21. Environmental mitigation measures as needed or required.
 22. Establishment charges, on-costs, overhead charges and profit.

Notwithstanding Specification requirements for materials and/or equipment to be supplied under one division and fixed or laced in position under another division in the Bills of Quantities, all such materials/equipment are priced as supplied and fixed in the division in which they have been measured unless clearly stated as "Fix Only" or "Supply Only" items.

3.3 Payment

1. The compensation, as herein provided, shall be full payment for furnishing all materials, labor, tools, equipment and incidentals necessary for the completed Work and for performing all work intended and included under the Contract; for mobilization, demobilization and clean-up (for the concerned work); for all temporary facilities and work (for the concerned work); for all losses or damages arising from the nature of the Work or from the action of the elements and/or from any unforeseen difficulties which may be encountered during the prosecution of the Work, except for conditions as provided herein until its final acceptance by the Employer.
2. Apart from imported construction materials, payment will be made for materials only when installed in place after passing all specified tests, as part of the item to which they relate, and no proportional payment shall be made for materials on the site but not yet installed.

3.4 Excavation and Earthworks

A. Measurement

	<p align="center">DESIGN OF TREATMENT WETLAND IN SHIRVAN</p>	<p>Document: SH_2019_E2</p>
	<p align="center">Technical Specifications</p>	<p>Page 28 of 79</p>

- I. Measurement of the quantities of excavation and filling shall be measured net from the new and existing levels and/or contours shown on the drawings on the basis that the gradient of the existing surfaces between the nearest adjacent spot levels and/or between contours is constant. Ground level means any level of commencement of excavation.
2. Measurement of clearing and grubbing shall be the removal of vegetation and roots, rocks, debris, etc. for the specified depth, and disposal of the resultant soil and specified and directed, including deposit in approved spoil dumps for surplus material. The activities will include the removal of top soil over the site area, and disposal of the resultant soil and specified and directed, including deposit in approved spoil dumps for surplus material.. Measurement will be in square meters.
3. Measurement of Excavation of CTW in drain, canal and existing embankment, shall be to the levels and grades specified and shown on the drawings, to depths and levels determined as herein below (7). Measurement shall be inclusive of transport and stock piling satisfactory materials at approved locations (for reuse in embankment formation and backfilling) or disposal of unsatisfactory materials as specified or directed. Haul distance up to 1500 m shall be included in rate of excavation. Haul distances shall be measured as straight line distances between the centers of gravity of excavation and deposit. Measurement will be in cubic meters.
4. Measurement of excavation in approved borrow area for construction of embankment or any other formation shall be measured in cubic meters as the balance required to make up the volume of material in embankment or formation to the value calculated as below (7) after taking into account incorporation of volume of suitable material (if any) available from material excavated in drain, canal, or existing embankment (as 4). Measurement shall be inclusive of transport and stock piling.
5. Embankment for CTW or other formation constructed to the dimensions shown on the drawings or ordered by Engineer, the volume of material therein shall be measured in cubic meters as the net volume above original ground surface to the minimum applicable dimensions so shown or ordered. Measurement shall be inclusive of embankment trim to shape activity.
6. Measurement of excavation for structure and pipeline trench excavation shall be to the levels and grades specified and shown on the drawings, to depths and levels determined as herein below (7). Measurement shall be inclusive of stock piling satisfactory materials at approved locations (for reuse in backfilling) and disposal of unsatisfactory materials as specified or directed. Measurement will be in cubic meters.
7. Measurement of excavation depth shall be the difference between cleared top soil elevation and:
 - a) Bottom embankment formation
 - b) Bottom formation levels of CTW ponds
 - c) Finished grade level over and around buildings and open areas
 - d) Rough grading contours over and around process areas
 - e) Bottom of blinding concrete
 - f) Sub-grade level for roads and pavements
 - g) Bottom of base course.
8. Measurement of any kind of excavation, shall include removal of portions of unsuitable excavation, as required to excavate the concerned area, as well as disposing of the resulting materials, and clean-up of the site (measured on a lump sum basis).
9. Measurement of backfilling shall be for finishing site grading over areas of structures and pipeline trench excavation, using satisfactory excavated materials. Measurement shall include filling and compaction, forming and trimming slopes, and preparation of subgrade, all as specified.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 29 of 79
	Technical Specifications	

10. Included Works

In addition as detailed in the Technical Specification:

- a) Additional excavation or filling required due to variation of the existing surface differing from a constant gradient between spot levels and/or between contours;
- b) Hand or machine work or any combination of the two as may be found expedient;
- c) for carrying out excavations in stages where required;
- d) for segregation of excavated materials as required;
- e) for grubbing up roots and root matter;
- f) Getting out excavated material, shoring or planking and strutting;
- g) Removing surplus excavated materials to temporary spoil heaps, creating spoil heaps and moving as required during the progress of the Works;
- h) Raised center to bottom of pit for plants, and loosening bottom of pit;
- i) Blasting, where permitted, including removal and disposal of resulting rock and boulders, and clean-up.

B. Payment

1. Payment for earthwork shall be made above at the unit prices bid in the BOQ. The price and payment shall be inclusive notwithstanding the method, equipment and tools used, inclusive of disposal.
2. Payment for excavation and earthworks, generally, shall include for:
 - a) Planking and strutting to uphold the sides of excavation by any means necessary;
 - b) Excavation in any ground including rock, concrete or asphalt to any depth, which shall be removed with drilling equipment, compressors or rippers as approved;
 - c) Sorting excavated material;
 - d) Importation of additional material if insufficient is available on site and subsequent additional disposal;
 - e) Trimming, leveling and ramming bottoms of excavation;
 - f) Double and multiple handling;
 - g) Stockpiling;
 - h) Keeping excavations free from storm water, percolating water and sub-soil water by pumping or any other means, including all the requirement stated in clause 3.8 "Dewatering" of the General TS ;**
 - i) Finishing and grading to any falls, cross-falls or slopes that may be required;
 - j) Benchmarks;
 - k) Backfilling and consolidating/compacting selected excavated materials not covered by a separate item in BoQ, but otherwise specified or required;
 - l) Temporary spoil heaps, provision of any approved tip and payment of all charges in connection therewith;
 - m) Warning markers.
4. Payment for rock and boulder etc. excavation and removal shall include in the price of the excavation items.

3.5 Concrete Works

A. Measurement

I. General

Concrete shall be measured net as placed and no deduction is made for voids not exceeding 0.10m^2 in square area voids not exceeding 0.50m^3 in cubic areas, or for the volume of an steel embedded in the concrete.

Technical Specifications

2. Concrete

1. Blinding beds shall be measured in cm.
2. Slabs on grade and suspended slabs, shall be measured in cubic meters, and measurements shall be taken over all bearings.
3. Foundations, wall footings and beams shall be measured in cubic meters as only that portion below the slab to which they are attached.
4. Walls shall be measured in cubic meter notwithstanding their thickness.
5. Columns shall be measured in cubic meters, from top of slab to underside of beams or slabs above.
6. Reinforced, cast in-situ concrete box culverts if required shall be measured in cubic meters, itemized in accordance with the type of culvert.
7. Cast in-situ concrete drop inlets (catch pits) shall be measured by the number, itemized according to internal dimensions.
8. Reinforced concrete rectangular channels shall be measured for length along the actual center line of the structure in linear meters. Measurement and payment shall be inclusive of grating and frame installed complete, all earthworks, concrete works, pipe connections, and all necessary and incidental works.

3. Reinforcement

Reinforcement, bar and fabric, shall be measured in ton.

4. Formwork

Formwork shall not be measured as a separate item and shall be deemed fully included in the concrete prices.

5. Precast Concrete Units

1. Lintels shall not be measured as a separate item and shall be deemed fully included with the item in which they are embedded or fixed
2. Rain water spouts shall be measured by the number.
3. Kerbs shall be measured in linear meters.

6. Waterstop

Waterstop and water-swelling shall not be measured as a separate item and shall be deemed fully included in the concrete prices.

7. Vapor Barriers, Water Proofing and Damp Proofing

All water, vapor and moisture protection works shall not be measured as separate items but shall be deemed fully included with the items to which they are applied or fixed.

B. Payment

I. Concrete

Payment for concrete work shall include for:

1. Designing mixes, including any specified additives;
2. Construction and control joints
3. Laying in bays including temporary supports
4. Vibrating and packing around and between formwork
5. Curing and sprinkling
6. Work of any cross-sectional area and at any height
7. Cutting or forming grooves, throats, holes, chases, rebates, chamfers, splayed angles, molding and the like
8. Cutting or forming mortices and grouting in
9. Making good holes left by other trades
10. Grading, tamping and troweling surfaces of unset concrete
11. Hacking or otherwise treating surfaces of concrete to receive finish
12. Cost of the required formworks, notwithstanding its location, shaped size or surface finish it is

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 31 of 79

expected to provided including surface treatment to forms as specified.

13. All surface finishes, including fair faced concrete and smooth surfaces (as required and indicated with drawing).
14. All construction and expansion joints, inclusive on their treatment, fillers, any temporary works and additional tying materials and all necessary works and materials, not covered by a separate item in the BOQ, but otherwise specified or required.
15. All vapor, moisture and water proofing works and materials (other than for roofs), not with stand their location, depth or thickness, complete.
16. All extra-expense for casting in underwater condition, , not covered by a separate item in the BOQ, but otherwise specified or required.

2. Precast Concrete

Rates for precast concrete shall include for:

1. Designing mixes
2. Lifting steel
3. Molds and surface finishes
4. Steel reinforcement, dowels and anchors
5. Concrete or mortar mix at in-situ joints
6. Transporting, hoisting, bedding and pointing in cement mortar
7. Temporary supports
8. Fair ends, stooled ends, returned ends, rounded ends, mitred angles, rebated angles, intersection and the like.

3. Steel reinforcement

Rates for steel reinforcement shall include for:

1. Support reinforcement bars not indicated on drawings and as required;
2. All bar and fabric reinforcement, installed complete in place.

3.6 Miscellaneous Concrete

A. Measurement

1. Measurement or payment for concrete furnished and installed shall be the actual quantity placed, irrespective of depth or location.
2. Concrete placed for miscellaneous purposes, where approved by the Engineer, will be measured in cubic meters.
3. Steel reinforcement for miscellaneous purposes where approved by the Engineer, will be measured in tons, to the nearest kilogram.
4. Thrust blocks/anchors, where required and directed, shall be measured, as miscellaneous purpose concrete, net as the actual quantity placed in position.

B. Payment

1. Payment for miscellaneous concrete will be made for the quantity as above-determined at the unit price bid in the BOQ, and shall be full compensation for furnishing and placing the concrete including formwork and other materials required, complete as shown on the Drawings and as specified herein.
2. Thrust blocks and anchors shall be paid for, as the actual quantity placed, at the unit price bid in the BOQ for blinding concrete.
3. Payment for concrete blinding, concrete manholes, chambers and surface boxes and concrete topping to pipeline below surface reinstatement, shall be paid for, as the actual quantity placed, at the unit price bid in the BOQ related at the concrete calls utilized.

3.7 Road Works

A. Measurement

Technical Specifications

Measurement of road works items shall be in cubic meter for the aggregates (sub-base and base course) and square meters for surfacing.

B: Payment

Rates for road work items shall include for;

1. Spreading to the required thicknesses
2. Leveling and compacting to the required elevations, falls and cross falls.

3.8 Pipe Works

The sitework piping works include uPVC pipe, HDPE pipe and valves and appurtenances. Measurement and payment for the piping work shall be divided into two separate sections; one for the pipes supply and installation (pipe laying works), another for the valves and appurtenances.

3.8.1 Piping Works

A. Measurement

1. Pipe of the type, class and size specified in the Contract Documents, as provided for in the BOQ will be measured actual in place on a linear meter basis.
2. Measurement of pipe works for length will be along the actual centerline of the pipe inclusive of all fittings (tees, bends, crosses, reducers couplings, retainer rings, sleeves, tappings, etc. including glands, bolts, nuts, tie rods, gasket and other accessories) irrespective of their weight, but exclusive of valves, which are measured separately. No deduction of pipe length shall be made for pipe within chambers. Measurement will be to the nearest ten (10) centimeters.
3. No deduction shall be made for exposed valves and valves in surface boxes.

B. Payment

1. Payment for furnishing and installing pipes will be made for the respective type, size and quantity as determined above at the unit prices bid under the relevant Items in the BOQ. These prices and payments shall be inclusive of the following fittings, if not covered by a separate item in the BOQ, but otherwise specified or required: laying, jointing and connecting to other pipes (welding or coupling as specified), all the required fittings (adaptors, spigots ends, flanges, elbow, Tee, end cap, cross, fittings, etc.), inclusive of furnishing and installing all fittings, joints, nipples (and tees associated with those nipple pieces), connections and branches; lining, coating, packing and wrapping; cutting the pipe, if necessary; temporary plugging and capping; flushing, disinfecting, cleaning and testing the pipeline during construction and upon completion; and all incidental work and materials, and all else incidental thereto, for which separate payment is not provided under other items in the BOQ.
2. Notwithstanding acceptance and/or measurement, a percentage of the payment due for furnishing and installing pipeline may be retained on the partial payment requests until the pipeline is tested as specified herein.

3.8.2 Valves and appurtenances

A. Measurement

1. Valves and appurtenances of the type and size specified in the Contract Documents, buried, manholes, in surface boxes or underground vault as provided for in the BOQ, will be enumerated actually installed and accepted by the Engineer
2. Valves shall be measured as complete units of the following types:
 - a) Gate Valves
 - b) Plug Valves
 - c) Globe Valves
 - d) Air Release Valves
 - e) Pressure Relief Valves
 - f) Flap Valves

Technical Specifications

- g) Pump Control Electric Check Valves
- h) Check Valves
- i) Sludge Valves
- j) Drain Valves
- k) Valve Actuators
- l) Hose Bibbs
- m) Wash Hose Stations
- n) Flowmeters
- o) Chlorine Diffusers
- p) Potable Water Outlets
- q) Tanker Filling/Discharge Points

B. Payment

Payment for furnishing and installing valves will be made for the quantity as determined above at the unit prices bid in the BOQ. This price and payment shall be full compensation for setting and jointing, inclusive of all works and materials, including furnishing and installing joints and fittings, faucets, standpipes and extension shafts operating nuts, valve boxes with adapters and covers; operating keys and wrenches; fasteners, ring seals, bonnet, tie rods and gland bolts and nuts; wedges, tapping sleeves, armored end gaskets and flanges; converters, where required; wiring and controls, if applicable; position indicating devices; surface boxes and covers, including reinforced concrete chambers complete, and blinding where required; precast concrete extension and leveling rings, manhole frames and covers, and manhole rungs; gravel pack were indicated; ventilation pipes; plywood, wood or heavy duty cardboard covers; flushing, cleaning and testing the items during construction and upon completion; and all work required for or incidental to the satisfactory completion of the items for which separate payment is not provided under other items in the BOQ.

3.9 Metalworks

A Measurement

- 1. Metalworks in general are measured by Kilos.
- 2. Handrails shall be measured complete, including fixations, bolts, anchors, etc., in linear meters.

B Payment

I. General

Rates for metalwork shall generally include for:

- 1. Cutting members to length
- 2. All scribing, rebates, grooves, chamfers, splayed and rounded edges, tongued angles, beads, moldings, fair and returned ends, miters, housing, holes for pipes, etc. and for all short or isolated lengths
- 3. For all shop and site welding
- 4. Grinding, drilling, countersinking, bolting and riveting
- 5. Assembling, adjusting and fixing complete
- 6. Cleaning and preparing surfaces to receive finishes including all treatments, primers and finishes.

2. Handrails, Grab rails, Balustrades, Grilles, etc.

Rates for handrails, grab rails, balustrades, grilles or the like shall include for:

- 1. All angles, bends, ends, returns, etc.
- 2. Extra material for supports and building into structure
- 3. Cleaning and preparing surfaces to receive finishes including all treatments, primers and finishes.

3. Pipe fitting embedded into structures

Rates for supply and laying pipe fittings embedded into structures shall include for;

- 1. Cutting to size, scribing, notching, etc. where require
- 2. Grounds, bearers and framing

Technical Specifications

3. Supporting systems and fixings
4. Cutting into works by other trades and making good existing works
5. Application of surface treatments where necessary
6. Any required sealants and the like at edges.

3.10 Fences

A. Measurement

Fences shall be measured as the actual length installed, in linear meters;

1. Measurement for length of fences shall not include for gates.
2. Gates shall be measured as stated in B.O.Q.

Fences and Gates shall include as the follows :

1. Fences will include, posts, galvanized steel grating or wire mesh of the sections and wire diameter and opening size, width, height and other details specified in the Contract Documents.
2. Gates will include for the wire mesh, frames, cross pipes, circular pieces, locking devices, hinges, flat bars, gate posts and all civil works, materials, fixations and accessories for a complete gate as specified and shown on the drawings.

B. Payment

Rates for fences and gates shall include for;

1. Excavation and earthworks where required
2. All formwork where needed
3. Reinforced concrete foundations and columns, where needed or shown
4. Posts
5. Grates or chain link fence, complete as shown or specified
6. Gates, complete as shown or specified
7. All additional structural and metal elements and works, whether temporary or permanent, as needed to support and strengthen the structure.

3.11 Landscaping


A. Measurement

1. Organic Top soil shall be measured by the cubic meters including loose compaction
2. Trees and shrubs shall be measured by the number
3. Grass seeding, flower planting and ground cover plants shall be measured in square meters.
4. Maintenance of trees, shrubs, ground covering plants, flower beds and grassed areas shall be included in the unit prices.

B. Payment

Rates for grass seeding or planting shall include for:

1. Provision of top soil as necessary, including any additional excavation and disposal
2. Fertilizer, leeching and mulching
3. Tilling and raking
4. Watering, cutting and pruning
5. Anti-desiccant and pesticides
6. Stakes, guys, chafing guards
7. Waterproof identification labels to trees and shrubs with botanical and common name.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 35 of 79
	Technical Specifications	

4 GENERAL SPECIFICATIONS

1 GENERAL REQUIREMENTS

1.1 GENERAL INFORMATION

1.1.1 Power, Current and Voltage

1. Nominal operating voltage is 380/220V AC and frequency 50 Hz. Voltage fluctuation is common in the Site.
2. The Contractor shall remain responsible for supplying temporary power to the entire extent of the works. The Contractor shall obtain and pay for all permits related to electrical work, arrange for all electrical inspections covering his work, pay all fees and charges, and make all deposits that are in any way connected with the installation of the systems included in the Contract. He shall give all necessary notices to authorities having jurisdiction and shall be responsible for complying with all applicable public ordinances.
3. The materials, equipment and installation shall comply with the regulations laid down by the Electricity Authorities.

1.1.2 Offices and Services Provided by the Contractor

1.1.2.1 Contractor's Own Staff and Personnel

The Contractor shall provide all necessary offices, social premises, accommodation and other necessary facilities for his own and any other personnel under his control working on the Contract.

1.1.2.2 Offices for the Engineer

With effect from the Commencement Date of the Contract the Contractor shall provide an adequately furnished, lockable site office with surface of not less than 10 sqm, for the sole use of the Engineer and his staff. Adequate (more than 300 Lux) electrical lighting and heating shall be provided.

The Office shall include the following:

- (1) One (1) ink jet or laser A3/A4 format

The Contractor shall maintain and service the office and furniture and pay the cost of all electricity and water for the duration of the Works.

All the above-mentioned office furniture and equipment shall be returned to the property of the Contractor upon the satisfactory completion of the work.

1.2 INFORMATION AND OBLIGATIONS RELATING TO SITE ARRANGEMENTS

1.2.1 Working Conditions

- (2) The work shall be carried out during normal working hours and if the work is temporarily performed as over-time work, the performance and supervision of work has to be agreed upon with the Engineer in advance;
- (3) First-aid facilities shall be provided by the Contractor;
- (4) The Contractor shall provide safety and protective clothing for persons under his control on the Site;
- (5) The Contractor shall organise the Site and his methods of working such that all are safe;
- (6) Adequate lighting of the work places and Sites shall be provided by the Contractor; and

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 36 of 79

(7) Fire-fighting equipment shall be arranged by the Contractor.

1.2.2 Safety Regulations and General Order of the Site

1. The Contractor shall be fully responsible for complying with the safety regulations and requirements for general order on Site in accordance with the applicable laws, regulations, instructions of the local authorities and as provided in the Contract.

2. The Employer will notify the Contractor in full of the safety regulations which the Employer imposes on his own employees and the Contractor shall comply with such regulations.

3. The Contractor shall inform the Employer in writing in full of any special risks anticipated during the execution of the Works.

4. For each working area the Contractor shall designate a foreman who will, besides supervision of the work in progress, be responsible for safety and security in the working area.

5. The Employer's property, such as machines and instruments, shall when necessary be protected against damage.

6. The following noise levels measured at a distance of approximately 1m from mechanical and electrical facilities are permitted for the following standards and regulations:

- | | |
|---------------------------------------|------------|
| (1) Hydraulic and pneumatic equipment | max. NR 80 |
| (2) Gears and drives | max. NR 80 |
| (3) Water pumps | max. NR 80 |
| (4) Rotary piston blowers | max. NR 85 |

where NR 80 and 85 are noise rating numbers of the EN ISO 8253 Standard 1998.

1.2.3 Standards, Weights and Measures, Abbreviations, Labelling and Symbols

1. All material and equipment shall be referred to in the metric/SI international standards with regard to their weights and measures.

2. All Plant, materials and workmanship unless otherwise specified shall be in accordance with EN standards where such standards or recommendations exist.

3. In the absence of applicable EN standards or recommendations, the workmanship and material shall comply with the relevant and latest editions of the standard specifications and codes of practice issued by the following organisation:

Name of Organisation

Address

International Organisation for Standardisation

P.O. Box 56, 1211 Geneva 20,
Switzerland

3. In the absence of applicable EN and ISO standards or recommendations, the workmanship and material shall comply with the relevant equivalent Standards of other European countries, eg BS, DIN, ONORM, etc.

4. The Contractor shall provide on Site within 28 days after the Commencement Date, English versions of all international standards and codes to be used in the implementation of the contract. Upon completion of the Contract these standards shall remain the Contractor's property.

6. Pipes and valves shall be labelled to indicate the direction and type of flowing substance in the system. The size and shape of the label shall be as defined in EN standards. All text shall be in English and Greek.
7. Machines, equipment, control valves and panels shall be fitted with a non-corrosive label setting out the item number, make, model, serial number, key performance data and the like.
8. Warning signs and colours shall be no substitute for protective appliances and devices. The warning signs and colours shall all be approved by the Engineer. Warning signs and colours where used shall warn about:
 1. danger of explosion or fire in the area;
 2. noise which exceeds safety levels;
 3. poison or toxic substance if stored in the area, including first aid instructions;
 4. automatically started and operated appliances;
 5. appliances having moving parts which can cause accidents;
 6. structures which obstruct the walkways; and
 7. danger of slip or fall.

1.3 Setting out

1. The Engineer will provide to the Contractor all data relating to the bench marks used in the design of the Facilities.
2. The Contractor is responsible for setting out all additional traverse points and bench marks required in the working area at the commencement of his work.
3. The Contractor shall take care that the location and level of the traverse points and bench marks are not changed during the construction. When the traverse points or bench marks occur in areas to be built up, the Contractor shall establish new traverse points and bench marks before abandoning the old ones. The Contractor shall submit the calculations and measurements of the new traverse points and bench marks for the approval of the Engineer and no original traverse points or bench marks shall be destroyed without approval by the Engineer.
4. The accuracy of the new points shall be the same as that of the original traverse points and bench marks.

1.4 PROTECTION REQUIREMENTS

1.4.1 General

The Contractor shall be responsible for protection against vandalism, theft or malicious mischief of all of the Facilities at all times from the start to completion of the facilities.

1.4.2 Underground Services

1.4.2.1 General

1. Before starting any construction at the Site the Contractor shall arrange with the Employer and owners of the underground services to show and/ or locate their services so as to avoid damage during construction.
2. The Contractor shall temporarily support all underground services during the excavation of and whilst working in trench and also provide permanent and adequate support for services as required and all costs associated with this are deemed to be included in the Contractor's rates and prices.

1.4.2.2 Unknown Underground Services and Installations

1. The Contractor shall take all reasonable precautions, including but not necessarily limited to the use of cable detection equipment, to ensure that unknown underground services within and near the confines of excavations are detected and safeguarded from damage.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 38 of 79
	Technical Specifications	

2. If, despite such precautions having been taken, damage to unknown underground services occurs, the Contractor must take appropriate measures to minimise such damage and immediately inform the Engineer and the owner or Responsible Authority.

3. If the Engineer so instructs, after consultation with the owner or Responsible Authority, the Contractor shall make good the damage in a manner and at times to be approved by such Authority or owner or the Engineer. Payment for such additional work will be made in accordance with the Contract, provided always that the necessity for such repair work has not arisen due to the fault of the Contractor.

4. However, if the Contractor fails to take appropriate precautions and damage to unknown underground services occurs as a result of such negligence, then the Contractor will be held responsible for making good the damage, as if presence of the service had in fact been known beforehand.

1.4.2.3 Known Services and Installations

1. The Contractor shall take every precaution to ensure that all known existing services, pipes, culverts, cables, boundary walls and fences, retaining walls, drainage and irrigation ditches and the like, within and near the confines of excavations are located, supported and safeguarded from damage. Any damage caused to any such services, pipes, culverts, cables, boundary walls and fences, retaining walls, drainage and irrigation ditches and the like attributable to the Contractor's operations, his constructional traffic or his negligence shall be made good by or for the Contractor at his own expense to the satisfaction of the Engineer, owner or Responsible Authority.

2. In the event of the owner or Responsible Authority electing to repair such damage, the Contractor shall pay the cost of doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented, the Employer reserves the right to settle the account and deduct the sum paid by him from money due or which may become due to the Contractor.

1.4.3 Temporary Removal of Existing Services

1. If it should become necessary for the proper execution of the work to temporarily remove or divert any existing pipe, sewer, field drain cable, drainage or irrigation ditch or other service, the Contractor shall obtain permission from the Responsible Authority or owner or Engineer and shall carry out the work at his own expense in a manner and at times to be approved by such Authority or owner or the Engineer and shall subsequently reinstate the work to the satisfaction of such Authority or owner or Engineer.

2. In the event of the owner or Responsible Authority or Engineer electing to arrange for the temporary removal of an existing service, the Contractor shall pay the cost of his or their doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented, the Employer reserves the right to settle the account and deduct the sum paid by him from money due or which may become due to the Contractor.

3. The Contractor's attention is particularly drawn to the requirement to maintain drainage and irrigation ditches in order to avoid any interruption of flow of water therein to the satisfaction of the Engineer, owner or Responsible Authority and the Contractor shall be deemed to have included in his rates and prices for all temporary works so required.

1.4.4 Permanent Diversion of Existing Services

1. If, in the opinion of the Engineer and / or of the Responsible Authority or owner, it should become necessary to permanently remove or realign any existing pipe, sewer, field-drain, cable, ditch or other service, other than allowed for in the Bill of Quantities, the Contractor shall obtain permission, where necessary from the Engineer or Authority or owner and shall carry out and complete the work to the satisfaction of the Engineer and such Authority or owner. Payment for such additional work will be made in accordance with the Contract, provided always that the necessity for such permanent diversion has not arisen due to the fault of the Contractor.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 39 of 79
	Technical Specifications	

2. In the event of the owner or Responsible Authority electing to arrange for the permanent diversion of an existing service, the permanent diversion of which has become necessary due to the fault of the Contractor, the Contractor shall pay the cost of them doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of the account being presented, the Employer reserves the right to settle the account and deduct the sum paid by him from moneys due or which may become due to the Contractor.

1.4.5 Permanent Support for Existing Services, Etc

If, in the opinion of the Engineer and / or the Responsible Authority or owner, it should become necessary to provide permanent support for any existing pipe, sewer, cable, structure or other things exposed or injured during or after the execution of the Works, the Contractor shall carry out promptly such additional works as the Engineer may require to provide such permanent support.

1.4.6 Responsible Authority or Owners May Carry Out Work

Any of the work involving repair, replacement or realignment of existing pipes, sewers or other services may be carried out by the Responsible Authority or owner if they so desire. In such case, the Contractor shall allow them the facilities and assistance they may require and shall bear the full expense of work except in the case of permanent removal or re-alignment which will be paid for by the Employer, provided that the necessity for such removal or re-alignment has not arisen due to the fault of the Contractor.

1.4.7 Care of Boundary Walls and Fences

1. The Contractor shall not cut through or remove any section of any boundary wall or fence without the prior approval of the Engineer who will determine the limits of such cutting or removal.
2. Approval for the cutting through or removal of boundary walls and fences will normally be limited to those crossing the route of mains and pipelines and the Contractor shall so conduct his operations as to minimise the extent of such cutting through or removal.
3. The Contractor shall repair and reinstate in a manner similar to the original or by other approved means any wall or fence which he may have cut through or remove with or without the approval of the Engineer or damaged during his operations and all such repairs and reinstatement shall be the Contractor's sole liability and shall be carried out to the satisfaction of the Engineer and the Responsible Authority.
4. The Contractor shall, at his own expense, provide temporary fencing and security measures at all times to protect any affected properties.

1.4.8 Protection of Property

1. The Contractor shall be responsible for the preservation and protection of property, private or public, on or adjacent to the work Site against damage or injury as a result of his operations under this Contract.
2. Any damage or injury occurring on account of any act, omission or neglect on the part of the Contractor shall be restored in a proper and satisfactory manner or replaced by and at the expense of the Contractor to an equal or superior condition than previously existed.
3. The Contractor shall restore all surfaces and property damaged or disturbed by his operations and shall bear full responsibility for the protection of all finished exterior and interior surfaces, fixtures and equipment from stains, marks, dirt or damage of any kind whatsoever from the time of their construction, finishing or installation until the time of handing over.

Technical Specifications

4. In the event of any claims for damage or alleged damage to property as a result of work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defence against such claims. Prior to commencement of work in the vicinity of property adjacent to the work Site, the Contractor at his own expense shall take such surveys as may necessary to establish the existing condition of the property. Before final certificate can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled.

1.4.9 Pre-inspection/Approval Requirements

Before requesting an inspection of the completed works, the Contractor shall do all necessary cleaning, making good, and touching up that may be required to leave all finished surface, fixtures and equipment in accordance with the full intent and meaning of these specifications.

1.4.10 Open Excavations

1. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, cones and warning lights to prevent accidents to persons, and damage to property. All signs with script shall be in both Palestinian and English language and shall comply with regulations of the local authorities.

2. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles which could be dangerous to the public shall be well illuminated from half an hour before sunset until half an hour after sunrise and other times when the visibility is poor. The position and the number of lamps shall be such that the extent and position of the works is clearly defined.

1.4.11 Fire Protection

1. Contractor shall take all necessary precautions to prevent fires at or adjacent to the work, buildings, etc, and shall provide adequate facilities for extinguishing fires which may occur. No burning of trash or debris will be permitted at the Site.

2. When fire or explosion hazards are created in the vicinity of the work as a result of the locations of fuel tanks, or similar hazardous utilities or devices, the Contractor shall immediately alert the local authorities and the Engineer of such hazards. The Contractor shall exercise all safety precautions and shall comply with all instructions issued by the local authorities and the Engineer to prevent the occurrence of fire or explosion.

1.4.12 Explosives and Blasting

1. The Contractor shall be allowed to use explosives only in open, rural areas and with the express permission of the Engineer. After having obtained the said permission, all blasting shall be done only by properly trained and qualified workmen under the supervision of an experienced foreman, who shall be in possession of an official and authenticated current blasting certificate.

2. The Contractor shall provide a special store for explosives in accordance with existing regulations. Transporting and storing of explosives and blasting shall also be in accordance with the Laws regulating their use.

3. The greatest care shall be taken when blasting to protect persons, the works and any other property. No blasting shall be done within 10 m of any existing structure. The last 15 cm of rock above foundation level shall be removed by use of power tools or by hand.

1.4.13 Tree and Green Area Protection

The Contractor shall not be allowed to remove, relocate, or cut down any trees located in public areas without the approval by the Engineer. It shall be the Contractor's responsibility to protect all existing trees and green areas located in his working area. If in the opinion of the Engineer a tree or a green area has been unnecessarily destroyed or

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 41 of 79
	Technical Specifications	

damaged to any degree by the Contractor then the Contractor shall replace the damaged tree and/ or green area with a new one of equal quality and characteristics.

1.4.14 Safety Precautions

1.4.14.1 Safety Programme and its Implementation

1. Within fourteen (14) calendar days from the date of receipt of Notice to Commence the Contractor shall submit in writing his proposal for a comprehensive safety programme covering all aspects of the Works.
2. This safety programme shall detail policies, procedures, and plans which the Contractor intends to implement to insure the safety and health of his employees. It shall comply with the standards listed below.
3. The Contractor shall designate a competent engineer especially trained and experienced, to act as Safety Officer, who will administer and be responsible for the implementation of the Safety Programme. He shall carry out frequent and regular safety inspections on the working areas, materials and equipment. The name and qualifications of the Safety Officer shall be submitted for approval to the Engineer prior to his appointment.
4. The Contractor shall be responsible for enforcement of the health and safety provisions by his subcontractors, if any, to be employed at the Site.

1.4.14.2 Safety Standard

In addition to the requirements specified herein, the Contractor shall comply with the national safety requirements

1.4.14.3 Personal Safety Equipment

1. The Contractor shall provide his personnel and visitors with appropriate safety equipment, such as helmets, safety footwear, gloves, waterproof clothing, dust masks and safety belts. The use of such safety equipment shall be compulsory.
2. Emergency equipment such as explosion proof lamps, gas masks, signalling devices, flashlights in good working conditions, etc. shall be stored in the Contractor's office.

1.4.14.4 Power Supply and Lighting

1. All working sites in the open, transit areas, excavation sites, etc. shall be adequately illuminated during night work, as specified above.
2. Electrical cables shall be well insulated, protected and firmly fixed by means of adequate insulators. Lamps shall be well protected against damage.
3. All equipment and appliances which are exposed to lightning shall be earthed electrically, and the effectiveness of such earthing shall be periodically checked by the Contractor's specialised personnel.

1.4.14.5 Fire Precautions

The Contractor shall organise a fire brigade equipped for the fighting of any fires which may break out on the construction sites, in temporary structures, stores, residential quarters, etc. An adequate number of fire extinguishers shall at all times be available at each construction site or camp and shall be maintained in satisfactory working order. Fire protection facilities shall be of the gas, dry powder or other suitable chemical or pumped water type. Their number, type and location will be subject to the approval of the Engineer.

1.4.14.6 Dust Abatement

During the performance of the works and any operations appurtenant thereto, the Contractor shall carry out proper and efficient measures, such as sprinkling by water or by other means, whenever and wherever necessary to reduce the dust nuisance, and to prevent dust which has originated from his operations from damaging crops, cultivated fields and

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 42 of 79
	Technical Specifications	

dwelling, or causing a nuisance to persons. The Contractor will be held liable for any damage resulting from dust originating from his operations.

1.5 MATERIALS AND EQUIPMENT, APPROVALS AND SUBSTITUTIONS

1.5.1 General

The Contractor shall state the particular materials and equipment offered to satisfy the Specifications. Manufacturer's catalogues, technical data and samples when appropriate, shall be submitted. This technical documentation will assist for approval of the Engineer for materials and equipment to be supplied/ built in.

1.5.2 Substitutions

1. Unless otherwise specified, all materials and equipment incorporated in the work under the Contract shall be new.

2. Whenever specific references are made in the Specifications, to manufacturers or brand names, or standards, the intent is to establish a standard of type, quality and function of the required material or equipment. The products of the manufacturers must be equivalent to the product so specified. The fact that one or more manufacturers might be listed in a List of Approved Sub-contractors, Suppliers and Vendors, shall not relieve the Contractor of the responsibility for providing materials complying with the Technical Specifications. The fact that manufacturers' names are specified or approved for any item shall not be construed as implying that such item need not comply with the performance, construction or other requirements specified for the item. In all cases, the Technical Specifications requirements shall take precedence over the manufacturers' standard.

3. Only those products originally specified and/ or approved upon the Contractor's requests as substitutions may be used in the work. Whenever requests for substitutions are approved, it shall be understood that such approval is conditional upon strict conformance with all requirements of the Contract and further subject to the following:

- (1) Any material or article submitted for approval in accordance with the above procedure must be equal, in the sole opinion of the Engineer, to the material or article specified. It must be readily available in sufficient quality and quantity not to delay of any work, inspection or tests; it must be available in a reasonably equivalent range of colours, textures, dimensions, gauges, types and finishes as the material or article specified; it must be equal to the specified item in strength, durability, efficiency, serviceability, compatibility with existing systems, ease and cost of maintenance; it must be compatible with the design; its use must not impose additional work, or require changes in, the work of any other Contractor without the written agreement of such Contractor.
- (2) Request for all substitutions shall be accompanied by all information needed for the Engineer to make an evaluation, including manufacturer's brand or trade names, model numbers, description or specification of item, performance data, test reports, designs, calculations, samples, history of service, and other data as applicable.
- (3) Additionally the Contractor shall revise and provide to the Engineer for approval all drawings that are affected by any request for substitution.
- (4) All requests for substitution of materials or other changes from the Contract requirements, shall be accompanied by an itemised list of all other items affected by such substitution or change. The Engineer shall have the right, if such is not done, to rescind any approval for substitutes or changes and to order such work removed and replaced with work conforming to requirements of the Contract, all at the Contractor's expense, or to assess and charge all additional costs resulting from the substitution to the Contractor.
- (5) All substituted manufactured articles, materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with the manufacturer's printed instructions, unless otherwise specified.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 43 of 79
	Technical Specifications	

- (6) The Contractor shall have and make no claim for an extension of time or for damages by reason of the time taken by the Engineer in considering a substitution proposed by the Contractor or by reason of the failure of the Engineer to approve a substitution proposed by the Contractor. Any delays arising out of consideration for an approval of a substitution shall be the sole responsibility of the Contractor requesting that substitution and he shall arrange his operations to make up the time lost.
- (7) Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

1.5.3 Storage and Protection of Equipment and Materials

The Contractor shall minimise the storage periods for material and equipment at the Site by scheduling deliveries to coincide with construction needs. The Contractor shall not store unnecessary materials or equipment at the Site and shall take care to prevent any structure from being loaded with a weight which will endanger its integrity or the safety of persons. The Contractor shall post and follow regulatory signs for allowed loading on structures and other safety precautions. The Contractor shall obtain from the manufacturers information detailing the method of storage and the maintenance of the stored items and shall comply with these requirements. Any costs associated with the storage and protection of materials and equipment shall be deemed to be included under the Contract and no additional payment will be made. No material shall be brought to the Site until the following conditions are met:

- (1) The manufacturer's recommendation for Site storage have been received by the Engineer; and
- (2) The area in which the material is to be stored is identified and approved by the Engineer.

1.5.4 Installation and Testing of Equipment and Construction Work

1.5.4.1 General

1. The Contractor shall have on hand sufficient qualified personnel, proper equipment, and machinery to facilitate the work.
2. The Contractor shall be responsible for locating, aligning and levelling and shall employ an experienced surveyor to set all lines and levels to the accuracy required.
3. Complete manufacturer's installation instructions, including permissible tolerances, shall be furnished with the shop drawings.
4. All work shall be installed in accordance with the drawings; inclusive of manufacturer's specifications, drawings and tolerances.
5. Testing procedures and methodology to be adopted shall be submitted to the Engineer for approval before any tests commence.

1.5.4.2 Damage During Tests and Training Periods

The Contractor shall be fully responsible for the proper operation of the Works during tests that are carried out on it and during the training with it.

1.5.4.3 Services of Manufacturers' Specialists

The contract price shall include when required by the manufacturer all costs of furnishing manufacturer's specialists to the Project Site for:

- (1) Assisting the Contractor to install, adjust and/ or test the equipment in conformity with the Contract; and
- (2) Supervising start-up operations and adequately instruct the employees of the Employer in the proper operation and maintenance procedures.

1.5.4.4 Tests in General

1. Various clauses of the Technical Specifications state the types of tests which the Contractor shall carry out for the quality control of the Works, together with the frequencies at which each type of test shall be conducted. The Contractor's attention is drawn to the fact that the frequencies of testing specified in the relevant clauses are intended to represent only a general guide. Subject to SCC and GCC the Engineer shall be empowered to vary the frequencies at which tests are conducted should he deem this necessary for the proper control of the quality of the Works.
2. For manufactured materials or goods the Contractor shall obtain Test Certificates which are representative of the delivered materials or goods from the suppliers of such materials and shall send two copies of certificates to the Engineer. Such certificates shall certify that the materials or goods concerned have been tested in accordance with the requirements of the Contract and shall give the results of all tests carried out. The Contractor shall provide adequate means of identifying the materials and goods delivered to the Site with the corresponding certificates.

1.5.4.5 Testing of Mechanical and Electrical Equipment

(1) General

1. Testing of all equipment shall be carried out in accordance with the requirements of all the relevant standards.
2. Where tests and inspection have been completed to the Engineer's satisfaction and when the test certificates, curves, etc. have been checked, the Engineer will confirm approval in writing and none of the equipment shall be incorporated in the Facilities or delivered until this approval has been received.
3. Two copies of all test certificates and curves shall be supplied to the Engineer within two weeks of any witness tests.
4. Where witness tests are not required the test certificates and curves shall be forwarded to the Engineer within four weeks after the decision to waive witness tests has been received.
5. All apparatus, instruments and connections required for the tests of the Facilities shall in all respects comply with the appropriate safety regulations and/ or requirements regarding electrical apparatus for the safety of the Facilities and the persons working thereon.

(2) Site testing and commissioning

In the field the vibration amplitude due to the physical imbalance of rotating parts of the pumps, measured at top of electric motor and pump bearings, shall not exceed the requirements of the Hydraulic Institute Standards for horizontal, centrifugal and vertical turbine pumps. The vibration shall be measured at rated speeds and within plus or minus ten percent (10 %) of rated capacity. Sound levels shall not exceed 85 decibels for the motor measured at a distance not exceeding 1.5 m from any point of the motor.

1.6 CLEANING

1.6.1 General

1. The Contractor shall remove from the Site and dispose of, all debris and rubbish resulting from his work at least once a week and more often if the same interferes with the work under any contract or the work of other service, or presents a fire or accident hazard.
2. The Contractor shall thoroughly clean and eliminate mortar droppings, marks of concrete leakage, formwork marks, tar spatters and paint droppings.
3. All debris, rubbish and scrap pieces resulting from clean-up operations shall become the property of the Contractor and shall be removed from the Site in such a manner as to create no nuisance in the streets nor to the adjoining property owners and legally disposed of.

Technical Specifications**1.6.2 Final Cleaning**

After completing and testing a section of the Facilities the Contractor shall remove all rubbish and excess material from and about the Site including all temporary structures, construction signs, tools, scaffolding, materials, supplies and construction machinery or equipment which he or any of his subcontractors may have used in the performance of the work. The Contractor shall clean all the Works and leave the Site in a neat condition.

1.6.3 Employer's Right to Clean

Should the Contractor fail, refuse or neglect to remove rubbish and waste materials and temporary work or clean the paved areas or pedestrian sidewalks as required herein, then the Employer may or shall, without obligation to do so, remove and dispose of the said rubbish, waste materials and temporary work, clean the paved areas or pedestrian sidewalks and deduct the cost thereof from any money due, or to become due to the Contractor under this Contract.

1.6.4 Final Cleaning Timing Constraints

Final cleaning of work areas shall be finished within seven (7) days of reinstatement of the surfaces.

1.7 SITE RECORDS AND PROGRESS PHOTOGRAPHS OF THE WORK

1. The Contractor shall ensure that records to the Works are kept up to date. These records shall include labour, plant, material on site, excavation, additional work ordered, price fluctuation if applicable, etc.
2. The Contractor shall take a series of colour digital photographs illustrating the progress of the work. The electronic files in JPEG format shall be supplied on CD-ROM, together with a Word file including a complete listing of all photographs and captions, as required below.
4. All photos should be numbered consecutively throughout, indicating clearly the section of the plant which are referred and the date of execution.

1.8 AS BUILT DRAWINGS

1. The Employer shall furnish to the Contractor a CD-ROM or USB files (that contain the Drawings prepared by Auto-CAD®) of the Drawings.
2. The Contractor shall maintain a set of prints of the construction drawings. A daily record in red shall be kept on these prints of the work installed and all modifications or changes therein. This set of prints shall be available at all times for inspection. In addition to the new construction the Contractor shall record on these prints all other information encountered during excavation. During the progress of the Works the Contractor shall transfer once a month all information from the aforementioned set of prints to the negatives or Auto-CAD® files and submit to the Engineer two prints showing the work completed and highlighting the changes made.
3. All additional work installed shall be shown on as-built drawings to a scale of at least equal to the scale of the Drawings. These additional drawings shall be negatives and shall be referenced to and on other drawings to show the area covered. The sheet size of the additional drawings shall be maximum A1.
4. Upon completion of all work the Contractor shall produce digital files in CAD and PDF format, and n°1 hard copy, signing each drawing indicating that the work was installed as shown.
5. The "As Built Drawings" shall include all information recorded on the aforementioned set of prints and any other modifications that occurred during the Contract. The "As Built Drawings" shall be A1 size. If not otherwise agreed the Works shall not be considered to be completed for the purposes of taking over until As-Built Drawings have been submitted to and approved by the Engineer.

Technical Specifications**1.9 TEMPORARY WATER, POWER AND SANITARY FACILITIES****1.9.1 General**

1. All temporary facilities shall be provided by the Contractor in a manner as hereinafter specified. The Contractor shall co-ordinate and install all temporary facilities in accordance with the requirements of the local authorities or utility companies having jurisdiction and in accordance with all local codes and regulations.

2. All costs in connection with the temporary facilities including but not limited to, installation maintenance, relocation and removal shall be borne by the Contractor.

1.9.2 Temporary Water

1. The Employer will make water available for construction purposes.

2. The Contractor shall bear all the related costs.

1.9.3 Temporary Wastewater and water Piping

The Contractor shall provide and pay for all temporary piping arrangements including pumping, if any, for temporary conveyance of wastewater or water during the construction works to the satisfaction of the Employer. The arrangements shall be submitted in advance to the Employer for approval.

1.9.4 Temporary Power

The Contractor, at his own expense, shall furnish install, operate and maintain all necessary temporary power system required for construction, field offices and testing purposes. The Contractor shall make all the arrangements with the local Electrical Network Company for the temporary electrical power. The Contractor shall pay the local Electrical Network Company for all charges for service connection and furnish all labour, material and equipment for the installation of the temporary power supply. The Contractor shall de-energise and remove the temporary power supply system in co-ordination with the local Electrical Network Company upon the completion of the work in the area. When the temporary power system utilises engine generators stations, then these stations shall be acoustically shielded with special enclosures from neighbouring residences.

1.9.5 Sanitary Services

The Contractor shall provide and pay all costs for temporary toilet and washroom facilities in sufficient numbers for his employees. The facilities shall be maintained in clean condition and sewered in a satisfactory manner.

1.10 PROJECT PLANNING**1.10.1 Form of Progress Planning Schedule**

1. A schedule shall be prepared based on a Network Analysis Critical Path Program or equal in the form of a bar chart showing in detail the proposed sequence of the work and identifying construction activities for each structure.

2. The schedule shall be time scaled, identifying the first day of each week, with the estimated date of starting and completion of each stage of the work.

3. The schedule shall be comprehensive and shall cover all portions of the work. The Contractor shall supply information including work activity descriptions, sequence of work and time estimates for each activity.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 47 of 79

1.11 ENVIRONMENTAL ISSUES.

The construction works will cause nuisances and disturbances to the public. This fact shall be recognised by all parties involved in the Project. As a consequence it is an essential requirement that the Contractor shall minimise and mitigate the negative impacts of the construction.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 48 of 79
	Technical Specifications	

2 DEMOLITION AND SITE CLEARANCE

2.1 SITE CLEARANCE

1. The scope of Site clearance work is to remove from the Site all obstructions, which may affect the execution of the Works. Any pipeline route or other site to be excavated shall be cleared and grubbed of bush, roots, stumps, vegetation and surface obstruction.
2. Clearing and grubbing up shall consist of clearing the Site of all trees, bushes, other vegetation, roots and other objectionable material.
3. No trees shall be felled, destroyed or interfered with by the Contractor without the approval of the Engineer. Trees shall be uprooted or cut down as near to ground level as possible only where directed by the Engineer. Branches and foliage shall be removed and burnt to ash or disposed of off Site. Useful timber shall remain the property of the Employer and shall be cut into suitable lengths and stored properly at the Site.
4. Stumps and roots whether existing or remaining after tree felling shall be grubbed up and disposed of off the Site. The resulting pits shall be filled with approved material and compacted to the same dry density as the surrounding soil.
5. Material suitable for landscaping shall be stockpiled at the Site. Other material shall be disposed of by the Contractor. All debris shall be removed from the Site and disposed of by the Contractor in a satisfactory manner. The Contractor is responsible for all costs associated with disposal of materials.
6. Materials and structures temporarily removed for later reinstatement and restoration shall be properly stored and protected.

2.2 DEMOLITION of STRUCTURES

1. The Engineer must be given 14 days notice in writing of any proposal to demolish or dismantle all or any part of any existing structure on the site which is necessary for the completion of the works.
2. The Contractor shall give the Engineer an explanation of the method and order of demolition and the steps taken to ensure the safety and stability of any remaining structure affected thereby.
3. Unless the due notice is given, the Contractor shall not be entitled to any claim for delay in his construction programme owing to the refusal of permission to demolish or dismantle the said structures.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 49 of 79
	Technical Specifications	

3 EARTHWORKS – EXCAVATION, FILLING, COMPACTION, DISPOSAL AND LANDSCAPING

3.1 Scope of Work

Under this section the Contractor shall furnish all labour, equipment and materials required to complete all excavation, backfill, drainage layers beneath and around structures, embankments, removal of all surplus excavated material, compaction beneath foundations and roadways, site grading, construction (or reconstruction) of road pavement, in-situ compaction, disposal of all unsuitable materials and the like and all other related and incidental work as required to complete the work in an acceptable manner, in accordance with the Contract Documents and as may be required by the Engineer.

3.2 LEVEL OF THE COMMENCING SURFACE

Before any excavation work commences, the Contractor shall agree with the Engineer the level(s) of the Commencing Surface (usually the original ground level(s)).

3.3 FOUNDATION METHODS

3.3.1 Excavation for foundations

1. All excavations for foundations, shall be carried out to the lines and limits shown on the drawings, or defined in the Specification. Said lines and limits may be amended by the Engineer to suit soil and other conditions encountered during actual excavation and field inspection. When excavating in any material other than rock for formation levels under any structure, the last 15 cm of excavation shall be taken out not more than 24 hours before placing of foundations. The bottoms of excavations shall be levelled and trimmed to full width to required lines and levels and shall be well watered and rammed before placing of concrete.

2. The Contractor shall well and effectively hold up the sides and ends of all trenches and excavations wherever necessary with strong, close timbering, and shall prevent any fall or run of earth or sand from any portion of the ground outside of the excavation. If, despite such precautions, or by reason of their neglect, any portions of the bottoms sides or ends of any excavations shall give way or be excavated without instructions from the Engineer, the Contractor shall at his own expense excavate and remove all the ground thereby disturbed both within and without the limits of the excavation.

3. Should the Contractor exceed in depth or extend the excavation of the formations or be ordered to take out extra excavation for the reasons given above, no payment will be made for such extra excavation, and he shall, if ordered by the Engineer, make it good with well rammed fill or in such class of concrete as may be ordered by the Engineer and at the Contractor's expense.

4. Should any existing subsoil or field drains be uncovered during any excavation, the Contractor shall carefully replace them when backfilling or, if this is impossible, he shall divert them to new drains or ditches, otherwise relay them as the Engineer may direct.

5. Before commencing any building work, all shattered and loose material must be removed by hand, the excavation being performed in such a manner as the Engineer shall direct so as to ensure that the work sits on an absolutely solid and clean foundation or abuts tightly against solid ground. In no case must concrete be placed in an excavation until the surface onto which such concrete is to be placed has been approved by the Engineer.

3.3.2 Preparation of Foundation

1. The Contractor shall prepare the areas of excavations against which concrete is to be placed or on which pipes are to be laid, in a manner suitable for forming a foundation. Foundations in earth upon which concrete is to be placed shall be finished accurately to the dimensions shown on the Drawings or prescribed by the Engineer, brought to proper moisture content by sprinkling as required, and thoroughly compacted with suitable tools. No boulders shall be left projecting within the minimum excavation lines shown on the Drawings.

2. Foundations for concrete on bedrock shall be trimmed to the prescribed lines, thoroughly cleaned of mud and debris, and moistened in advance of placing concrete. All foundation surfaces shall be free from pools of water at the time of placing concrete. Wherever any excavation in earth has been made below grade without the Engineer's instructions, it shall be refilled at the Contractor's expense.

3.4 TESTING FACILITIES

1. The Contractor shall perform the tests required by the Contract, at his own expense, at the frequencies specified therein and he shall be responsible for his own quality control of the works. Two copies of the results of each test performed by the Contractor in a form approved by the Engineer shall be submitted to him. The third copy of the test results of each test shall be retained on Site for as long as the Engineer may require.

2. The Contractor shall provide on the Site, maintain and remove as provided elsewhere in the Contract a laboratory including all necessary materials, equipment and tools needed for his own testing of materials. The Contractor's site laboratory shall be provided with all equipment needed to carry out the testing required under this Contract. The testing that cannot be performed in the Contractor's site laboratory shall be carried out in other laboratories, which must meet the Engineer's approval.

3. The laboratory shall be adequately staffed and so equipped that no interruption occur to the progress of the Works as a result of the need to carry out tests required under the Contract. The laboratory staff shall include a technician suitably qualified and experienced in the testing of soils, concrete and bituminous materials and a sufficient number of assistants.

4. Without relieving the Contractor of his responsibilities under the Contract, the Contractor shall perform any additional tests, which the Engineer may require and/ or repeat tests the results of which, in the opinion of the Engineer are not representative.

3.5 EARTHWORKS

3.5.1 Working Width or Area

In working in existing roads or streets the working width shall not exceed one half the total width of the road including any sidewalks or verges of the road and notwithstanding this requirement, the traffic flow shall be maintained at all times unless approved detours are provided by the Contractor.

3.5.2 Embankments and General Fill Areas

1. Where the filling of the Site is needed to achieve the final levels, all necessary clearing and grubbing up shall have been carried out and loose and soft material shall be removed before filling commences. Embankments shall be made to the lines and grades or levels as shown on the working drawings. The fill material shall be placed in horizontal layers not exceeding 200 mm thick. The layers shall be compacted by methods appropriate to the degree of compaction required.

2. In areas that are to receive permanent work the elevation of general fill shall be the underside of such permanent work. In areas not to receive permanent work filling shall be to the levels shown on the drawings.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 51 of 79

3. The material for embankment and general fill shall be granular, suitably graded for the specified compaction required and shall not contain organic matter or more than 15% clay or silt by weight.

3.5.3 Excavation

1. Excavation shall include the excavation of all materials of whatever nature encountered as required to complete the work. The construction methods used shall be to the approval of the Engineer.
2. Excavation shall be carried out to the lines, levels, dimensions, and depths indicated on the Drawings or in the Technical Specifications or as directed by the Engineer.
3. The Contractor may carry out trial pits excavation as he considers necessary. The work involved in test pits shall include the digging and reinstatement of the test pits and the determination of the position and elevation of existing pipes, sewers, conduits and the like, and shall be at his own expense unless specifically instructed in writing by the Engineer.
4. All excavation shall be carried out in such a manner as to create a minimum of inconvenience and interference with traffic and with access to buildings or other properties. All excavated material shall be piled in a manner that will not endanger the work or the personnel engaged therein or third parties and will avoid obstructing sidewalks and driveways or rest on permanent structures.
5. To provide the public with the necessary safety and protection, the Contractor shall at his expense provide barricades, lights, warning signals, guard rails and crossings over trenches to the satisfaction of the Engineer and in accordance to the other applicable sections of the Specifications.
6. Where required, and where otherwise necessary to prevent caving in of trench sides or to protect adjacent utility services, excavation shall be adequately supported.

3.5.4 Excess Excavation

1. Excess excavation is defined as excavation outside the measurement lines as indicated on the Drawings or as specified herein. The Contractor shall not be entitled to any payments for such excess excavation or filling of excess excavation unless such excavation was required by the Engineer.
2. Where excess excavation occurs the Contractor shall fill volume of overbreak with approved backfilling material compacted as specified for the material or with concrete as approved by the Engineer on a case by case basis.
3. Where the Engineer instructs the Contractor to vary the depth of excavations below the depth shown on the drawings or specified herein in order to obtain a sound and satisfactory foundation, the extra volume of material excavated and the extra volume of crushed, granular bedding or concrete fill shall be measured and an extra payment will be made based on the appropriate rates in the BoQ.
4. In the event excavation collapses in any manner due to any unforeseen reason it shall not be considered as excess excavation but the Contractor remains responsible for reinstating the excavation as specified. The Contractor is also responsible for making good any settlement of existing or reinstated road, street and/ or sidewalk surfacing as a result of similar unforeseen reasons.

3.5.5 Keeping Excavations Free of Water

The Contractor shall maintain all excavations or trenches free from water, including ground water, river water infiltration, surface water run-off or sewage and the like, regardless of the source and at his own expense. Water prevented from entering excavations by the Contractor shall be disposed of in a manner approved by the Engineer.

3.5.6 Backfilling and Surplus Excavated Material

1. Surplus excavated material shall be used for backfilling only with the approval of the Engineer.
2. If required all backfill material shall be piled neatly along the sides of excavations or trenches provided they do not unduly obstruct traffic or access to buildings or other properties.
3. Surplus excavated material shall be disposed of at the Contractor's expense.

3.5.7 Testing of Backfill Material and Backfilling

1. For each class of backfill material to be used representative samples selected by the Engineer shall be used for testing purposes. The tests shall be carried out at the Contractor's expense.
2. During backfilling, soil samples shall be taken as required by the Engineer to determine the density of the compacted backfill. If the density of the compacted backfill is less than that specified, additional compaction shall be carried out and no further backfill material shall be placed until satisfactory compaction of the material previously placed is achieved. If compaction is still not acceptable, the backfill material shall be removed to within 150 mm of the level of the last successful compaction test and additional compaction shall be carried out until a successful test is achieved. Only then additional backfill material shall be placed. Density tests shall be made as directed by the Engineer at the Contractor's expense.
3. Compaction tests on trench backfill shall be conducted by the Contractor at intervals of 50 m on average. For coarse materials the density may be tested with plate bearing tests.

3.6 EXCAVATION, BACKFILLING AND COMPACTION FOR STRUCTURAL WORKS**3.6.1 Buildings and Structures**

1. Filled areas shall be compacted so that the density is not less than 95 % of maximum dry density obtained from the modified Proctor Compaction Test. In addition the material shall be such that the bearing modulus is at least $E_1 = 25$ MPa as measured by plate bearing tests on the surface of the fill.
2. When natural sub-soil is fine-grained (clay, silt or silty sand) a geotextile filter membrane shall be installed between the filling material and the natural soil.
3. Foundations shall be excavated to the lines and grades or elevations as shown on the drawings. These shall be of sufficient size to permit the construction of the structures. Compacted gravel or a crushed material layer shall be placed under the footings and slab-on grades. The gravel or crushed material shall be uniformly graded with a grain size between 1 and 100 mm.
4. Final trimming of excavations to the final grade and level shall only be done immediately before foundations are to be placed in order to protect the final bottom of the excavation from adverse effects. The bottom of the excavation shall not be allowed to become flooded. Unsuitable material at the bottom of the excavation shall be replaced with compacted sand or gravel. This fill shall be placed and built up in horizontal layers not exceeding 150 mm depth per layer. Each layer shall be thoroughly compacted with mechanical tampers. No backfilling shall be carried out until authorised by the Engineer.
5. Backfilling around structures shall be in horizontal layers not exceeding 150 mm depth per layer. Each layer shall be thoroughly compacted with mechanical tampers. Backfilling shall be completed raised evenly around structures.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 53 of 79
	Technical Specifications	

3.6.2 Subdrains to Structures

Where required a subdrain system will be installed to structures as shown on the Drawings. Subdrains shall be perforated plastic of diameter not less than 100 mm and manholes shall be either of thermo plastics or concrete. The initial backfill around the pipes shall be at least 100 mm thick and comprise of a uniformly graded gravel/sand of maximum grain size 20 mm and with grains < 0.5 mm in size not exceeding 10% by weight.

3.6.3 Excavation and Filling for Subgrade

1. Work includes excavation, filling and compaction needed to construct the sub-grade of roads and other trafficked areas. All excavation and filling shall be made in accordance with the sections above.
2. Where excavation is required to permit pavement construction, the bottom of the excavation shall be graded so that the thickness of the pavement will be uniform.
3. The allowable tolerance of the level of an embankment and the bottom of an excavation is ± 50 mm. Fill material shall be sand having at least the following properties:
 - (1) fraction passing the 0.002 mm sieve shall be not be greater than 10%;
 - (2) fraction passing the 0.425 mm sieve shall not have liquid limit greater than 25% and plasticity index greater than 6%.
4. Fill material shall be compacted to a density of 90% of maximum dry density obtained from the modified Proctor Compaction Test.

3.7 EXCAVATION, BACKFILL AND COMPACTION FOR PIPE LAYING WORKS

3.7.1 Excavation of Trenches

1. Trenches and excavations for underground pipe networks, manholes and chambers shall be excavated to the lines and grades or elevations shown on the Drawings or as directed by the Engineer. The width of trenches on the centreline level of the pipe shall be at least equal to the outside diameter of the pipe plus 0.6m (measurement lines) unless otherwise shown on the Drawings.
2. Before commencing trench excavation the Contractor shall mark out the route of the pipelines accurately and jointly survey the natural ground level along the pipeline route with the Engineer.
3. Trenches shall be excavated to such depths as is required to obtain a minimum cover over the pipe. The depth of cover shall be measured from the final established grade to the top of the pipe.
4. The excavation for trenches shall not only be of sufficient size to accommodate the pipes and bedding material, but also to allow the provision of supporting the trench and making possible the use of formwork as necessary.
5. Where road, street and sidewalk surfaces, as well as gutters and kerbs, are to be broken for trench excavation the Contractor shall first cut the surfaces etc. in neat and straight lines and shall remove and dispose of the pavement or other surface material to the satisfaction of the Engineer.
6. The surfaces etc. shall be cut and removed to the full width of the trench and to the full depth of the pavement in such a manner as to leave undisturbed the adjacent surface etc. and any other work to be left in place. The edge of the surface etc. left in place shall have a sharp, even, vertical face and be true to line.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 54 of 79
	Technical Specifications	

7. Boulders, organic or any other objectionable materials encountered on the bottom of the excavation shall be removed to leave the finished surface true to line, level and grade.
8. The bottom of the trench shall be filled level with a compacted sand layer of thickness not less than 150 mm.
9. Excavation for pipe trenches shall not be started until all necessary piping materials are on Site. Unsuitable material at the bottom of the excavation shall be replaced with compacted sand or gravel. This fill shall be placed and built up in horizontal layers not exceeding 150 mm depth per layer. Each layer shall be thoroughly compacted with mechanical tampers.
10. After excavation is complete the Contractor shall notify the Engineer to that effect and no pipes shall be placed until the Engineer approves the depth of the excavation and nature of the foundation material.

3.7.2 Backfilling of Trenches

1. No backfilling shall be carried out until all debris and other objectionable materials have been removed from the excavation. The trenches shall be backfilled without delay but not before pipes and structures have been inspected and approved by the Engineer.
2. After the pipes, structures and bedding have been installed and approved, the initial backfill material shall be placed around and over the pipe in 150 mm thick layers.
3. In placing backfill, the material shall be placed simultaneously to approximately same elevation on both sides of the pipe, manhole, abutment, pier or wall. The pipe or the manhole shall be maintained at the intended line and grade. The backfilling shall be carried out carefully and in not more than 150 mm thick layers. Each layer shall be separately compacted to a dry density not less than 95% of maximum density obtained in Modified Proctor Test, where the pipeline is under existing roads and to 90% where the pipeline is not subject to vehicular traffic and under new roads included in the Contract. The initial filling shall extend to a distance above the pipe as shown on the Drawings.
4. The remainder of the backfilling up to ground level shall be placed and compacted in layers not exceeding 300 mm thick. Heavy tampers shall not be used within 300 mm above the top of pipes of diameters < 200 mm and within 500 mm above larger pipes. Under vehicular trafficked areas backfilling shall be performed in layers not exceeding 200 mm.
5. Care shall be taken to ensure that the pipes will be uniformly supported on the bedding and under no circumstances shall large stones, rock projections or other hard objects be permitted to come in contact with the pipe. The bedding material shall be constructed so that adequate socket pits are provided beneath each socket pipe joint.

3.7.3 Backfill Material

3.7.3.1 General backfill

Excavated or borrow material used for general backfilling, shall be free from cinders, ashes, organic matter and debris or other contamination and shall be granular and suitably graded to obtain the required compaction and shall not contain stones or crushed rock larger than 75 mm in the largest dimension. Additionally backfill material for trenches shall conform to the following requirements:

Uniformity Coefficient	6 minimum
Plasticity Index	15 maximum
Liquid limit	35 maximum

3.7.3.2 Backfill in vehicular traffic and other surfaced areas

Surfaces such as roads, streets, sidewalks and the like pavements that are removed shall be reinstated over their original depth or as directed by the Engineer.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 55 of 79

3.7.3.3 Initial backfill

Sand shall be used for initial backfilling of trenches. Material shall be sound, clean, uncontaminated granular material, uniformly graded and maximum size of particles 20 mm and particles smaller than 0.02 mm less than 10 %. In addition material shall be free from organic and deleterious matter and shall not contain more than 15 % by weight of clay or silt, individually or in combination.

3.7.3.4 Pipe bedding

Pipe bedding shall be granular material in accordance with the requirements of EN 12620, or equivalent for the range of grain size between 0 and 16 mm and with compaction fraction of not exceeding 0.15. Testing for the bedding material shall be in accordance with EN 882, or equivalent. Bedding material shall be placed to a depth of 150 to 200 mm below the level of the underside of the pipe.

3.7.4 Manholes and Chambers

Materials and the construction of manholes and chambers shall be in accordance with the relevant Technical Specifications.

3.7.5 Underground Cables

Cable trenches shall be in accordance with the Technical Specifications for the Electrical Works.

3.7.6 Compaction

Compaction is expressed in percentages and in all cases refers to the optimum dry density according to the modified Proctor Test or the BS 1377-4:1990 (Test 13), or equivalent. In case the requirements of compaction are not met by the Contractor all the affected work including backfilling material, installed pipe and bedding material shall be removed and reconstructed by the Contractor at his expense.


3.7.7 Grassing

1. Areas re-covered with top-soils shall be grassed in accordance with the instructions of the Project Manager. The grassed areas shall be irrigated by the Contractor until growth and spread of the grass is achieved. Appropriate fertilizer shall be applied to assist the spread and growth of planted grass. The Contractor shall undertake the first cutting of grassed areas.

3.8 DEWATERING

3.8.1 Scope of Work

1. The Contractor shall furnish all labour, materials and equipment, perform all work necessary to lower and control the groundwater levels and hydrostatic pressures to permit all excavations and construction to be performed in dry conditions.
2. The work shall include the testing, operation, maintenance, supervision, dewatering and final dismantling and removal from the Site of the dewatering system as described herein.
3. The Contractor will be responsible for the cost of dewatering, and it is deemed to be included in the cost of excavation and concrete casting, as detailed in the Particular Specification . He will also be responsible for all costs for claims by third parties and costs of any replacement or rehabilitation of the subgrade, buildings, structures and services damaged during the process of dewatering. The responsibility covers also all costs for damages due to dewatering

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 56 of 79
	Technical Specifications	

system failures or Contractor's negligence. The Contractor shall comply with all local regulations relating to the dewatering works.

4. Dewatering shall include the diversion, collection and removal of all surface runoff from the work areas; removal of groundwater from new excavations to permit construction in a dry pit/trench.

3.8.2 General Information

1. Prior to any excavation, the dewatering system shall be placed in operation to lower the water level, as required. Thereafter, the system shall be operated continuously twenty-four (24) hours per day, seven (7) days per week until all structures have been satisfactorily constructed, including placement of fill materials and dewatering is no longer required.

2. Both primary and standby power for the dewatering system shall be provided by the Contractor, including all costs for installation, energy and fuel. For any fuel powered system the Contractor shall maintain adequate fuel supply on Site. The Contractor shall make all necessary arrangements for the temporary power service and provide all necessary accessories required.

3. Prior to starting dewatering operations the Contractor and the Engineer shall make a joint inspection of the condition of all existing structures on or adjacent to the Site that is to be dewatered to establish their present condition. Photographs shall be taken to record any details that may become subjects of possible damage claims. The Contractor shall include in his Tender the cost for adequate photo coverage of such existing structures. The Contractor shall supply the Engineer one set of copies of all photographs taken which shall be annotated with adequate reference details.

3.8.3 Submittals

1. The Contractor shall submit for the Engineer's approval a detailed description of the sequence of dewatering operations. The description shall include but not be limited to:

- (1) plans showing the methods and location of dewatering and discharge. The drawings shall include sufficient details to clearly illustrate the work;
- (2) lists of materials and equipment to be used; and
- (3) calculations for the design of the dewatering system.

2. The Engineer shall verify that the general scope of work is adequate and that the Contractor is qualified to perform the work as shown on the dewatering drawings. Review of the Contractor's plans and methods of construction by the Engineer shall not relieve the Contractor in any way from his responsibility for the successful performance of the dewatering work.

3. The Contractor shall also submit daily operating logs which shall include results from water quality tests for suspended matter at the discharge point including time of day and elapsed times of tests, daily discharge rates, installation and removal of wells and general observations on the system such as equipment running times and failure.

3.9 ROADS AND YARDS

3.9.1 General

3.9.2 Aggregate Sub-base and Road Base

Technical Specifications

1. Aggregate road base and sub-base shall be placed and compacted in accordance with these specifications and to the lines, levels, grades, dimensions and cross-sections shown on the Drawings. The material of sub-base shall be separated from natural sub-soil with a filter fabric (geotextile) when the soil is fine graded (fine sand, silt or clay).
2. All material shall be free from organic matter and lumps of clay particles. Sand aggregate for sub-base shall spread and compacted in layers not more than 200 mm. The bearing modulus value E_2 shall be 90 MPa or more measured by plate bearing tests.
3. The road base of crushed material shall be compacted in one layer to a density so that the bearing modulus E_2 is 120 MPa or more measured by plate bearing tests. The Los Angeles value and crushing value of crushed base material shall not exceed 25%.
4. The ratio of the second and first loading stages, E_2 / E_1 , shall be less than 2.2 both for sub-base and road base courses and individual values shall not differ by more than 30% from specified values.
5. In addition the material of sub-base shall conform with the requirements of Table 3-1.
6. Fill material shall be compacted to a density not less than 90% of Modified Proctor Density.
7. Compaction of sub-base material shall be completed as soon as possible after the material has been spread.
8. If water-bound Macadam is used as roadbase the material shall conform to Table 3-2.
9. The material shall be mixed in a stationary mixing plant which shall be of a power driven paddle or pan type of the batch or continuous type. The Engineer may at his discretion allow the Contractor to employ other measures as the Contractor may propose for the mixing of constituent materials for the production of the roadbase.

Table 3-1: Requirements for sub-base

(i)	Grading (BS1377 Test 7A)	BS 410 Sieve Size	% by weight passing (Sub-base material)
		75 mm	100
		37.5 mm	85-100
		10 mm	45-100
		5 mm	25-85
		600 micron	8-45
		75 micron	5-45
(ii)	Liquid Limit (BS1377 Test 2a)	30 max.	
(iii)	Plasticity Index (BS1377 Test 3)	6 max.	
(iv)	Plasticity Modulus (product of Plasticity Index and % by weight passing 425 micron sieve)	250 max.	
(v)	California Bearing Ratio (BS1377), Test 16 sample at 95% Maximum Dry Density BS1377 Test 13 4.5 kg rammer with 2 day soak	30 min.	

Table 3-2: Requirement for water-bound Macadam used as roadbase material

Grading (BS1377 Test 7A)	BS 410 Sieve Size	% by weight passing
	50 mm	100
	37.5 mm	95-100

Technical Specifications

	20 mm	60-80
	10 mm	40-60
	5 mm	25-40
	2.36 mm	15-30
	600 micron	8-22
	425 micron	5-20
	75 micron	0-8

10. The moisture content at the time of compaction shall be within the range of 1.0% above and 0.5% below the optimum as determined in accordance with BS 1377 Test 13.

11. Water-bound macadam roadbase material shall be placed and spread evenly.

12. Compaction of crushed stone macadam roadbase material shall be started immediately after spreading to achieve a relative density of at least 95% of the maximum dry density determined by BS 1377 Test 13. At least three tests in accordance with BS 1377 Test 14 shall be carried out on each day's production run of roadbase laying to ascertain compliance with the above requirement and such tests shall be made at more frequent intervals if deemed necessary by the Engineer. Test holes shall be filled with properly compacted materials to the satisfaction of the Engineer at no cost to the Employer.

3.9.3 Wearing Courses of Roads and Yards

3.9.3.1 General

1. Roads and yards shall be graded and paved with granular material as shown on the Drawings or as directed by the Engineer. Before starting surfacing works the base course shall be inspected and approved by the Engineer.

2. The wearing course shall be laid to the shapes and levels as shown on the Drawings and shall meet the specified bearing capacity.

3.9.3.2 Granular Surfaces

Granular surfaces shall be of gravel or crushed gravel with particle size from 0 to 20 mm. The thickness of the granular layer shall be 100 mm and it shall be levelled in one layer and well compacted to 95 % relative density.

3.9.4 Tolerances


1. The surfacing material shall be laid to an accuracy such that the maximum allowable difference between the surface and the underside of a three (3) metres straight-edge, when placed parallel with and at right angles to the centre line of the road, at points decided by the Engineer shall be as in Table 3-3.

Table 3-3: Tolerances for surfacing material.

Surfacing material	Maximum distance under 3 m long test straight-edge (mm)	
	Along road	Across road
Wearing courses	3	5
Base courses	5	8
Bituminous road bases	8	10

2. An adequate number of 3 m long test straight-edges shall be provided by the Contractor.

3. If any specified tolerances or limits are exceeded the full extent of the area concerned shall be removed and replaced with new material that conforms with the requirements.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 59 of 79
	Technical Specifications	

4. Testing of the wearing course shall be carried out as soon as possible after completion of the surfacing and any remedies completed before the road is opened to traffic. No attempts whatsoever to correct the surface accuracy with any dressing or the like shall be allowed. The rejected areas shall be rectified at the Contractor's expense.

3.10 GROUND IMPROVEMENT MEASURES

3.10.1 Geotextiles or Filter Fabric

Geotextiles shall be spread between fill material and natural soil when the soil is fine graded (silty sand, silt or clay) to prevent the inter-penetration of fine sub-soil with the fill material or coarse aggregates. Geotextiles shall be installed according to the specifications of the manufacturer.

The geotextile shall be manufactured from durable synthetic polymers and shall have the following properties:

- max. pore size diameter $O_{95} = 0.05$ mm
- weight category > 200 g/m²
- permeability, k-value within ranges 10^{-3} and 10^{-4} m/s
- tensile strength (breaking load) > 150 kN/m.

3.11 FINISH GRADING AND LANDSCAPING

3.11.1 General

The work specified here covers the filling, finished grading and landscaping of unsurfaced areas not specified elsewhere. The Contractor shall prepare drawings for this work for the approval of the Engineer.

3.11.2 Grading of Unsurfaced Areas

After the completion of the construction Works the areas not shown to be paved on the Drawings shall be graded to provide smooth surfaces. Suitable excavated material shall be used for the finish grading. The finish grading shall be shaped as directed by the Engineer.

3.11.3 Soft Landscaping

1. The Contractor shall furnish all labour and materials necessary for topsoil, seeding, planting and miscellaneous work for soft landscaping.
2. The type of soft landscaping to be planted on the unpaved areas and the planting period shall be as directed by the Engineer. The Contractor shall schedule his supply of plant and fertiliser material and shall give the Engineer at least 14 days notice before making any delivery and planting. Fertiliser shall be delivered in standard bags marked with weight, analysis of the contents and the name of the manufacturer.
3. Soil used for soft landscaping shall be free of stones, lumps, plants, roots, and other extraneous matter and shall contain no waste oils, materials and the like that will be detrimental to plant growth.
4. All plants shall be healthy, sound, free of any defects, sunstroke injuries, abrasions of the bark, broken or dead branches and be nursery-grown stock of minimum one year old. The trees to be planted shall be not less than 2.5 m in height. Plants shall have normal well developed branch systems and vigorous root systems. The Contractor shall provide stakes and stake out all tree locations and planting areas as directed by the Engineer.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 60 of 79

5. The Contractor shall excavate tree pits to a depth equal to the tree ball plus 500 mm. The diameter of each pit shall be at least twice the size of the tree ball. Care shall be exercised to set plants truly vertical. Before backfilling all debris, stones and the like shall be removed from the pits. Backfilling shall be soil improved with fertiliser.
6. The Contractor shall be responsible for protecting and watering the soft landscaping after planting, seeding and the like up to the Completion of the Works. The Contractor shall replace according to the original specifications any planting, seeding and the like that dies, becomes unhealthy or is likely to die up to the end of the Defects Liability Period. The Engineer shall be the sole judge of the condition of the planting, seeding and the like in question.
7. The soft landscaping affected by the laying of pipes or cables shall be reinstated by the Contractor to the same condition as before the commencement of the works.

4 CONCRETE WORKS

4.1 General

1. The standard of materials and workmanship shall be not inferior to the recommendations of:
 - (1) EN 206-1:2000 Concrete - Part 1: Specification, performance, production and conformity;
 - (2) ENV 13670-1:2000 - Execution of concrete structures - Part 1: Common;
 - (3) British Standard Code of Practice BS 8110 - The Structural use of Concrete, or equivalent and all work shall be carried out in accordance with the recommendations given in this code except where modified by these Technical Specifications;
 - (4) British Standard Code of Practice BS 8007 - Design of Concrete structures for Retaining Aqueous Liquids, or equivalent; and
 - (5) Appropriate European, British and Palestinian Standards.
2. As and when required by the Engineer the Contractor shall prepare and submit, before commencing the work, a time-chart detailing the various operations for concrete work. At least 48 hours notice shall be given to the Engineer by the Contractor prior to any concrete works of any type being carried out. No concrete shall be poured without the prior written approval of the Engineer.
3. No material shall be used in the works until prior approval for its use has been given by the Engineer.
4. Test certificates shall be supplied as soon as possible to the Engineer.

4.2 Materials

4.2.1 Cement

1. The Contractor shall submit to the Engineer for approval the name(s) of the manufacturer(s) of the cement he proposes to use. Cement shall be ordinary Portland Cement and shall conform to EN 197-1:2000.
2. Sulphate resisting cement shall comply with BS 4027:1996, or equivalent. If the Contractor elects to use a Pulverised Fuel Ash (PFA) or Ground Granulated Blast Furnace Slag (GGBS) mix he shall only be able to do so with the approval of the Engineer.
3. Cement shall be fresh when delivered to Site and the consignments shall be used in the order of their delivery. If the cement is delivered in bags it shall be stored in a waterproof shed or building at a temperature of not less than 8°C and the bags shall be placed on dry boards above the floor to prevent deterioration or contamination from any cause.

4.2.2 Aggregates

1. Fine and coarse aggregates shall be as defined by the quality and nature required by EN 12620, or equivalent. In addition they shall be chemically inert to alkali reaction unless appropriate adjustment can be made to the concrete mix in order to prevent such reaction.
2. Except where aggregates have been otherwise specified the grading of coarse aggregates shall be as follows :
 - (1) 10 mm max. size, graded, for all "fine" concrete.
 - (2) 20 mm max. size, graded, for all reinforced concrete in beams, and for walls and slabs not greater than 400 mm thick.

3. The water absorption of aggregates for concrete designed to retain water shall not exceed 3% when measured in accordance with EN 1097-3:1998, EN 1097-3, or equivalent.
4. If required by the Engineer, the Contractor shall submit the results for the following tests:
 - (1) Sieve analysis
 - (2) Test for clay, silt and dust content
 - (3) Test for organic impurities
 - (4) Test for salt content
 - (5) Shape and Porosity
 - (6) Strength
5. Tests (1) and (2) with test of moisture content shall be carried out on the samples used for each trial mix. In test (4) the percentages given by the following table shall not be exceeded.

Table 4-1: Shell content

Nominal size of aggregate (mm)	% by weight of dry aggregate of shell as Calcium Carbonate	
	Normal reinforced concrete	Liquid retaining structure
20	10	5
10	15	15
Fine aggregate	45	30

4.2.2.1 Water

The water for use in concrete and mortar shall be from potable water supply or source approved by the Engineer. Water for washing and curing shall be such that it will not impair either the strength of the finished concrete nor its appearance.

4.2.2.2 Admixtures

1. Admixtures shall be used only when and as specified herein or approved by the Engineer. Approval will only be given for the use of admixtures which can be administrated in fixed calibrated amounts through a mechanical dispenser, and which are added directly to the mixing water. Where the approval is given for the use of more than one type of admixture for the same concrete mix they shall be dispensed separately.

- (1) Water-reducing - the Contractor shall include an approved water-reduction admixture (plasticiser) where, in the opinion of the Engineer, the workability of the mix is otherwise inadequate to achieve an acceptable compaction and /or surface finish, or where excessive bleeding of the concrete is in evidence.
- (2) Set-retarding admixtures - where large quantities of concrete are to be placed or where concreting is undertaken under hot conditions, the contractor may include for approval a set-retarding admixture to reduce the heat of hydration.
- (3) Set-accelerating admixtures - the Contractor shall not use set-acceleration admixtures except for cold weather concreting and after the approval of the Engineer. The set-accelerating admixtures shall not be used for the thrust blocks of PVC or PE pipes.

2. To ensure a maximum impermeability and density of the concrete appropriate admixtures may also be used with the Engineer's approval.

4.2.2.3 Strength of Concrete

The basis for assessing the strength of concrete shall be related to the characteristic strength, defined as the strength of the concrete at 28 days as determined by the standard method of testing.

4.2.2.4 Concrete Mixing

1. The concrete mixes are designed mixes to be supplied in accordance with EN 206-1:2000, or equivalent.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN Technical Specifications	Document: SH_2019_E2 Page 63 of 79
--	--	---

2. Details of the compressive strength grades are:

(1) Concrete mix C15 - Lean concrete.

- Compressive strength grade C15
- maximum size of aggregate 10 mm
- aggregate and cement see above
- minimum cement content 180 kg/m³
- maximum free water/cement ratio 0.8

(2) Concrete mix C35A - Water retaining structures.

- Compressive strength grade C35
- maximum size of aggregate 20 mm
- aggregate and cement see above
- minimum cement content 325 kg/m³
- maximum cement content 400 kg/m³
- maximum free water/cement ratio 0.55

(3) Concrete mix C25 - Other concrete structures.

- Compressive strength grade C25
- maximum size of aggregate 20 mm
- aggregate and cement see above
- minimum cement content 275 kg/m³
- maximum free water/cement ratio 0.65

3. Where Drawings refer to C35 grade concrete for water retaining structures this shall be deemed to be C35A as specified above.

4.2.2.5 Quality Control

1. The principal basis of control shall be by comparison of the results of the compression cube tests at 28 days, except for small quantities of concrete work whose strength can be otherwise derived and which is permitted for use by the Engineer. Forty sample cubes shall be made initially in eight samples each day for five days of concreting to establish the suitability of the design mix.

2. Cube test results will be examined individually in 10 consecutive sets of four and the mean strength of each set will be calculated. The concrete mix proportions will only be acceptable if all of the EN 206-1:2000, BS 8110 and BS 8007, or equivalent requirements are fully complied with.

3. Where the results do not conform to the above requirements the mix proportions shall be modified to obtain the required specification requirements.

4. In the event of failure to meet the requirements by the 28th day, the Contractor shall be responsible to produce evidence that the related element of structure is satisfactory. This can be achieved by taking samples of a type and location approved by the Engineer from the affected part of the structure and having them tested by Testing Material Laboratory approved by the Engineer.

5. In the case where concrete does not meet the requirements even after the Laboratory testing, all the affected structural elements shall be demolished and reconstructed by the Contractor at his own expense.

6. In order to determine and therefore maintain the consistency of the mixed concrete for a particular structure and/ or section of the work, the Contractor shall carry out a slump or compacting factor test in accordance with EN 12350-2:2000 at all of the following intervals:

- (1) For every mixer lorry load arriving on Site,
- (2) For every 6 m³ of Site batched/mixed concrete produced by each Site mixer,
- (3) As requested by the Engineer.

4.2.2.6 Reinforcement

(1) Steel

Steel reinforcement shall comply with the relevant provisions of the appropriate British Standards, as set below, or equivalent:

Table 4-2: Standards for reinforcement

Type	BS
Carbon steel bar	4449 (EURONORM 80)
Cold reduced steel wire	4482
Steel fabric	4483

All reinforcement shall be Type 2 high yield deformed bars complying with BS 4449 or equivalent unless otherwise noted on the drawings. The characteristic strength shall be 460 N/mm².

(2) Submittals

The Contractor shall provide in addition to mill test certificates which must be provided in advance for approval, a certificate confirming that samples, taken from the bars delivered to the Site, pass the tensile strength test. The frequency of sampling and the method of quality control shall be as and when required by the Engineer in accordance with the provisions elsewhere in the Contract.

(3) Fabrication and Storage

1. All reinforcement shall be cut and bend cold accurately to the dimensions approved. Bends shall be made in accordance with EN ISO 4066. If shipped to the job fabricated, steel reinforcement shall be properly bundled and tagged so that it can be handled without damage and readily with the approved placing diagrams.

2. Reinforcement shall not be straightened or rebent.

3. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.

(4) Cleaning and Placing

1. Before being placed in position, the reinforcement shall be thoroughly cleaned of all loose scale and rust and of any dirt, coatings, or other material that might reduce the bond of concrete to the reinforcement.

2. All reinforcement shall be placed in the exact positions and with the spacing shown on the Drawings, or as otherwise directed. It shall be so securely fastened in position by saddle tying at intersections with annealed wire or by suitable clips, that no displacement will occur for any reason. Where splicing is permitted, bars shall overlap at least 45 diameters unless otherwise noted. Precast concrete blocks or metal chairs as approved by the Engineer shall be used for supporting horizontal reinforcement in slabs, beams and footings. No reinforcement shall be placed so that there is less concrete between it and the finished concrete surface than the minimum cover shown on the Drawings or specified in BS 8110, or equivalent.

(5) Welding of Reinforcement

Reinforcement shall not be welded on the Site except where described in or permitted under the contract. All welding procedures shall be subject to the prior approval of the Engineer in writing.

(6) Built-in Items

Where pipes, sleeves, water bars or other items are built into concrete, they shall be rigidly secured in position to prevent movement and shall be free from external coatings which might reduce the bond. The Contractor shall take precautions to prevent the formation of air pockets, voids or other defects whilst the concrete is being placed.

4.3 Execution of Work

4.3.1 General

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 65 of 79
	Technical Specifications	

1. Forms for concrete shall be of wood, plywood, steel or other approved material. Type, size quality, and strength of the materials from which forms are made shall be subject to the approval of the Engineer. However the design of formwork its construction and removal shall be responsibility of the Contractor. No falsework of forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the Site.
2. Forms for concrete shall be true to line and grade, and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. Forms shall be smooth and free from surface irregularities. Bolts and rods used for internal ties shall be arranged in such a manner that all metal will not be permitted where the concrete surface will be exposed to either water or weathering. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Suitable mouldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls and slabs.
3. All shuttering shall be sufficiently light, without plugging, to prevent loss of grout during the vibration of the concrete. When required by the Engineer joints between shutter facing boards shall be sealed with foam rubber sealing strips or other approved material.
4. Shuttering which as a result of prolonged use or general deterioration does not, in the opinion of the Engineer, conform to the particular requirements, shall not be used. Boxes for forming holes shall be constructed so as to be easily removable without damaging the concrete during removal. They shall be properly vented to permit the escape of entrapped air, and shall be capable of being sealed, subsequently, to prevent the loss of grout. The use of polystyrene blocks for the forming of holes, sinking, etc. will not be allowed except by the Engineer's permission.
5. Before concreting, the areas which are intended to receive the concrete shall be cleaned by getting with compressed air, and all water and extraneous material removed.
6. Shutter ties which provide a direct leakage path or leave an open hole through any structural element of any water retaining structure or beneath the finished ground level of any structure shall not be used.

4.3.2 Formwork

4.3.2.1 Sawn Formwork (Type A)

This shall be designed formwork or moulds of closely jointed sawn boards or other approved material. Small blemishes due to entrapped air or water shall be allowed but the surface shall be free from voids, honeycombing or other large blemishes.

4.3.2.2 Wrought Formwork (for "Fair Face" Finish) (Type B)

1. Where concrete is described as having "Fair Face" finish it shall have a smooth finish of uniform texture and appearance. This finish shall be a high quality hard smooth finish resulting from a high quality concrete with forms or moulds having a hard smooth finish.
2. The concrete surface shall be smooth with true clean arises and only very minor surface blemishes shall be allowed with no staining or discoloration from release agents. Whilst the concrete is still green all surface blemishes shall be filled after Engineer's permission with a fresh specially prepared cement and fine aggregate paste.
3. For circular columns metal formwork shall be used.

4.3.2.3 Tolerances

Concrete surfaces in the final work shall have no abrupt irregularities to an extent observable by eye. Subject to retaining the required concrete cover to reinforcement, other deviations from the surfaces described in the Contract shall be no more than the permissible amounts given in Table 4-3.

Table 4-3: Permissible deviations in concrete surfaces

Technical Specifications

Type of finish	Deviation from line, level, verticality, cross section dimension or length (mm)	Any abrupt irregularity (mm)
Sawn formwork	10	5
Any other	5	3

4.3.2.4 Striking and Removal of Shuttering

- Formwork shall be removed without shock or to disturbance of the concrete.
- Formwork to vertical surfaces or sloping formwork not supporting concrete in flexure shall not be removed until, the concrete strength shall be sufficient to meet any wind load upon the concrete likely to arise at the time when the formwork is removed; and
 - The concrete strength (as confirmed by tests in cubes cured under representative conditions) has reached 5 N/mm²; or
 - For concrete containing Portland cement only, in the absence of cube test results a minimum period shall have elapsed since the concrete was poured equivalent to 11 hours at 15 OC for unsealed plywood forms, or 8 hours at 15 OC for impermeable forms
- Formwork supporting concrete in flexure shall not be removed until:
 - The concrete strength (as confirmed by tests in cubes cured under representative conditions) has reached 10 N/mm²; or twice the stress to which the concrete will then be subjected, whichever is the greater, or
 - For concrete containing Portland cement only, in the absence of cube test results or any formal procedure agreed with the Engineer, the periods before striking calculated from the relevant formula as given in Table 4-4 shall be used.

Table 4-4: Periods for striking formwork

Type of formwork	Period calculated for mean ambient temperature (t) between 5 and 25°C
Soffit form to slabs and beams	$100 \div (t + 10)$ days
Props to slabs and beams	$250 \div (t + 10)$ days

4.4 Concreting

4.4.1 General

- Before any major concrete pour is started, the Contractor shall prepare and submit to the Engineer for approval a schedule of his proposed operations. Approval of the schedule by the Engineer shall not relieve the Contractor of his responsibility for producing concrete work of the highest quality.
- No concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the Engineer.
- Water shall be removed from the trenches before casting the concrete. Loose particles and other impurities shall be removed, washed and/ or blown away from forms and from inner surfaces of mixing and casting equipment with pressurised air.
- No concrete shall be placed until all reinforcing steel, anchor bolts, pipes, conduits, sleeves and other work required to be built into concrete have been inspected and approved by the Engineer.

4. All concrete shall be placed during the daylight hours except with the consent of the Engineer, the placing of concrete in any portion of the work shall not be started unless it can be completed in daylight. If special permission is obtained to carry on work during the night, and adequate flood-light system must be provided.

5. In the event of the Contractor electing to carry out site mixing of concrete the batching plant shall be to the approval of the Engineer. Aggregates and cement shall be proportioned by weight batching and water by volume. Batch mixing machines shall comply with the requirements of EN 1305 and shall be provided in such numbers and of such capacity to ensure a continuous supply of fresh concrete. The contractor shall, if required by the Engineer, arrange to have all gauges of his batching plant tested and calibrated. The tests shall be carried out at a frequency required by the Engineer and the cost borne by the Contractor.

6. The transport of and delivery times for ready mixed concrete shall be in accordance with the requirements of EN 206-1:2000.

4.4.2 Pouring

1. Concrete shall be placed in forms as soon as practicable after mixing, and in no case shall any concrete be used which does not reach its final position in the forms within 30 minutes of discharge from the mixer, unless carried in a purpose-made agitators operating continuously, when the time shall be within 2 hours of the introduction of the cement to the mix and within 30 minutes of the discharge from the agitator.

2. The method and manner of placing concrete shall be such as to avoid the possibility of segregation of the concrete materials or the displacement of the reinforcement.

- (1) Dropping the concrete a distance of more than 2.0 m or depositing a large quantity at any point, running or working it along the forms will not be permitted.
- (2) Placing of concrete shall be so regulated that the pressure caused by wet concrete shall not exceed that used in the design of the forms.
- (3) All concrete shall be deposited in approximately horizontal layers. Each part of the form shall be filled by placing the concrete as near to its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the inserts, piping and reinforcing bars without disturbing them.
- (4) All concrete shall be consolidated by continuous working with suitable tools and also by the use of approved mechanical vibrating devices.
- (5) Mechanical vibrators shall be of an approved type transmitting vibrations directly to the concrete with sufficient intensity to cause flow and settlement. Their operation shall be carefully controlled to give sufficient duration to accomplish thorough compacting without over-agitation which will cause segregation of the materials. Every effort shall be made to ensure that all concrete work is solid, compact, watertight, and smooth to prevent the formation of laitance.
- (6) If concreting is interrupted for any reason for a long enough time for a cold joint to be likely (30 minutes) then a stop-end will be introduced to produce a well compacted, square, formed construction joint, to the approval of the Engineer, at the point where concreting must stop. Any concreting which is allowed to cure on a feather edge without a stop-end thus producing poor quality uncompacted concrete will be chopped back to sound concrete before continuing the pour.

4.4.3 Hot Weather Concreting (for Temperature above +20°C)

Concreting shall not be permitted if its temperature of placing is in excess of +38°C. In order to maintain the temperature of the concrete below this value the following precautions shall be taken:

- (1) All aggregate stockpiles, water lines and tanks as well as the mixer shall be protected from the direct rays of the sun;
- (2) Coarse aggregate shall be cooled by constant watering where possible;
- (3) Mixing water shall be cooled by the addition of ice to the storage tanks where necessary;

Technical Specifications

- (4) Rapid-hardening cement shall not be used;
- (5) Where the above precautions are inadequate concreting shall be carried out during the cooler parts of the day or during the night as may be approved by the Engineer;
- (6) When the air temperature is above +20°C loss of mixing water by evaporation shall be considered in arriving at the amount of water to be added to the mix. In order to maintain the water/cement ratio within permissible limits an approved water-reducing agent shall be included in the mix;
- (7) In order to reduce premature drying of the concrete during transporting and placing, all chutes, shuttering and reinforcement shall be cooled by watering when possible, or shall otherwise be protected from the direct rays of the sun.

4.4.4 Wet Weather Concreting

1. Concreting during periods of constant rain shall not be permitted unless aggregate stockpiles, mixers and transporting equipment, and the areas to be concreted are adequately covered.
2. During raining weather, the Contractor shall ensure the work can be concluded at short notice by the provision of stop ends. Adequate covering shall be provided to protect newly placed concrete from the rain.

4.4.5 Cold Weather Concreting

1. Concreting at ambient temperatures below +2°C may be carried out only if the following conditions are met:
 - (1) the aggregates and water used in the mix shall be free from snow, ice and frost
 - (2) before placing concrete, the formwork, reinforcement and any other surface with which the fresh concrete will be in contact shall be free from snow, ice and frost and shall be at a temperature above 0 °C
 - (3) the initial temperature of the concrete at the time of placing shall be at least +10 °C
 - (4) the temperature at the surface of the concrete shall be maintained at not less than +10 °C at any point until the concrete reaches a strength of 5 N/mm², as confirmed by tests on cubes matured under similar conditions, and
 - (5) temperatures at the surface of the concrete shall be measured where the lowest temperature is expected.
2. The contractor shall take precautions to prevent the temperature of any concrete falling to 0°C during the first five days after placing.

4.4.6 Protection and Curing

1. Careful attention shall be given to the proper curing and protection of all concrete in the structures. The work shall be protected from the elements, flowing water and from defacement of any nature during construction operations.
2. After placing and finishing of concrete, concrete shall be cured and protected in accordance with BS 8110, or equivalent.
3. Finished surfaces and wall edges located where travel and further construction work is necessary shall be suitably protected from damage by temporary guards or covers as directed by the Engineer.
4. The curing time shall be the number of days given in Table 4-5.
5. Where a curing compound is used the Contractor must be able to demonstrate adequate coverage of the concrete by the compound. The compound to be used by the Contractor must be approved by the Engineer.

Table 4-5: Curing time

Type of cement	Ambient conditions after casting	Minimum period of curing and protection (days)	
		+5°C to +10°C	Above +10°C

EN 4027 or equivalent	Average Poor	4 6	3 4
Others	Average Poor	6 10	4 7

4.4.7 Construction Joints

- Except where construction joints are shown in the approved drawings, the Contractor shall obtain the Engineer's approval to the positions and details of such joints before any work is commenced.
- Concreting shall be carried out continuously up to construction joints.
- The surface of any concrete against which new concrete is to be cast shall be free from laitance and shall be roughened to the extent that the large aggregate is exposed but not disturbed. The joint surface shall be cleaned immediately before the fresh concrete is placed against it.
- Where practicable, such preparation of joints shall be carried out when the concrete has set but not hardened.

4.4.8 Waterstops and Jointing Materials

4.4.8.1 Waterstops

- A waterstop of stainless steel strip 2 mm thick, $h = 200$ mm, shall be located in every joint in water retaining structures.
- Waterstop shall be located and maintained accurately in correct position. On no account shall any waterstop be secured by nails or by any other means involving puncture of or damage to the waterstop materials unless purpose made nailing flanges are incorporated in the design of the waterstop.
- All waterstop joints shall be welded.

4.4.8.2 Installation of Joint Fillers and Sealants.

- Joint fillers and sealants shall be installed in accordance with manufacturer's recommended procedures. Joint filler that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The filler shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.
- A bond breaker of polyethylene film shall be used between filler and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied.
- Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.

4.4.9 Internal Epoxy paint for wastewater treatment concrete works

- Two component epoxy modified paint based on hydrocarbons resins and special additives: for the protection of sewage treatment plants, cisterns and concrete sewer pipes in contact with aggressive chemicals such as acids, alkalis, hydrocarbons, detergents and sewage.
- The epoxy paint is design for contact with sewage and is also resistant to frost and sunlight, and creates a vapour barrier.

3. Application procedure:

- Substrate preparation: substrate must be thoroughly clean, solid and dry. Completely remove loose materials, dust, traces of formwork, release agents, paints and varnishes by sandblasting. Fill any cracks and repair degraded sections. Seal and level any irregularities in the substrate.
- Mixing: the paint's two component must be mixed together. Pour part B (hardener) into part A (resin) and mix at low speed with a mechanical stirrer until completely homogenised.
- Application: the paint can be applied using conventional techniques, brush, roller, or spray, in at least two coats. Wait from 6 to 24 hours between coats, depending on ambient conditions.

4.4.10 Concrete Finish without Formwork

4.4.10.1 General

1. All exposed faces of concrete unless otherwise specified shall be hard, smooth and free from honeycombing, air and water holes and other blemishes.
2. All projecting imperfections shall be rubbed down with carborundum stone or by other approved means and grit and dust therefore shall be thoroughly washed off with clean water.

4.4.10.2 Surface finishes.

1. Wood float finishes - shall be formed by smooth floating the accurately levelled and screened surface. Care shall be taken to ensure that the concrete is worked no more than is necessary to produce a uniform surface free from screed marks.
2. Steel trowel finishes - shall be formed when the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, the surface to the wood float finish shall be steel-trowelled under firm pressure to produce a dense, smooth, uniform surface free from trowel marks.
3. Where the type of finish is not given it shall be wood float finish.

4.4.10.3 Repairs

Honeycombed or damaged surfaces of concrete, which in the opinion of the Engineer, are not such as to warrant the cutting out and replacement of the concrete, shall be made good as soon as possible after removal of the shuttering as follows: 1:1½ Portland cement and sand mixture shall be worked into the pores over the whole surface with a fine carborundum float in such a manner that no more material is left on the concrete face than is necessary completely to fill the pores so that a uniformly smooth and dense concrete of uniform colour is finally presented.

4.4.11 Removal and Replacement of Unsatisfactory Concrete

The Contractor shall on the Engineer's instructions to do so cut out and replace any concrete in any part of the structure if in the Engineer's opinion :

- the concrete does not conform to the specifications; or
- deleterious materials or materials which are likely to produce harmful effects have been included in the concrete; or
- the honeycombed or damaged surfaces are too extensive; or
- the finished concrete sizes are not in accordance with the Drawings with permissible tolerances; or
- the setting out is incorrect; or
- the steel cover has not been maintained; or
- the protection, including curing, of the concrete during the construction was inadequate, resulting in damage; or
- the work of repairing or remedial measures the Engineer may indicate are not carried out to his satisfaction, or
- undue deformation of or damage to the works has taken place due to inadequate shuttering, or to premature traffic or to excessive loading; or

- any combination of the above points has taken place resulting in unsatisfactory work.

4.4.12 Test of Water-Tightness of Finished Structures

- All water retaining structures shall be made watertight by the production of a well compacted dense concrete. The Contractor shall be responsible for the water-tightness of the concrete and all water-containing structures shall be tested for water-tightness when the concrete has achieved its design strength, the Contractor providing all labour, water drain stoppers, water, energy, etc. for conducting the test. All water retaining structures shall be tested before the placing of the backfill, banking, etc.
- The exposed faces shall be deemed to be watertight if they show no signs of leakage and remain visibly dry during the test period of seven days.
- Covered structures, the surface of which are not accessible for inspection, shall be filled with water for a period of twenty-one days. On the expiry of this period, the level of the water surface shall be recorded and further measurements be taken at 24 hour intervals for seven days. Consideration shall be given to losses resulting from absorption and evaporation. The structure may be deemed to be watertight if the total drop in surface level does not exceed 1/500 of the average water depth of the full tank or 10 mm, whichever is less, in seven days after due consideration has been given to absorption and evaporation.
- For open reservoirs, due regard should be paid to atmospheric conditions throughout the test period.
- All observed leakages due to cracks or honeycombing etc in water-retaining structures shall be repaired by the injection of epoxy resins, watertight epoxy plaster or any other approved method. The cost of all repair works, as well as the new water-tightness test after repair works, shall be borne by the Contractor.

4.4.13 Concrete protecting coating

- The protective coating to all buried concrete surfaces shall be heavy duty bituminous coating.
- The bituminous coating shall consist of penetrating bituminous primer and a three-coat high build bituminous base coating capable of being brush, trowel or spray applied to give a total dry film thickness of 1 mm. The coating shall be capable of being applied to a vertical surface without running.

4.4.14 Tolerances for prefabricated concrete units

The tolerances for prefabricated concrete units shall be as follows:

- columns**
 - length: ± 10 mm or L/1000, whichever greater
 - cross-section: ± 10 mm
 - curvature: ± 10 mm or L/750, whichever greater
- beams**
 - length: ± 15 mm or L/1000, whichever greater
 - cross-section: ± 10 mm
 - curvature: ± 10 mm or L/500, whichever greater
- walls**
 - length, height: ± 10 mm
 - thickness: ± 5 mm

5 SPECIFICATION FOR UNDERGROUND PIPEWORK

5.1 GENERAL

5.1.1 Scope of Work

The complete construction of pipelines as stated hereunder is included in the scope of underground pipe work. The works shall include but not limited to clearing of the Site, excavation, foundations of pipework and auxiliaries, furnishing and installing to the required elevation all specified underground piping with all fittings (including valves etc.) and appurtenances, backfilling, embankments, connections to manholes and chambers, crossings in general, pipe supports, testing of pipelines and cleaning of Site all as required for a complete installation.

5.1.2 Quality Assurance

5.1.2.1 Shop Tests

All pipe materials, fittings, sealing rings and other materials for pipeline network covered by these specifications shall be tested in accordance with the applicable standards.

5.1.2.2 Witnessed Shop Tests

Visits and inspections of a manufacturer's facilities before and /or after the approval of materials may be required as set out in the Special and General Conditions of Contract.

5.1.3 Submittals

5.1.3.1 General

No material furnished under these specifications shall be shipped to the Site until all submittals have been approved.

5.1.3.2 Product Literature etc.

1. Each submittal shall be complete in all aspects incorporating all information and data listed herein and all additional information required to evaluate the compliance of the proposed piping material(s) with the Contract.

2. Data to be submitted shall include but is not limited to:

- (1) Catalogue data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various components and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly;
- (2) Complete assembly drawings of fittings etc. with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts;
- (3) Listing of all lubricants required for the equipment with a minimum of four equivalent and compatible natural and/ or synthetic lubricants produced by different manufacturers. The listing shall include the estimated quality of lubricant required for one year of operation;
- (4) Lists of spare parts and special tools;
- (5) Weight of all component parts;
- (6) Tabulated pipe schedule, which shall include the following information for all pipe and fittings: service, pipe size, working pressure, wall thickness; and
- (7) Manufacturer's instructions for transporting, unloading, storing and installing pipes, fitting and other pipe accessories.

5.1.3.3 Certified Shop Test Results

Copies of current authenticated test results in accordance with the manufacturing standard shall be submitted in accordance with the Contract provisions.

5.2 MATERIALS

5.2.1 General

1. All pipes, fittings, couplings and the like shall be marked with the manufacturer's name or trademark, size, pressure, class, date of manufacture, angle of bends etc. and additionally all as required in the applicable manufacturing standard.
2. All bolts, nuts and washers and the like shall be as specified herein.
3. Acceptable standards for pipes and fittings are as follows all to the latest editions:
 - (1) Polyethylene (PE): EN 10284:2000, or equivalent;
 - (2) uPVC gravity (PVC): EN 1401-1:1998, or equivalent;

5.2.2 Pipes and Pipe Fittings

5.2.2.1 Polyethylene (HDPE) Pipes and Fittings


1. HDPE pipes and fittings shall be manufactured according EN 12201-2.
2. PE pipes and fittings shall conform to outside diameters as stated in standards. Pipes and fittings shall have the working pressure (PN) as shown on drawings.
3. The pipe and fitting will be PE100 types according ISO/TR 9080 (Mpa 10). The polyethylene pipes shall satisfy all current applicable health and safety requirements with regard to suitability for use in potable water services.
4. HDPE pipes manufacturer shall have a Factory Conformity Certification according UNI 10910, and Quality System Certification according UNI ISO 9001 or equivalent. Outside diameters and wall thickness shall comply with EN 10001-2 sheet 1 and 2.
5. Pipes shall be supplied with plain ends either to fit couplings or suitable for welding. The pipes couplings shall be manufactured according UNI EN 12201-3, and the welding coupling shall be according UNI 10520. In addition Pipe manufacturer's specifications shall be strictly followed for butt welded and electro-fusion joints.
6. All the fittings shall be as shown on drawings.
7. Eventual connections into steel pipes and fittings shall be made with threaded adapters or flanged joints.
8. Minimum bending radius shall be in accordance with Table 3-3 below.

Table 3-3: Minimum bending radius of PE pipe

Material type	Minimum radius (x outside diameter)
PE-HD	50
PE-MD	40
PE-LD	30

5.2.2.2 Unplasticised Polyvinyl Chloride (uPVC) Pipes and Fittings

1. uPVC pipes and fittings shall conform to outside diameters as stated in standards. Unless otherwise specified pipes and fittings shall be suitable for minimum PN10 working pressure.

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2
	Technical Specifications	Page 74 of 79

2. Pipes and fittings shall be jointed with spigot and socket joints with elastomeric sealing rings. Solvent cement type joints shall not be used.

3. Fittings of steel or iron coated and lined with an epoxy system or, aluminium alloy with nylon or equal coating and lining are also acceptable.

4. Connection into steel pipes and fittings shall be made with flanged socket or spigot fittings manufactured of iron, steel or aluminium alloy. Corrosion protection of the iron or steel fittings shall be with an epoxy system.

5.2.2.3 Unplasticised Polyvinyl Chloride (uPVC) Pipes and Fittings for Gravity Sewers

1. uPVC sewer pipes and fittings shall conform to outside diameters as stated in standards.

2. Minimum wall thickness shall be as specified in EN 1401-1:1998, or equivalent.

3. Pipes and fittings shall be jointed with spigot and socket joints with elastomeric sealing rings. Solvent cement type joints shall not be used.

5.2.2.4 Concrete Pipes and Fittings

1. Unreinforced and reinforced concrete pipes and fittings with flexible joints shall comply with BS 5911, or equivalent. Reinforced concrete pipes and fittings shall comply with EN 639:1994 and EN 640:1999 or EN 641:1992, or equivalent, as appropriate.

2. All pipes and fittings shall have gasket-type joints of spigot and socket.

3. Concrete pipes for pipe jacking, if any, shall comply with the relevant provisions of BS 5911, or equivalent. The Contractor shall ensure that the pipes can withstand the jacking loads to which they will be subjected during installation, without cracking or spalling. A certificate shall be supplied, confirm that the pipes are suitable for jacking and stating the distributed jacking loads for which they were designed.

5.2.3 Pipe Jointing, Saddles and Repair Clamps

5.2.3.1 Joint Seals and Lubricants

1. Elastomeric joint seals shall comply with the relevant provisions of EN 545, or equivalent.

2. Joint lubricants shall have no deleterious effects on either the joint rings or pipes, and be unaffected by the liquid to be conveyed. Lubricants to be used for jointing water mains shall not impart taste and/ or colour to the water to be conveyed, or any effect known to be injurious to health, and shall be resistant to bacterial growth.

3. Lubricants shall be as recommended by the pipe manufacturer.

5.2.3.2 Flanges for Pipes and Pipeline Fittings

Flanges for pipes and pipeline fittings shall comply with EN 1092-1:2001 for steel flanges or EN 1092-2:1997 for cast iron flanges, or equivalent.

5.2.3.3 Gaskets for Flanged Joints

Gaskets for flanged pipe joints shall be of the inside-bolt-circle type. The material and dimensions of gaskets shall comply with the provisions of EN 1591-2:2001, or equivalent.

5.2.3.4 *Pipe Saddles and Repair Clamps*

1. Pipe saddle body shall have female thread or be undrilled and material shall be cast iron or ductile iron and coated with an epoxy system. Saddle strap shall be stainless steel. Bolts, nuts and washers shall be stainless steel. Rubber insert and O-ring shall be EPDM rubber or similar.
2. Alternatively for disconnection work stainless steel pipe repair and coupling clamps can be used. The clamp to be equipped with EPDM gasket seal or similar. Bolts, nuts and washers shall be stainless steel.

5.2.4 **Valves**

Valves shall be as specified in the Mechanical Specifications.

5.2.5 **Miscellaneous Fittings and Appurtenances**

5.2.5.1 *Manhole Covers and Frames*

Manhole covers and frames shall comply with the relevant provisions of EN 124:1994, or equivalent having a minimum clear opening of 600 mm. Manhole covers shall have closed key-slots. In vehicle traffic areas, covers and frames shall be designed for 40 ton load and outside vehicle traffic areas for 25 tons respectively.

5.2.5.2 *Extension Spindles and Protection Tubes*

Valves not in chambers and valves to be operated from outside the chamber shall be fitted with extension spindles and spindle support/guides. Valves installed in the ground shall be fitted with extension spindles and equipped with protection tubes. The material of the extension spindle shall be galvanised steel and the protection tube shall be PE.

5.2.5.3 *Surface Boxes*

Surface boxes shall comply with the relevant provisions of BS 5834, or equivalent.

5.2.5.4 *Nuts, Screws, Washers and Bolts*

1. Mild and high strength nuts, screws, washers and bolts shall comply with the relevant provisions of the appropriate British Standard, or equivalent, as set out below in Table 3-4.

Table 3-4: Requirements for mild and high strength nuts, screws, washers and bolts

Type	BS
Black hexagon bolts, screws and nuts	4190
Metal washers for general purposes	4320
High strength friction grip bolts, nuts and washers	4395

2. Bolting for pipes and fittings shall comply with the relevant provisions of EN 1515-1:1999, EN 1515-2:2001 and EN 1092-1:2001 or EN 1092-2:1997 or equivalent, except that bolts for use with ductile iron fittings shall be manufactured from metal complying with the provisions of EN 1563:1997 for Grade 500/7 or equivalent.
3. All carbon steel bolts, nuts and washers shall be hot dip galvanised.
4. Stainless steel nuts, screws, washers and bolts shall be manufactured from Grade 316S31 steel complying with EN 10130:1991 + A1:1998 or EN 10085, or equivalent.

5.3 **EXCAVATION, BACKFILLING AND RESTORATION**

5.3.1 **Excavation**

	DESIGN OF TREATMENT WETLAND IN SHIRVAN	Document: SH_2019_E2 Page 76 of 79
	Technical Specifications	

Trenches for underground network, manholes and chambers shall be excavated to the lines and grades or elevations shown on the Drawings and as required in the Particular Specification. The Contractor shall avoid unnecessary opening of the pipe excavation before installing the pipe.

5.3.2 Backfilling

Backfilling shall be carried out as specified in Section 3.7.2.

5.3.3 Surface Reinstatement

Surface reinstatement shall be carried out as shown on the Drawings and specified in Section 3.9.3.

5.4 INSTALLATION

5.4.1 General

1. All precautions shall be taken to protect the pipes and prior to installation all pipes shall be checked for soundness and cleanliness. Any material found to be defective shall be marked and removed from the Site. Pipes, fittings and other accessories shall be stored as recommended by the manufacturer.
2. Proper and suitable tools and appliances for the safe and convenient handling and laying of pipes shall be used and shall comply with manufacturer's recommendations. Should any pipe be discovered to be defective after being laid, it shall be removed and replaced with sound pipe by the Contractor at his expense.
3. Pipes shall be lowered into the trench in such a manner that neither the pipe nor the trench will be damaged or disturbed and so as to prevent earth or debris from falling into the previously prepared pipe bed or gaining entrance to the pipe. Under no circumstances shall pipe materials be dropped or dumped into the trench.
4. Pipes, fittings and other accessories shall be laid to conform with the lines and grades shown on the drawings. Invert levels to be set to a tolerance of plus or minus five (± 5) millimetres.
5. Socket and spigot pipe shall be laid with the socket ends facing the direction of laying.
6. After each pipe is installed the interior of the pipes shall be cleaned of all dirt and superfluous materials. Where cleaning after laying is difficult because of small pipe size, a suitable swab or drag shall be kept and pulled forward past each joint immediately after the jointing has been completed.
7. Trenches shall be kept dry and pipes shall not be laid when the condition of the trench is unsuitable. Under no circumstances shall water be allowed to run through the pipes during construction.
8. Whenever pipe laying is stopped the open ends of pipe and fittings shall be securely and satisfactorily closed with caps so that no water, earth or other substance will enter the pipe or fittings. The pipe shall be secured and protected to prevent displacement of the pipe by any movement of the backfilling. In case water or any foreign material enters the pipe or the pipe is displaced from its position, the Contractor shall clean the pipe and reinstall it at its correct position at his expense.
9. Free distance between the top of one pipe and/ or service and the underside of another shall not be less than 100 mm.

5.4.2 Thrust Blocks for Pressure Pipelines

1. Thrust blocks shall be provided at all bends, caps, tees, valves, etc. Thrust blocks shall be cast between undisturbed ground and the fitting to be anchored/supported. A bituminised membrane with a nominal thickness of 3 mm shall be placed between the pipe fitting and the concrete. The Contractor shall provide the thrust block designs in accordance with the soil conditions.
2. Thrust blocks may be replaced with an anchored joint system with the approval of the Engineer. The anchoring fittings shall be manufactured of carbon steel, hot dip galvanised and protected against corrosion with factory made epoxy coating. Bolts, nuts and washers of hot dip galvanised carbon steel.

5.4.3 Welded Joints in Steel Pipes

This shall be in accordance with the General Mechanical Specification.

5.4.4 Cutting of Pipes

Pipe shall be cut to provide a clean square profile without splitting or fracturing the pipe wall and with minimal damage to any protective coating and lining. Where necessary, the cut ends of pipes shall be formed suitable for the type of joint to be used and protective coatings and linings shall be made good and the ends of the cut sealed.

5.4.5 Chambers

Cast in situ reinforced concrete chambers shall be constructed where shown on Drawings.

5.4.6 Step Irons and Miscellaneous Ironwork

The steps shall be securely installed in perfect alignment, both horizontally and vertically and shall comply with BS 1247, or equivalent.

5.5 TESTING

5.5.1 General

1. The Contractor shall furnish all necessary labour, materials and equipment necessary for carrying out the tests. The Contractor will be responsible for arranging water as necessary for flushing and testing, including any charges levied by the local water utility for water used as well as for all temporary piping, storage and / or transportation of the water.
2. The Contractor shall provide all means and apparatus necessary for introducing the water into the pipelines for flushing and testing including all pumps, gauges, meters, plugs, caps, blow off piping, etc, as well as necessary strutting, thrust blocks etc to prevent pipe movement during the flushing and testing. All pressure pipelines shall be flushed and tested in lengths not exceeding 500 m. The Contractor shall give at least one week's notice of testing of pipelines.
3. The Contractor shall be responsible for ensuring the testing has no adverse affect on the design concrete strength of the thrust blocks.

5.5.2 Testing of Non-Pressure Pipelines

5.5.2.1 General

1. Non-pressure pipelines laid in open trench shall be tested after they are jointed, and before any backfilling is commenced, other than such as may be necessary for structural stability whilst under test.

2. The pipelines shall be tested by means of an air or water test or by visual inspection in lengths determined by the course of construction, in accordance with a programme approved by the Engineer.

3. A further test shall be carried out after the backfilling is complete.

5.5.2.2 Water Test for Non-pressure Pipelines

1. The test pressure for non-pressure pipelines up to and including 800 mm nominal size shall be not less than 1.2 m head of water above the pipe soffit or ground water level, which ever is the higher at the highest point, and not greater than 6 m head at the lowest point of section. Steeply graded pipelines shall be tested in stages in cases where the maximum head, as stated above, would be exceeded if the whole section were tested in one length.

2. The pipeline shall be filled with water and a minimum period of two hours shall be allowed for absorption, after which water shall be added from a measuring vessel at intervals of 5 minutes and the quantity required too maintain the original water level noted. Unless otherwise specified, the length of pipeline shall be accepted if the quantity of water added over a 30 minute period is less than 0.5 litre per lineal metre per metre of nominal size.

5.5.2.3 Air Test for Non-pressure Pipelines

Non-pressure pipelines to be air tested shall have air pumped in by suitable means until a pressure of 100 mm head of water is indicated in a U-tube connected to the system. The pipeline shall be accepted if the air pressure remains above 75 mm head of water after a period of 5 minutes without further pumping, following a period of stabilisation. Failure to pass the air test shall not preclude acceptance of the pipeline if a successful water test, ordered by the Engineer, can be subsequently carried out in accordance with the relevant clause of these Technical Specifications.

5.5.2.4 Infiltration

1. Non-pressure pipelines and manholes shall be tested for infiltration after backfilling. All inlets to the system shall be effectively closed and any residual flow shall be deemed to be infiltration.

2. The pipeline including manholes shall be accepted as satisfactory if the infiltration, including the infiltration into manholes, in 30 minutes does not exceed 0.5 litre per lineal metre per metre of nominal size.

3. Notwithstanding the satisfactory completion of the above test, if there is any discernible flow of water entering the pipeline at a point which can be located either by visual or CCTV inspection, the Contractor shall take such measures as are necessary to stop such infiltration.

5.5.3 Testing of Pressure Pipelines

5.5.3.1 General

1. Pipelines shall be tested after the completion of the pipeline with the exception of any backfilling not necessary for the stability and safety of the work and shall be tested before backfilling over joints and fittings.

2. The section of pipe shall be slowly filled with water and air expelled completely from the pipe and all pipeline fittings to be tested. The specified test pressure, based on the elevation of the lowest point of the section under test, shall be applied by pumping. The Contractor shall arrange for the pressure gauges to be used in the test to be independently checked and a dated certificate of its accuracy shall be provided to the Engineer.

3. The volume of water that must be added is converted into litres/metre/hour and shall not exceed the quantity which is obtained by the formula:

$$Q = (L \times D \times \sqrt{P}) / 71,526$$

where:

Q = allowable leakage in litres/hour

L = length of pipe tested in metres

D = inside diameter of the pipe, in millimetres

Technical Specifications

P = average test pressure during the test, in bar

4. As an example, an allowable leakage in litres per 100 m of pipeline at test pressure 8 bar is as set out in Table 3-5 below.

Table 5-1: Example of allowable leakage

DN (mm)	100	150	200	250	300	400	500	600
	0.39	0.59	0.80	0.99	1.19	1.58	1.97	2.38

5. If defects are found during the tests the Contractor shall immediately make the necessary repairs at his own expense. The Contractor shall then repeat the test until no defects are found and until the test is within the result limits stated above.

6. Irrespective of test results, visual inspection of the pipeline shall be carried out with the Engineer during the test and any defects made good.

5.5.3.2 Plastic Pipes

1. The pipe section shall be subject to an internal pressure corresponding to the nominal working pressure (normally 6 bar). This pressure shall be maintained for 2 hours by adding water as soon as the pressure has dropped 0.2 bar.

2. After the initial 2 hour period the pressure is increased to 1.3 x nominal working pressure and maintained for a further 2 hours by adding water as soon as the pressure has dropped 0.2 bar.

3. After 4 hours the pressure is reduced to the nominal working pressure and the test pump valve closed. After a further 1 hour the quantity of the water is measured that is needed to increase the pressure back up to the nominal working pressure.

5.5.3.3 Iron and Steel Pipes

1. The pipe section shall be subject to an internal pressure corresponding to the nominal working pressure (normally 6 bar). This pressure shall be maintained for 2 hours by adding water as soon as the pressure has dropped 0.2 bar.

2. After the initial 2 hour period the pressure is increased to 1.5 x nominal working pressure and maintained for a further 2 hours by adding water as soon as the pressure has dropped 0.2 bar.

3. The pressure is kept at 9 bar by adding water every 1/2 hour. The amount of water needed to restore the pressure is measure. The test shall be continued for 2 hours.